00	First Issue	19/06/2023	S Murugan	Ucchintala, Ravindra-Kumar	L Saravanan
REV.	**DESCRIPTION**	**DATE**	**DRAWN**	**CHECKED**	**APPROVED**

PROJECT		**TALCHER THERMAL POWER PROJECT STAGE-III (2x660 MW)**
OWNER	एनटीपीसी NTPC	**NTPC LIMITED**
CONTRACTOR	बी एच ई एल BHEL	**BHARAT HEAVY ELECTRICALS LTD Transmission Business Group Noida (U.P.)**
GIS MANUFACTURER	GE	**GE T&D INDIA LIMITED. GAS INSULATED SUBSATION, CHENNAI.**
TITLE	**420kV GIS- DESIGN MEMORANDUM**	
GE DOC. No.	**GD53A000732**	
VENDOR DOC. No.	4540-001-230-PVE-K-001	

SCALE: NTS	PREPARED BY	CHECKED BY	APPROVED BY	REVISION
SH. SIZE: A4	S Murugan	Ucchintala, Ravindra-Kumar	R Senthil Kumar	00

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PURPOSE OF THE DOCUMENT

The purpose of this design memorandum is to define for 400 kV GIS, the following:

- Design philosophy
- System description
- Input parameters for design
- Standard and codes
- Design and selection criteria
- Equipment data
- Material specification
- Major technical features
- Basic arrangement and single line diagram.

1.DESIGN PHILOSOPHY AND SYSTEM DESCRIPTION

1.1 GENERAL CONSIDERATION

1.2 KEY FEATURES OF THE PROPOSED SWITCHGEAR

The proposed type T155 switchgear offered for this project has the following key features:

- Consistent phase-by-phase compartmentalisation
- Good maintenance access to contact unit because of horizontal circuit breaker design
- CB energy consumption held low by self-blast principle.
- Newest-generation spring operating mechanism
- Small overall dimensions
- Light weight thanks to use of aluminium alloys
- Minimal gas losses due to proven seal system
- Easy access to switchgear components

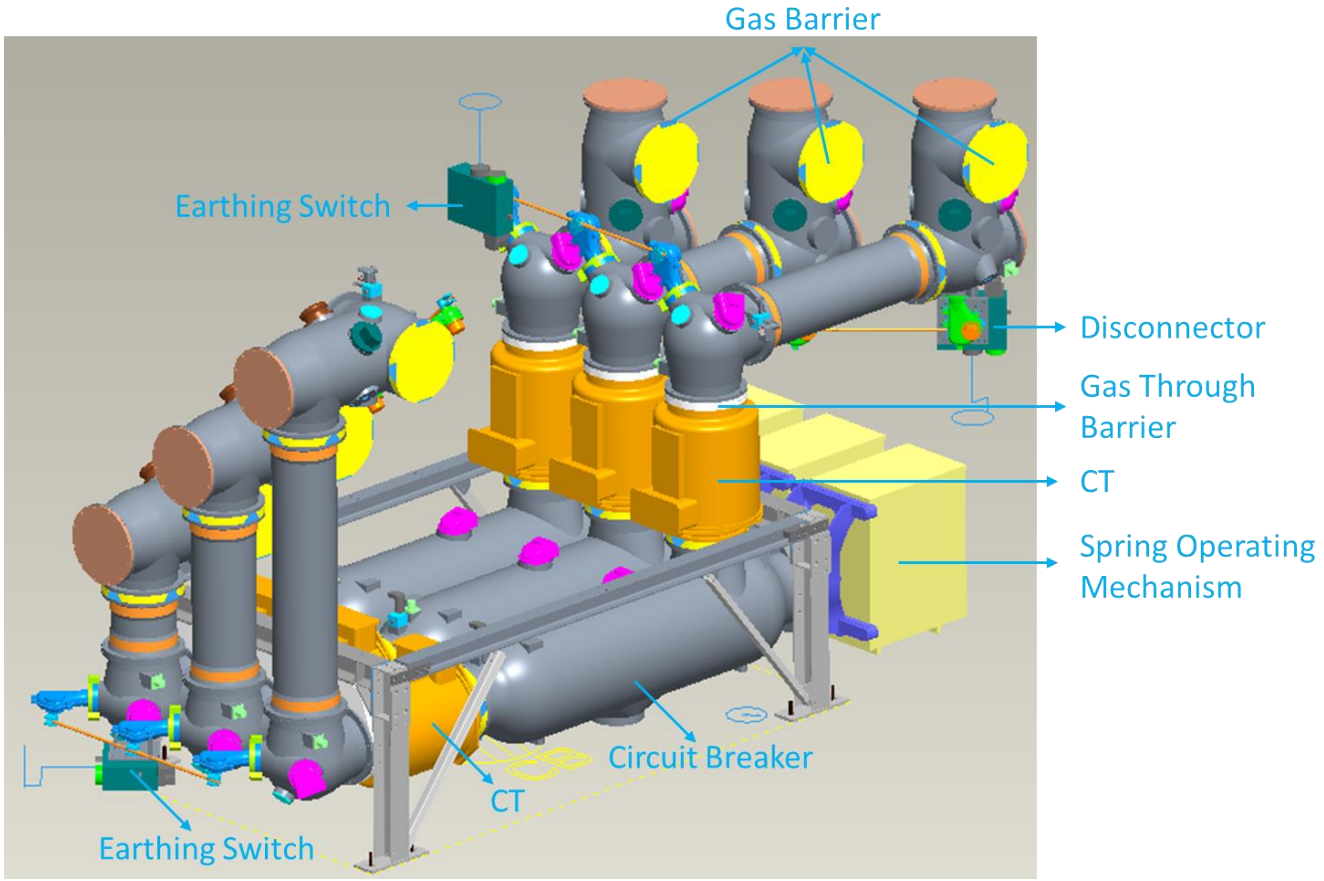
1.2.1 SWITCHGEAR DESIGN CONCEPT

The T155 design is based on GE long experience for the delivery of Gas Insulated Switchgears since 1970. Lightweight aluminium alloy housings enclose each phase separately. The gas compartments of the bay are also separated by insulating partitions for reliable operation. The bus bar has partitions separating the bays as well.

The manufacturing of the switchgear-components is executed in GE-works, or they are bought from approved suppliers. All components have to fulfil the highest quality standards.

The switchgear is usually shipped in separate units. A light-duty overhead crane is adequate for installation and maintenance (a gantry crane may be used under special circumstances). Bay frames allow vertical adjustment and can be attached directly to the building floor with adhesive cemented anchors.

Open interfaces on the components (motor drives, instrument transformers and monitoring elements) and on the local control cubicle make it possible easy to integrate the switchgear into a wide variety of instrumentation and control systems.



1.3 SPECIAL CONSIDERATION

The 420 kV GIS is a single-phase GIS and has 1.5 CB bus bar arrangement.

The GIS will include:

420kV GIS SUBSTATION

* Bus Reactor Bay	:	1 No
* ST Bay	:	2 Nos
* GT Bay	:	2 Nos
* Spare Bay	:	1 No
* Line Bay	:	4 Nos
* Tie Bay	:	5 Nos

Our modular concept includes:

- Fail safe inter and intra bay interlocking scheme.
- Interchange ability of similar parts
- Gas density switch for each isolated section / module

GIS is subdivided into the following separately monitored zones:

- Each SF6/air bushing termination (line / Transformer) with its associated disconnector and high-speed earthing switch
- Each circuit-breaker, including its associated CT's.
- Bus bar with Low-speed Earthing switch,
- Future bay extension module

Each zone (Compartment) is furnished with gas density meter & switches for different gas levels.

The gas insulated bus duct enclosures are the aluminium alloy material.

Windows for viewing physical status of switches.

Position indicator will be supplied for each circuit breaker pole.
Position indicator will be supplied for each disconnector or maintenance / fast acting earthing switch Mechanism.

Earthing circuit will be Aluminium type.

1.4 MAIN RATINGS

Rated voltage	420kV
Rated frequency	50Hz
Power frequency withstands voltage (Ud)	
- Ph to Earth and between phases	650kV
- Across open terminals	815kV
Lightning Impulse withstand voltage (U_p)	
- Ph to Earth and between phases	1425kV
- Between open contacts	1425(+240) kV

Switching Impulse withstand voltage (U_s)	
- Ph to Earth	1050kV
- Between open contacts	900(+345) kV
Rated short-time withstand current, kA (rms)	63 for 1 sec
Rated peak withstand current, kA crest	157.5
Rated normal current, A (rms)	
- Bus bar	3150A
- Bus Reactor Bay	3150A
Rated SF6 gauge pressure at 20°	
-All compartments	6.3bar
SF6 refill level	
- CB	6.0bar
- All compartments (except CB)	5.8bar
SF6 blocking & Zone trip level.	
- CB	5.7bar
SF6 Zone trip level	
- All Compartments (except CB)	5.5bar

1.5 PERFORMANCE CRITERIA AND GUARANTEE

The equipment / components of GIS along with all auxiliaries and accessories can perform intended duties under specified conditions and as per GIS Technical Specification.

1.6 DESIGN AND CONSTRUCTION

All mechanical parts, which are outside of gas filled compartments, are externally accessible and serviceable without disconnecting the main bus bar or feeder circuits.

All current carrying components of the equipment are capable of continuous operation at the specified rated current without exceeding the maximum temperature rises specified in the relevant IEC standards.

1.7 ARRANGEMENT AND ASSEMBLY

The arrangement is single-phase enclosed. The assembly consists of separate pressurized sections designed to minimize the risk of damage to personnel or adjacent sections in the event of a failure occurring within the equipment. Rupture diaphragms are provided to prevent the enclosures from uncontrolled bursting and suitable deflectors provide protection for the operating personnel.

2. INPUT PARAMETERS FOR DESIGN, STANDARDS/CODES, DESIGN AND SELECTION CRITERIA.

2.1 STANDARDS/CODES

All equipment is designed, built, tested, and installed to the latest revisions of applicable IEC standards as listed in the GSLD & GTP.

Enclosures comply with CENELEC code.

Pressure Vessel	CENELEC -EN 50052 & EN 50 064
Cast resin partitions	CENELEC -EN50089

2.2.INPUT PARAMETERS AND DESIGN/SELECTION CRITERIA

- Indoor GIS
- Creepage distance of SF6 / Air bushing – Silicon type : 16060 mm
- Minimum temperature of GIS building : -5 °C
- Maximum temperature of GIS building : +50 °C
- Design temperature of GIS : +50°C
- Relative humidity : 95%
- Seismic withstand : Zone V defined in IS 1893 - 2002
- Colour of GIS will be as follows

RAL 7032 for GIS inside building
RAL 7047 for SF6-Air bushing (Silicone sheds)
RAL 7032 for outside GIS bus ducts

3. EQUIPMENT DATA AND MATERIAL SPECIFICATION.

3.1 SPECIFIC CHARACTERISTICS & DATA

All characteristics and date of equipment for this specific project are described in enclosed GTP.

3.2 GENERAL DESCRIPTION OF SWITCHGEAR

3.2.1 CIRCUIT BREAKER

The circuit breaker uses state-of-the-art self-blast technology for safe, restrict-free arc quenching. As a consequence, the device requires less operating energy, and the spring operating mechanism can be *optimally* integrated. The user benefits from high availability, minimal maintenance, and low dynamic floor loads.

Circuit breakers are easily accessible from the operator aisle for inspection, maintenance, and manual actuation in case of feeder outage. No crane is required for easily pulling out horizontally the breaking element of the circuit breaker enclosure into the operator's aisle for maintenance.

3.2.2 SPRING OPERATING MECHANISM

GE has used spring operating mechanisms since 1934. The circuit breaker features a spring operating mechanism of the latest generation, which forms a unit with the circuit breaker and operates one breaker pole through a linkage. Energy for one open-close-open (O-C-O) cycle is stored in a permanent and loss-free manner in the two integral compression springs. Recovery of the excess closing energy and the tripping brake built into the operating mechanism permit low-shock operation. This generation of operating mechanisms also offers short windup times and good operating-time reproducibility. The operating mechanisms require no maintenance over long intervals with many operating cycles.

3.2.3 DISCONNECTOR

The disconnector elements, with linear-travel contacts, are installed in standardized housings. The three poles are mechanically connected (through a linkage) to the common motor drive mounted on one pole and to the position indicator. The disconnectors reliably handle capacitive currents due to the making and breaking of switchgear components as well as commutation currents due to busbar reconfiguration.

The disconnector's operating mechanism consists of a motor with gearbox and the mechanically coupled auxiliary control and alarm switches. Emergency manual operation by hand crank and mechanical interlocking are standard. The three modes –motor operation, emergency manual

operation, and mechanical interlocking – each mechanically locks the others out.

3.2.4 EARTHING SWITCH

Make-proof or maintenance earthing components can be mounted anywhere on the switchgear. The three-pole operating mechanism of the maintenance earthing switch is the same standard motor unit as used for the disconnector. For make-proof earthing switches, the drives are equipped with springs for rapid making. These switches can thus handle not only making on short circuit but also induced currents under severe conditions (IEC 62271-102 Class B). Emergency manual operation by hand crank and mechanical interlocking are standard. The three modes – motor operation, emergency manual operation, and mechanical interlocking – each mechanically lock the others out.

An available option for control measurements in the primary circuit is to have earthing switches that can be isolated from the switchgear earth. Simple and reliable links shunt the insulation and serve as earthing connection in normal service.

3.2.5 CURRENT TRANSFORMER

The HV conductor serves as the primary winding of the inductive current transformer. The secondary windings are arranged on toroidal cores outside the gas compartment. The length of the current transformer depends on the number and size of the cores due to the purchaser's specification. The secondary windings are connected to terminals in the terminal box of the current transformer.

Transient over voltages transmitted by current transformers to control, protective and instrument circuits meet and within the latest IEC requirements for electromagnetic compatibility (EMC).

3.2.6 COMPOSITE SF6/AIR BUSHING

The SF6 air bushing consists of a Silicon type insulator and is pressurised with SF6 gas. The conductor is supported by the insulator cone at the switchgear end and the high-voltage electrode at the air end.

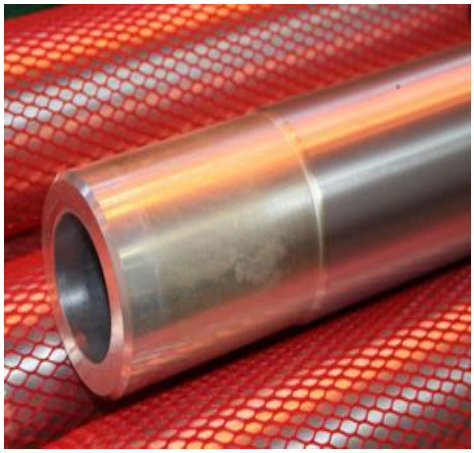
The shed form and Creepage path length are adapted to the purchaser's requirements and service conditions.

3.2.7 CONNECTING ELEMENTS

All switchgear components have standard flanges and standard plug contacts. Conductors and electrodes are supported in their housings by insulating cones wherever necessary.

Tubular bus and telescoping elements are used for connecting one part of the switchgear to another. Telescoping elements are employed wherever extension

requirements make it necessary to separate the switchgear in a simple way and without dismantling other elements.



3.2.8 ENCLOSURES AND CONDUCTORS

The enclosures are of cast construction, with the exception of the bus duct which is made from welded tubes. The aluminium alloys have been chosen for their excellent withstand to corrosion, whatever the atmosphere (salt spray, industrial pollution, etc.).
Outside surfaces are painted to enhance appearance and the inside surfaces are left bare. Enclosure design complies, in particular, with the European CENELEC code for gas-filled switchgear enclosures.
All connecting conductors are made of aluminium tubes, silvered at the ends, and fitted into silvered contacts. These contacts are of the sliding type to allow for expansion without transmitting mechanical stresses to the supporting insulators.

3.2.9 GAS COMPARTMENT

Each SF_6 switchgear is subdivided into several independent gas compartments separated by bulkhead-type insulator cones. The gas compartments for the three phases are also completely separated from each other and they are monitored individually.

Every gas compartment consists of:

- Its own gas supply with quick-disconnect coupling. An integral filter keeps dust and contaminants from getting into the compartment. The gas supply is designed to permit the connection of all instruments and maintenance equipment.
- A pressure-relief device to guard against excessive overpressure.
- An absorber to take up residual moisture and degradation products.
- A density switch.
- The standard density switch is a purely mechanical device functioning as a temperature-compensated pressure monitor. A two/ three-level alarm is actuated if the gas density drops.

3.2.10 GAS BARRIERS



All conductors and live parts are mounted on molded epoxy-resin insulators. Top quality manufacturing and rigorous inspection guarantee excellent dielectric withstand. Alumina mixed with the resin creates excellent mechanical strength at any operating temperature and prevents any chemical attack from SF6 decomposition products.

The insulators, which are also sized in compliance with the European CENELEC code, are positioned in such a way as to minimize the consequences of a leak or of dismantling. They also resist internal arcing and prevent its propagation to the next compartment.

3.2.11 PRESSURE RELIEF DEVICE



Automatic pressure relief devices are incorporated in the basic design as a precaution against bursting of enclosure.

Pressure relief device consist of a bursting disc system with a preset opening pressure.

Deflection devices are installed and oriented to ensure that personnel will not be endangered.

3.2.12 SF6 GAS

Our supply includes the SF_6 gas required for first filling is furnished with the switchgear, along with connecting hose and fittings. Containers belonging to GE will be used for gas delivery. After delivery the container will be sent back to GE premises.

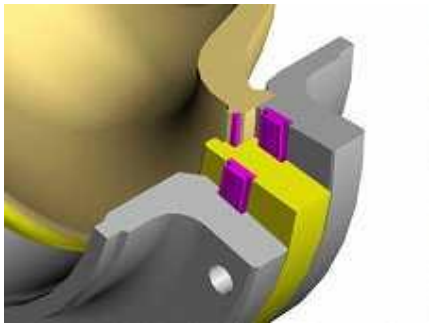
SF_6 gas to be filled in GIS shall confirm to latest IEC60376, however following parameters shall be here under

Requirement for technical grade SF6

Air	≤ 0.05%
CF_4	≤ 0.05%
Moisture	15 ppm
Hydrolysable fluorides expressed as HF	1.0 ppm

3.2.13 GAS SEALING

Sealing between flanges is ensured by a synthetic elastomeric gasket, of a specially designed cross-section providing three concentric seals. The two internal seals are thus perfectly protected from the external environment. Excellent long-term gas tightness is achieved, which has been confirmed by experience in operation.



3.2.14 SUPPORT STRUCTURES

Steel structures and supports are normally hot dip galvanized and remain not painted.

3.2.15 EMC

Field strengths in the switchgear room are held down to a level unobjectionable for human beings and equipment by the fully bonded metal enclosure of the SF6 switchgear and the interconnected earthing system.

Transient voltage surges imposed on control and instrument circuits are minimised by design practices and remain below the levels called for by the most recent IEC requirements. Particularly current and voltage transformers are constructed so that no excessive high peak voltages will be transmitted to the local control system.

3.2.16 EARTHING

Every bay is earthed to the substation earthing system by links according to the possible short circuit current. Recommendations for the earthing system will be given by GE. The switchgear earthing grid itself is part of the civil works and therefore not in our scope of supply.

3.2.17 PAINTING

Main enclosures only are painted. Accessories and small part remain unpainted. Aluminium cast enclosures as well as welded aluminium tubes are normally coated by the following method:

Internal code:	P1
Number of layers:	1
Layer thickness:	70 µm minimum
Protective coating method:	surfaces preparation and 2 component epoxy siloxane paint
Composition:	Siloxane – epoxy

3.2.18 LOCAL CONTROL

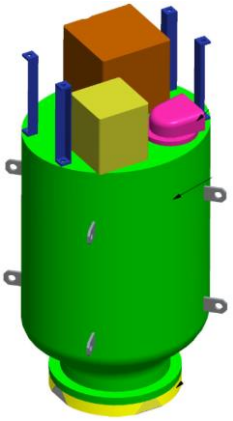
The entire switchgear bay module is supplied with a local control cubicle of the floor standing type. The cubicle has full height, hinged, gasket lockable double doors. One door has safety glass window through which various controls can be viewed without opening the door. The cubicle is utilized as both the switchgear bay local control module and as the terminating centre for all power supply, control, annunciation, and supervisory wiring interfacing with the system. Adequate number of potential free contact is made available for providing necessary input/output interface.

The local control cubicle contains all the equipment required for controlling and monitoring the bay. Each bay's local control cubicle has the following main function:

- The mimic diagram with control switches for electrically operated circuit-breakers, disconnector, and earthing switches as well as the position indication of all components provided with auxiliary switches.
- Alarm facia with indicating lamps for monitoring of gas density.

- Trip circuit healthiness.
- Electrical interlocking between devices.
- Position padlocking of Disconnector and earthing switches.
- Local / remote padlocking.
- Interface between central control and the switchgear.
- Interior lighting, safety shrouding, heating to prevent condensation, single phase socket.

3.2.19 VOLTAGE TRANSFORMER



The inductive voltage transformer is built as an iron-core Transformer consisting of the customized secondary winding Surrounded with the primary winding. The primary winding Is film-insulated and has a shield electrode on the High-voltage side. The active part is located in a separate Housing and always constitutes a separate gas compartment.

Transient over voltages transmitted by voltage transformers To control, protective and instrument circuits meet and exceed The lates IEC requirements for electromagnetic compatibility (EMC)

4. QUALITY ASSURANCE & QUALITY CONTROL IN FACTORY

4.1 QUALITY ASSURANCE

The High Voltage GIS Department of GE applies a Quality-Assurance Programme which complies with the requirements of the standard EN 29 001, ISO 9001 and ISO 14001.

4.2 QUALITY CONTROL

Within the scope of the Quality Assurance Programme, inspection plans are systematically implemented by the Control Department for all the equipment manufactured by GE, whether an inspection by the customer (or its representative) takes place or not.

4.3 ROUTINE AND WITNESS TEST

Every functional unit is routine tested by the manufacturer at the manufacturer's works according to international (IEC), national and GE requirements. Each transport unit is also routine tested. This includes gas tightness tests of all gas compartments, mechanical and dielectric tests of all components.

Witness tests according to the agreement with the customer are carried out at the works of the functional unit manufacturer and need about 2 days. The test will be carried out as per MQP.

5. SHIPPING, INSTALLATION AND COMMISSIONING

5.1 SHIPPING

The shipping bays will be shipped as it is after routine tests and small shipping components will be shipped as it is after routine test and same will be assembled at site along with respective bays.

5.2 SITE CONDITION

Erection can begin only when satisfactory cleanliness conditions are fulfilled i.e. dust-free switchgear room with closable windows and doors in place, civil works completed. These conditions are the subject of a site-acceptance report.

5.3 INSTALLATION

Depending on access and unloading capabilities at the installation site, we rely on the purchaser to furnish appropriate lifting equipment (e.g., pneumatic crane, forklift). The bay frames are attached directly to the floor with pasted anchors and can be adjusted in height, so that there is no need to install costly floor framing. The adjustable frames can compensate for any irregularities in the floor up to about ±2 cm.

For efficient installation, we recommend mounting an electric crane in the switchgear room. The crane should have a lifting capacity of 5T, and the hook height should be the height of the switchgear plus 500 mm.

5.4 FINAL TESTING AT SITE

The switchgear is carefully tested after installation is complete. The following tests are performed, among others:

- Check to verify that the installed switchgear complies with the purchaser’s order
- Functional testing of all apparatus; inspection of electric wiring and interlocks
- Gas leak testing; measurement of gas humidity
- Dielectric test; measurement of contact resistances

5.5 COMMISSIONING AND ACCEPTANCE OF SWITCHGEAR

Once ready for service, the switchgear is delivered as agreed between purchaser and vendor. After the test report has been submitted, the legal signature of the delivery report marks the delivery of the switchgear to the purchaser and purchaser’s assumption of responsibility for its operation.

6.MAINTENANCE

SF6 gas-insulated switchgear is designed for long maintenance intervals. Under normal service and ambient conditions, only switching elements and moving parts of the switchgear need regular servicing. What operations are required will depend on the time in service, the number of mechanical switching cycles, and the number of times making on short-circuit currents.

फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION

सभी माप मि.मी. में है/ALL DIMENSIONS ARE IN MM

Scale:	1:40	540000	Unit: mm	Format: A0	D. Authority: CHT	NTPC_THALCHAR 400kV_T155-3
EC Nbr:	----			Q Level: ++	Local Unit: CHT	CIVIL WORK DRAWING
Created:	Vigneshraj V				29/02/2024	GD378
Reviewed:	---				---	
Approved:	RAMU NATARAJAN				29/02/2024	//
T&D INDIA LTD				Sheet:	1/15	GD53A000725 Rev. 00
				Product type:	T155-3	

Recommendations for basement

STICKER REVISION v0

Cable trays under basement are out of GIS manufacturer scope of supply

Travelling crane

STICKER REVISION 0

a) For the minimum requirements regarding the travelling crane for GIS erection and maintenance purposes, as maximum load to be lifted, the minimun height of the lifting hook in upper position, and the minimum travels (lengthways and to the sides), please refer to layout drawing No: GD53A000704

Floor & walls treatment recommendation

STICKER REVISION v0

a) Finishes schedule of wall and floor of GIS room:
All surfaces must be dustless,
- Wall : surface smooth, clean and washable
- Floor : surface smooth, clean and dust free

b) Out of GIS manufacturer scope of supply

Minimum Concrete Compression Strength

STICKER REVISION v0

fck28 = 30 MPa

a) Valid for (Indoor) building primary concrete slabs AND (Outdoor) concrete foundation blocks

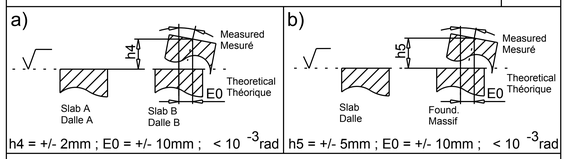
Recommendations for customer-provided earthing

STICKER REVISION v0

a) Refer to document No: GD53A460054

CW movements AFTER GIS erection (h4, h5, , , E0)

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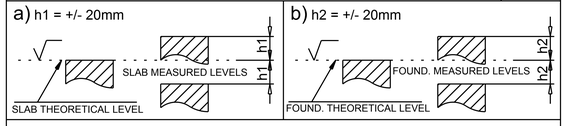
a) h4 = +/- 2mm ; E0 = +/- 10mm ; $< 10^{-3}$ rad

b) h5 = +/- 5mm ; E0 = +/- 10mm ; $< 10^{-3}$ rad

a) Maximum relative movement of two GIS slabs at expansion joint (if applicable)
b) Maximum relative movement of GIS slab and outdoor foundations (further to settling effect) (if applicable)

h1 & h2 CW altitude differences (theoretical vs actual)

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a) The difference (h1) between the actual level and the theoretical level of the GIS slab must not exceed +/- 20mm
b) The difference (h2) between the actual level and the theoretical level of the outdoor foundations must not exceed +/- 20mm

$O_{x.y}$: GIS reference pin

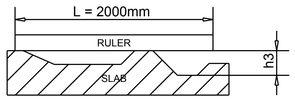
STICKER REVISION v0



a) Out of GIS manufacturer scope of supply.
b) This GIS reference pin has to be indicated ($O_{1.1}$, $O_{1.2}$, ...) and sized on Civil Work realization drawings.
c) GIS reference pin has to be set in concrete and shall be accessible and visible during the complete lifetime of the substation.
d) This GIS reference pin is used to define the main X & Y GIS horizontal axis (indoor and outdoor).

$h3_{slab}$: Flatness Tolerance for GIS slab

STICKER REVISION v0

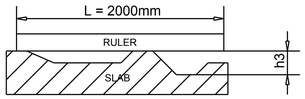


With $h3_{slab}$ < 5 mm

a) Flatness tolerance of GIS slab must not exceed 5mm under a 2000mm ruler.

$h3_{found}$: Flatness Tolerance for GIS Outdoor foundations

STICKER REVISION v0



With $h3_{found}$ < 5 mm

a) Flatness tolerance of outdoor foundation blocks must not exceed 5mm under a 2000mm ruler.
b) Concrete foundation block top heads must be finished "smooth and neat"

SURFACE FINISH(INSIDE BUILDING)

STICKER REVISION v0

INSIDE BUILDING SURFACE FINISH:-
Epoxy Coating Recommended by GE

General tolerance

STICKER REVISION v0

a) Unless specified, all dimensions are in millimeters.
b) Unless specified, general tolerance is +/- 10 mm.

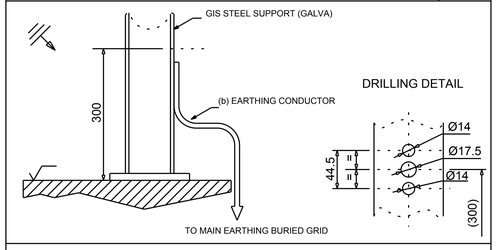
GIS Slab expansion joint

STICKER REVISION v0

a) Introduction of additionnal expansion joint or modification in location compared with this one recommended in this document : shall be submitted to approval of GIS manufacturer

Earthing connection of GIS supports (Equipotential)

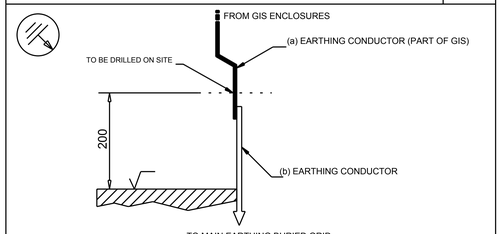
STICKER REVISION v0



a) Earthing connection of GIS supports for equipotential
b) Earthing connection to earthing grid : Out of GIS manufacturer scope of supply

Earthing connection of GIS enclosures (Icc)

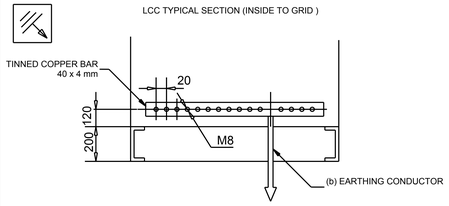
STICKER REVISION v0



a) Earthing connection of GIS enclosures with short-circuit carrying capability
Earthing conductor (part of GIS)
Material: Aluminium
Section: 100 x 10 mm
b) Earthing connection to earthing grid : Out of GIS manufacturer scope of supply

Earthing connection of Local Control Cubicle (LCC)

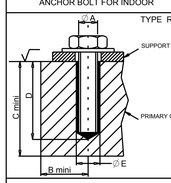
STICKER REVISION v0



a) Earthing connection of Local Control Cubicle
b) Earthing connection to earthing grid : Out of GIS manufacturer scope of supply

Chemical socket inserts for slab WITHOUT finished concrete layer

ANCHOR BOLT FOR INDOOR



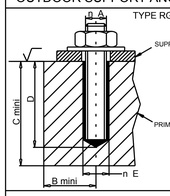
ØA	B	C	D	ØE	Couple N.m
M12	75	165	125	20	40
M16	95	205	160	24	80
M20	125	260	200	32	120

SIZES ARE INDICATED IN MILLIMETER

a) Primary concrete with minimum concrete compression strength at 25 MPa
b) To avoid reinforcement irun cut during slab drilling stage for chemical studs installation, chemical socket location has to be clearly shown (on top view) on civil work concrete reinforcement drawings.
c) Holes drilling will be done at site by GE during erection.

Chemical studs in foundation blocks

OUTDOOR SUPPORT ANCHORING



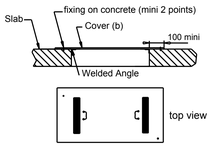
n A	B	C	D	n E	Couple N.m
M20	180	220	170	25	120
M24	210	266	210	28	150

SIZES ARE INDICATED IN MILLIMETER

a) Primary concrete with minimum concrete compression strength at 25 MPa
(No finished concrete layer on foundation blocks)

Obstruction of GIS slab holes

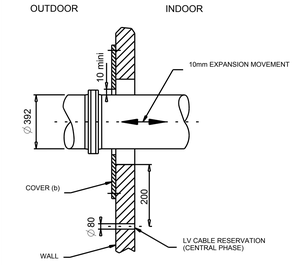
STICKER REVISION v0



For holes in GIS slab for which depth is over 1.20 m :
a) GE recommends obstructing these holes with a metallic cover leveled with slab, and rigidly fixed on the slab with screws.An example sheme is given hereafter.
b) This mettalic cover must be designed to support a total mass of 1000 kg. This maximal weight must appear on the cover
c) Its fixation screws must be at minimum distance of 100 mm from all GIS fixation holes defined in this document.
d) Out of GIS manufacturer scope of supply

GIB wall crossing

STICKER REVISION v0



a) No electrical contact between BUSDUCT and COVER
b) COVER : Out of GIS manufacturer scope of supply-EPC/ Civil contractor.

SUMMARY

PAGE	DESCRIPTION
1	- Civil works tolerances - Concrete qualities - Reference pins - Connection to the earthing circuit - Limits of supply
2	- Loads array - Circuit-breaker dynamic loads
3 - 4	- Indoor support structure and cat walk pedestal marking details
5 - 7	- Outdoor support structure pedestal marking details
8	- CB marking & LCC details
9 - 11	- Indoor Pedestal Details - Outdoor Pedestal Details - Catwalk Pedestal Details
12	Overall view
13	ELEVATION
14	WALL CUTOUT DETAILS
15	3D VIEW

VENDOR NAME	GE T&D INDIA LTD. 142, Vandalur-Walajabad Road Padappai, Chennai 601301 Tamilnadu, India
ग्राहक ड्राइंग संख्या CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003
ग्राहक CUSTOMER	एन टी पी सी लिमिटेड N T P C LIMITED
परियोजना PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW)
भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ.प्र.) /NOIDA (U.P.)	DEPT. CODE M; तैयारकर्ता/DRN LJ; रेखांकनकर्ता/DSN RN; जाँचकर्ता/CHD MS; अनुमोदनकर्ता/APPD SR
शीर्षक/ TITLE	CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION
विभाग DEPT. -- स्केल SCALE -- ड्राइंग संख्या / DRAWING NO.	GD53A000725
रेखांकन DRN. ईश्वर CHD. दिनांक DATE	शीट SHEET 1 OF 15 पुनरीक्षण REV. 00

REV.	DESCRIPTION	DRAWN	REVIEW	ELE	CIVIL	MECH	APPROVED	DATE
REV0	FIRST SUBMITTION	KADAKSH 28.02.24	RAMU 29.02.24				MURUGAN 29.02.2024	
REV1								
REV2								
REV3								
REV4								
REV5								
REV6								

REFR. DRG. NO. | DESCRIPTION

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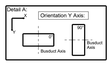
D:\A_PJT\GD\GD378_BHEL_NTPC_THALCHAR_400kV_T155-3\GD53A000725_Layout.fm

फॉर्मेट साइज A0
FORMAT SIZE A0

फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि॰ मी॰ में हैं/ALL DIMENSIONS ARE IN MM
GD53A000725 /DRAWING NO.
शीर्षक देखिए/SEE TITLE
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Scale: 1:10	Unit: mm	Format: A0	D. Authority: CHT	NTPC_THALCHAR 400kV_T155-3	
EC Nbr: -----	Q Level: --		Local Unit: CHT	CIVIL WORK DRAWING	
Created: Vigneshraj V			29/02/2024	GD378	
Reviewed: ---			---		
Approved: RAMU NATARAJAN			29/02/2024	//	
T&D INDIA LTD			Sheet: 2/15	GD53A000725	Rev. 00
			Product type: T155-3		

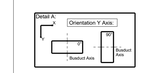
LOAD TABLE - FFL SUPPORT STRUCTURES





DETAIL NAME	FOUNDATION NAME	ORIENTATION Y AXIS (DETAIL A)	DEAD LOAD						Wind pressure loads in X direction on equipment wind speed = 50 m/s						Wind pressure loads in Y direction on equipment normal wind speed =50 m/s						Thermal loads Indoor Tmin = 0 C Outdoor Tmin = 0 C Indoor Tmax = 50 C Outdoor Tmax = 50 C						Short circuit loads Ik = 50kA						Seismic Loads ZONE - III Seismic acceleration According to 1893 - 2002																	
																															following X direction						following Y direction						following Z direction					
			Fx (kN)	Fy (kN)	Fz (kN)	Mx (kN.m)	My (kN.m)	Mz (kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)
GD53S72Z001	CB	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	2	0	5	1.8	0	-	-	-	-	-	-	5	0	0	0	10	0	0	24	0	48	0	0	0	0	12	0	0	0
GD53A721329	VI-03B	-	-	-	-4.8	1.4	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	0.8	1.7	-	-	-	-	-	-	-	-	0.2	0.3	2.1	0.7	0.6	-	-	0.3	3.4	0.6	-	-	-	0.2	0.8	0.3	-	-
GD53A721291	PFI-02	-	0	0	0	0.33	0.33	0	0	0.44	0.11	0.66	-	-	-	0.33	0.88	0.77	0.11	-	2.09	0.92	1.15	0.51	2.42	-	-	-	-	-	-	-	0.11	0.22	0.99	0.44	0.22	-	0.22	0.77	1.76	0.62	0.33	-	-	0.11	0.33	0.11	0.11	-
GD53A720604	PPI-01	-	0.59	0	12.72	0	0.44	0	-0.62	0	-3.03	0	-0.53	0	-0.12	0	0.95	0	-0.1	0	3.73	0	0.01	-0.01	-3.26	0	0	0	0.02	0	0	0	0.01	0	0.03	0	0	0	0	0	0.02	0	0	0	0	0.03	0	0	0
GD53A721233	SI-03	-	0.29	-0.08	6.66	-0.12	-0.08	0	0.01	0	-0.01	0	0	0	-0.02	0.01	0.02	0.01	0	0	39.59	2.52	-49.8	3.1	-10.1	-0.04	0	0	0	0	0	0	2.9	3	3.17	3.66	0.41	0	1.06	2.46	1.21	2.96	0.15	0.01	0.33	0.37	3.36	0.45	0.05	0
GD53A721331 GD53A721332 GD53A721333 GD53A721334	VI-03A VI-03C VI-03D VI-05A	-	-0.43	6.2	0	0.01	0	0.65	0.53	6.47	0	0.01	0	-0.87	-0.44	6.4	0	0.01	0	0.67	-0.28	-7.23	0	0.01	0	-0.34	-0.43	6.24	0	0.01	0	0.65	0.05	0.33	0.04	0.11	0	0.09	0	0	0	0	0	0	0.02	0.42	0.46	1.8	0	0.04
GD53A720534 GD53A720535 GD53A720536	PFI-02A PFI-02B PFI-02C	-	-0.4	6.01	1.87	1.99	0	0.51	-0.07	4.84	0.12	0.17	0	-0.08	-0.13	4.84	0.12	0.17	0	0.11	-4.52	4.32	2.2	2.35	0	4.55	-0.13	4.85	0.12	0.17	0	0.11	0.01	0	0	0	0	0	0	6.49	3.83	4.05	3.25	0	0	0	0	1.79	0
GD53A721288	VI-01	-	1.8	7.39	0.001	-0.037	-0.001	-0.374	1.2	0	0.5	0	3.2	0	0.002	0	0.5	0	0.004	0	0.312	-0.881	-0.001	-0.065	-0.001	-0.724	0	0	0	0	0	0	1.531	2.325	0.18	0.304	0.001	2.263	0.257	0.665	0.124	0.209	0	0.232	1.393	2.314	0.135	0.227	0.001	1.977
GD53A721254	VI-04	-	-0.088	10.281	0.037	0.04	0.004	-0.22	1	0	1.1	0	5.2	0	0.1	0	1.3	0	0.2	0	-0.027	-3.353	-0.384	-0.468	0.002	0.163	0	0	0	0	0	0	0.097	1.204	0.103	0.124	0.004	0.185	0.148	0.386	0.016	0.019	0.006	0.213	0.108	2.236	0.271	0.328	0.005	0.309

LOAD TABLE - FGL SUPPORT STRUCTURES





DETAIL NAME	FOUNDATION NAME	ORIENTATION Y AXIS (DETAIL A)	DEAD LOAD						Wind pressure loads in X direction on equipment normal wind speed = 50 m/s						Wind pressure loads in Y direction on equipment normal wind speed = 50 m/s						Thermal loads Indoor Tmin = 0 C Outdoor Tmin = 0 C Indoor Tmax = 50 C Outdoor Tmax = 50 C						Short circuit loads Ik = 50kA						Seismic Loads ZONE - III Seismic acceleration According to 1893 - 2002																	
																															following X direction						following Y direction						following Z direction					
			Fx (kN)	Fy (kN)	Fz (kN)	Mx (kN.m)	My (kN.m)	Mz (kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)
GD53A721292 GD53A721344 GD53A721345	PFE-01A PFE-01B PFE-01C	-	-	-	-0.24	0.17	-0.06	-	-9.30	-0.95	1.30	0.59	-2.12	-0.15	-0.40	-4.53	2.70	1.04	-0.25	-0.15	1.93	1.91	0.96	-1.08	-3.36	11.90	-	-	-	0.10	0.20	-	7.00	2.20	0.50	13.50	45.50	4.80	2.30	6.70	0.50	41.80	15.00	2.30	0.30	0.20	1.20	1.20	1.80	0.50
GD53A721384 GD53A721385 GD53A721347	FE-01A VE-02 PFE-01	-	-	-	-19.90	0.40	0.40	-	3.20	-	0.70	0.10	5.20	-	0.50	-	0.40	-	0.80	-	3.10	-	1.10	-	0.20	5.00	-	-	-	-	-	-	-	1.40	-	0.40	0.10	2.20	-	0.60	-	0.30	0.10	1.00	-	0.10	0.40	0.10	0.10	-
GD53A721336 GD53A721346 GD53A721342	VE-03A VE-03B VE-03C	-	0.185	0.359	5.814	-0.017	-0.021	0.003	-1.641	0.04	-8.737	0.077	0.246	0.014	0.665	-10.19	38.741	-1.14	0.348	-0.125	-0.241	-5.25	13.558	-0.498	0.221	0.063	0.007	-0.028	0.199	-0.003	-0.001	0	1.553	3.211	17.378	0.793	0.554	0.056	2.545	8.75	30.36	2.201	0.999	0.156	0.703	0.566	7.511	0.145	0.245	0.011
GD53A721337 GD53A721341	VE-01A VE-01B	-	0.006	-0.02	6.004	-0.043	-0.028	0	-1.772	0.012	0.392	0.033	3.667	0.001	0.017	-1.872	4.154	-3.835	0.04	0	-0.038	-1.009	-4.018	-2.65	0.082	-0.002	-0.002	0.004	-0.083	0.013	0.002	0	1.665	1.003	4.173	2.665	4.565	0.004	0.253	2.071	8.396	3.433	0.605	0.005	0.216	0.186	2.045	0.463	0.363	0.001
GD53A721340	TA-01B	-	-0.092	-0.091	5.247	-0.029	0.025	0.001	-3.799	0.342	16.019	-0.117	0.167	-0.059	-1.1	-6.019	26.226	-1.54	0.398	-0.095	3.326	-2.453	-14.104	-0.72	-0.893	-0.064	-0.4897	-0.0343	4.0714	-0.0217	-0.125	-0.0076	7.188	5.938	42.09	1.482	1.806	0.116	4.776	8.453	52.205	2.177	1.237	0.131	0.261	0.307	1.981	0.079	0.067	0.005
GD53A721338	TA-01A	-	-	-	3.61	0.03	-0.01	-	-6.88	2.3	3.3	0.43	1.32	-0.15	0.6	0.33	3.1	0.13	3.3	2.8	1.93	1.91	0.96	1.08	-1.08	-0.7	0.2	0.4	0.1	5.5	2.1	0.4	3.4	4.5	0.6	31.5	21.4	2.6	1.8	2.4	0.4	6.6	1.5	1.2	0.2	0.2	0.4	0.5	1.1	0.1

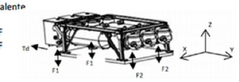
T155-CB3 : Circuit breaker dynamic loads - Frame HEB140 (3 phases)
T155-CB3 : Charges dynamiques du disjoncteur - Charpente HEB140 (3 phases)

		Case 1	Case 2
F1, F2 (kN)	Vertical load F1 (kN)	+ 44	- 44
	Vertical load F2 (kN)	- 9	+ 9
Td (kN)	Horizontal load (Y direction)	± 12	± 12

F1 and F2 are for one foot

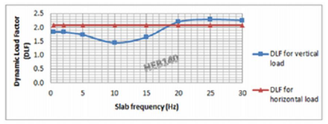
Static equivalent load
Charge statique équivalente

Fs1 = F1 x DLF
Fs2 = F2 x DLF
Ts = Td x DLF



It must be added to the dead load of the CB for combination of loads
(refer to ... in "Static loads" table").

Elle doit être ajoutée à la charge de poids propre du CB pour combinaison de charges
(voir ... dans le tableau "Charges statiques").



Nota: a safety factor of 1.3 is already applied on DLF curve for taking into account measuring divergences

NOTE:
Load table parameters :
1.) Min. Temperature '-20' deg C, Max Temperature +50 deg C
2.) Seismic Zone = Zone - III

VENDOR NAME	GE T&D INDIA LTD. 142, Vandalur-Walajabad Road Padappai, Chennai 601301 Tamilnadu, India
ग्राहक ड्राइंग संख्या CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003
NTPC ग्राहक / CUSTOMER	एन टी पी सी लिमिटेड N T P C LIMITED
परियोजना PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW)
भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ॰प्र॰) / NOIDA (U.P.)	DEPT CODE: M जाँचकर्ता / CHD: MS अनुमोदनकर्ता / APPD: SR
शीर्षक / TITLE	CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION
ड्राइंग संख्या / DRAWING NO.	GD53A000725
शीट / SHEET	2 OF 15
पुनरीक्षण / REV.	00

फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि॰ मी॰ में हैं/ALL DIMENSIONS ARE IN MM
GD53A000725 ON SHEET/ड्रॉइंग नंबर

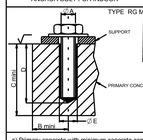
INDOOR CB MARKING DIMENSION, SUPPORT STRUCTURE AND CAT WALK PEDESTAL DETAILS

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EC Nbr: -----		Q Level: --	Local Unit: CHT	CIVIL WORK DRAWING
Created: Vigneshraj V			29/02/2024	GD378
Reviewed: ---			---	
Approved: RAMU NATARAJAN			29/02/2024	//
T&D INDIA LTD		Sheet: 3/15	Product type: T155-3	GD53A000725 Rev. 00

Chemical socket inserts for slab WITHOUT finished concrete layer

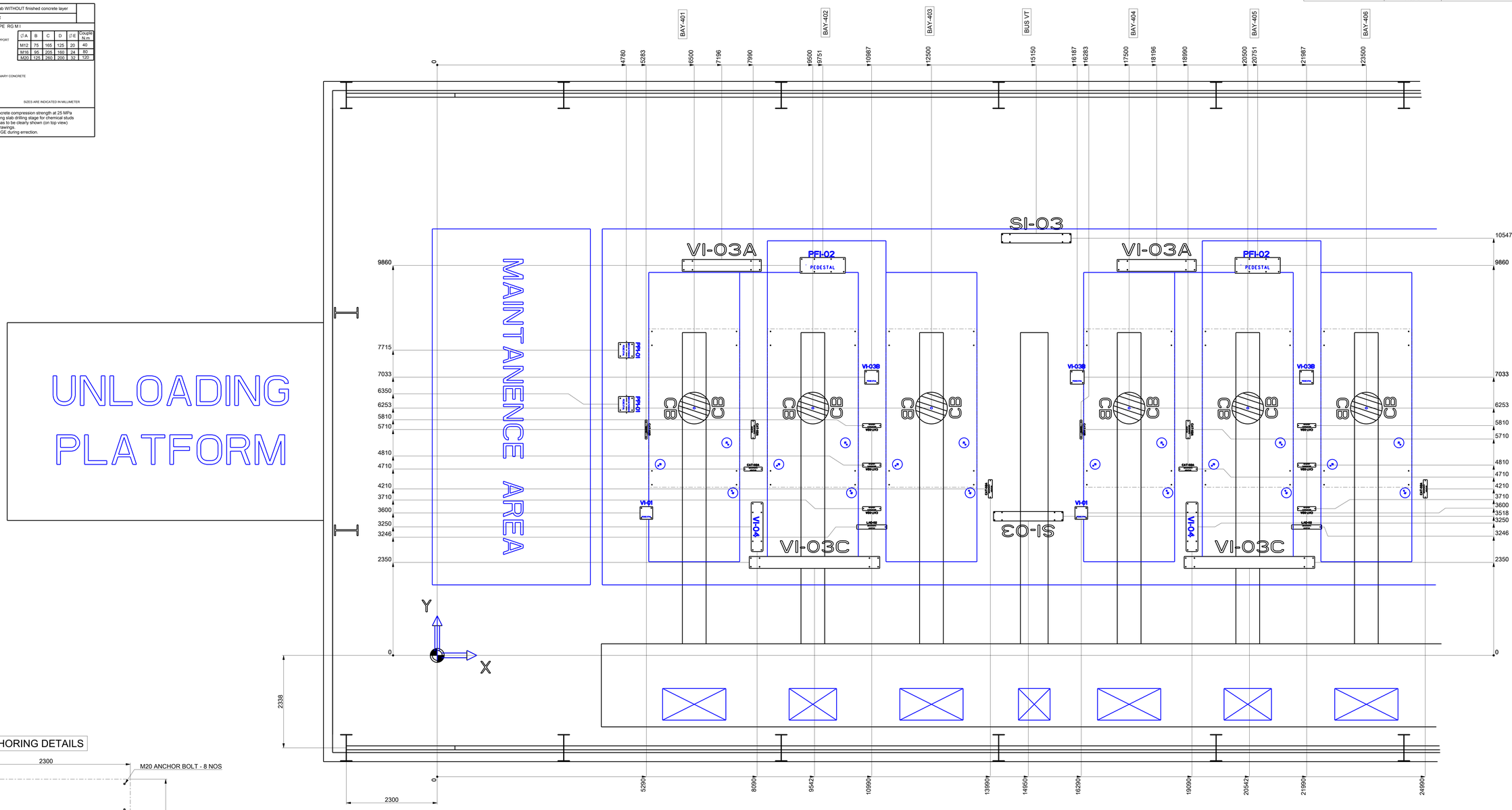
ANCHOR BOLT FOR INDOOR

TYPE RG M I

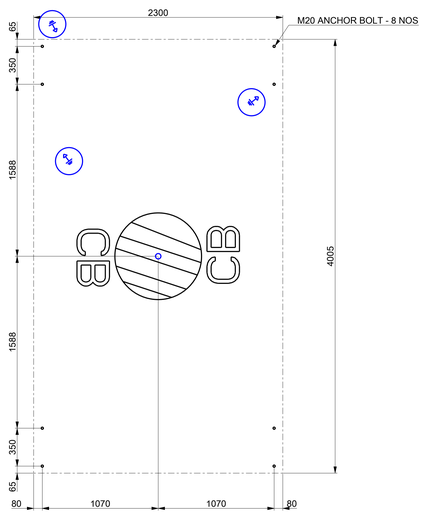


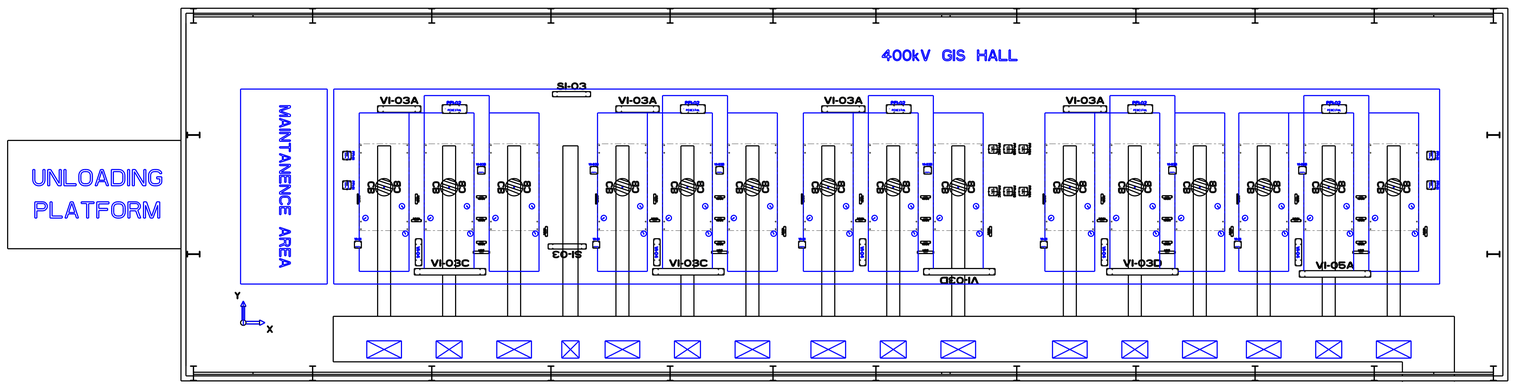
ØA	B	C	D	ØE	Couple N.m
M12	75	165	125	20	40
M16	95	205	160	24	80
M20	125	260	200	32	120

a) Primary concrete with minimum concrete compression strength at 25 MPa
b) To avoid reinforcement irun cut during slab drilling stage for chemical studs installation, chemical socket location has to be clearly shown (on top view) on civil work concrete reinforcement drawings.
c) Holes drilling will be done at site by GE during erection.



CB ANCHORING DETAILS





VENDOR NAME	GE T&D INDIA LTD. 142, Vandalur-Walajabad Road Padappai, Chennai 601301 Tamilnadu, India
ग्राहक ड्राइंग संख्या / CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003
ग्राहक / CUSTOMER	एन टी पी सी लिमिटेड N T P C LIMITED
परियोजना / PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW
	भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ॰प्र॰) / NOIDA (U.P.)
शीर्षक / TITLE	CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION
ड्राइंग संख्या / DRAWING NO.	GD53A000725
शीट / SHEET	3 OF 15
पुनरीक्षण / REV.	00

SHIPP CODE		नाम NAME	हस्ताक्षर SIGNATURE	दिनांक DATE
M	तैयारकर्ता / DRN	LJ		
	डिजाइनकर्ता / DES	RN		
	जाँचकर्ता / CHD	MS		
	अनुमोदनकर्ता / APP	SR		

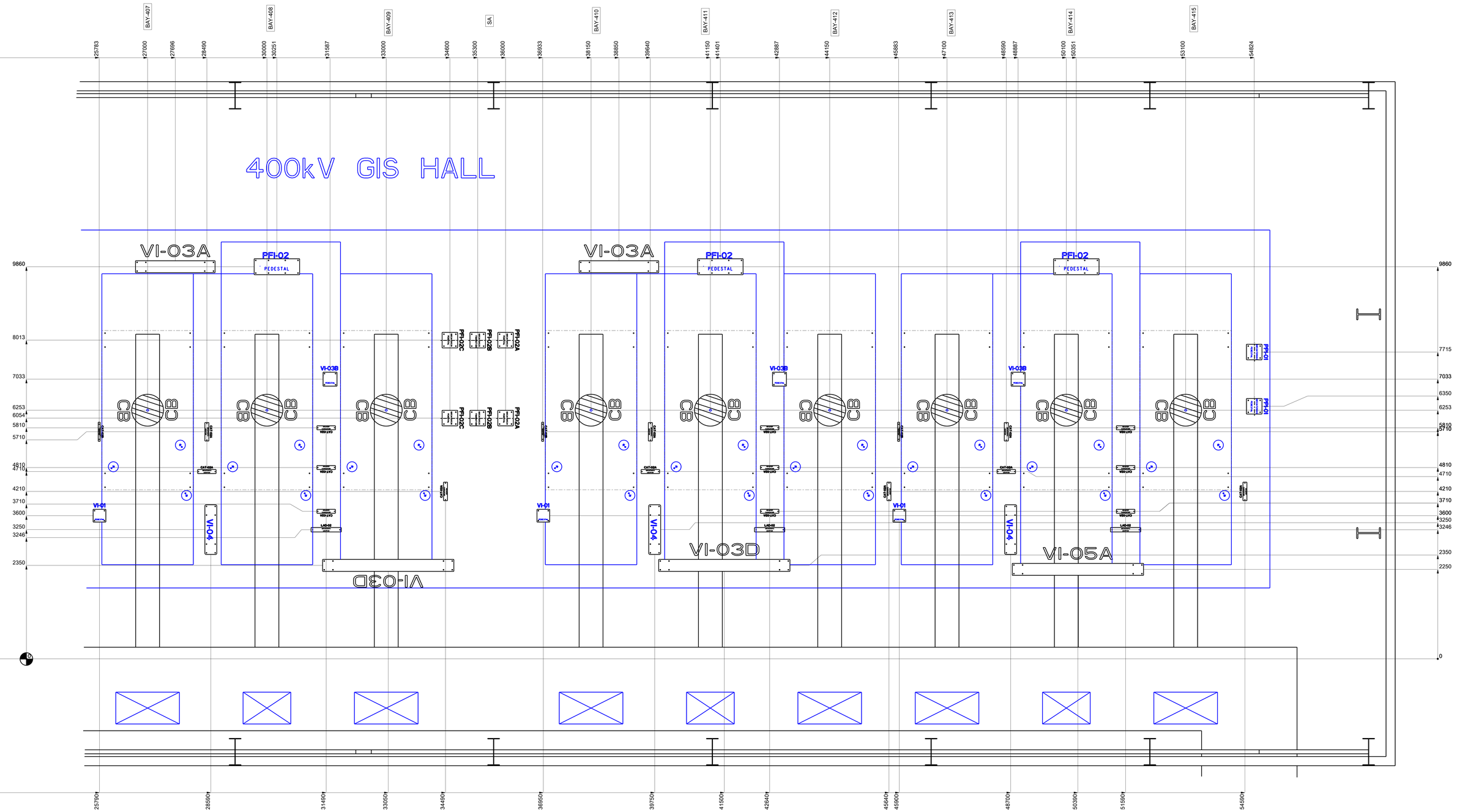
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D:\dg\1\GD53A000725_GRCL_NTPC_TALCHAR_400kV_T155-3\GD53A000725_GD378_Layout.dwg

फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि॰ मी॰ में है/ALL DIMENSIONS ARE IN MM
GD53A000725 ON SHEET NO.
प्रारूप संख्या

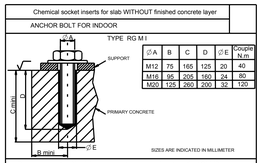
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Reviewed: ---			---
Approved: RAMU NATARAJAN			29/02/2024
T&D INDIA LTD	Sheet: 4/15	Product type: T155-3	

NTPC_THALCHAR 400kV_T155-3
CIVIL WORK DRAWING
GD378
//
GD53A000725 Rev. 00

INDOOR CB MARKING DIMENSION, SUPPORT STRUCTURE AND CAT WALK PEDESTAL DETAILS



Chemical socket inserts for slab WITHOUT finished concrete layer						
ANCHOR BOLT FOR INDOOR						
TYPE: RG M I						
ØA	B	C	D	ØE	Couple N.m.	
M12	75	165	125	20	40	
M16	95	205	160	24	80	
M20	125	260	200	32	120	



SIZES ARE INDICATED IN MILLIMETER

a) Primary concrete with minimum concrete compression strength at 25 MPa
b) To avoid reinforcement inrun out during slab drilling stage for chemical studs installation, chemical socket location has to be clearly shown (on top view) on civil work concrete reinforcement drawings.
c) Holes drilling will be done at site by GE during erection.

VENDOR NAME: GE T&D INDIA LTD.
142, Vandalur-Walajabad Road
Padappai, Chennai 601301
Tamilnadu, India

ग्राहक ड्राईंग संख्या / CUSTOMER DRAWING NO.: 4540-001-230-PVE-P-003

NTPC — ग्राहक / CUSTOMER: एन टी पी सी लिमिटेड / N T P C LIMITED

परियोजना / PROJECT: TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW)

भारत हैवी इलेक्ट्रिकल्स लिमिटेड / BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION BUSINESS GROUP
नोएडा (उ॰प्र॰) / NOIDA (U.P.)

DEPT CODE: M

	नाम / NAME	हस्ताक्षर / SIGNATURE	दिनांक / DATE
तैयारकर्ता / DRN	LJ		
डिजाइनकर्ता / DSN	RN		
जाँचकर्ता / CHD	MS		
अनुमोदनकर्ता / APPD	SR		

शीर्षक / TITLE: CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION

विभाग / DEPT.	स्केल / SCALE: --	ड्राईंग संख्या / DRAWING NO.	GD53A000725
हस्ताक्षर / SIGN			
दिनांक / DATE		शीट / SHEET 4 OF 15	पुनरीक्षण / REV. 00

फॉर्मेट साइज A0
FORMAT SIZE A0

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फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि.मी. में हैं/ALL DIMENSIONS ARE IN MM
GD53A000725 NO. DRAWING

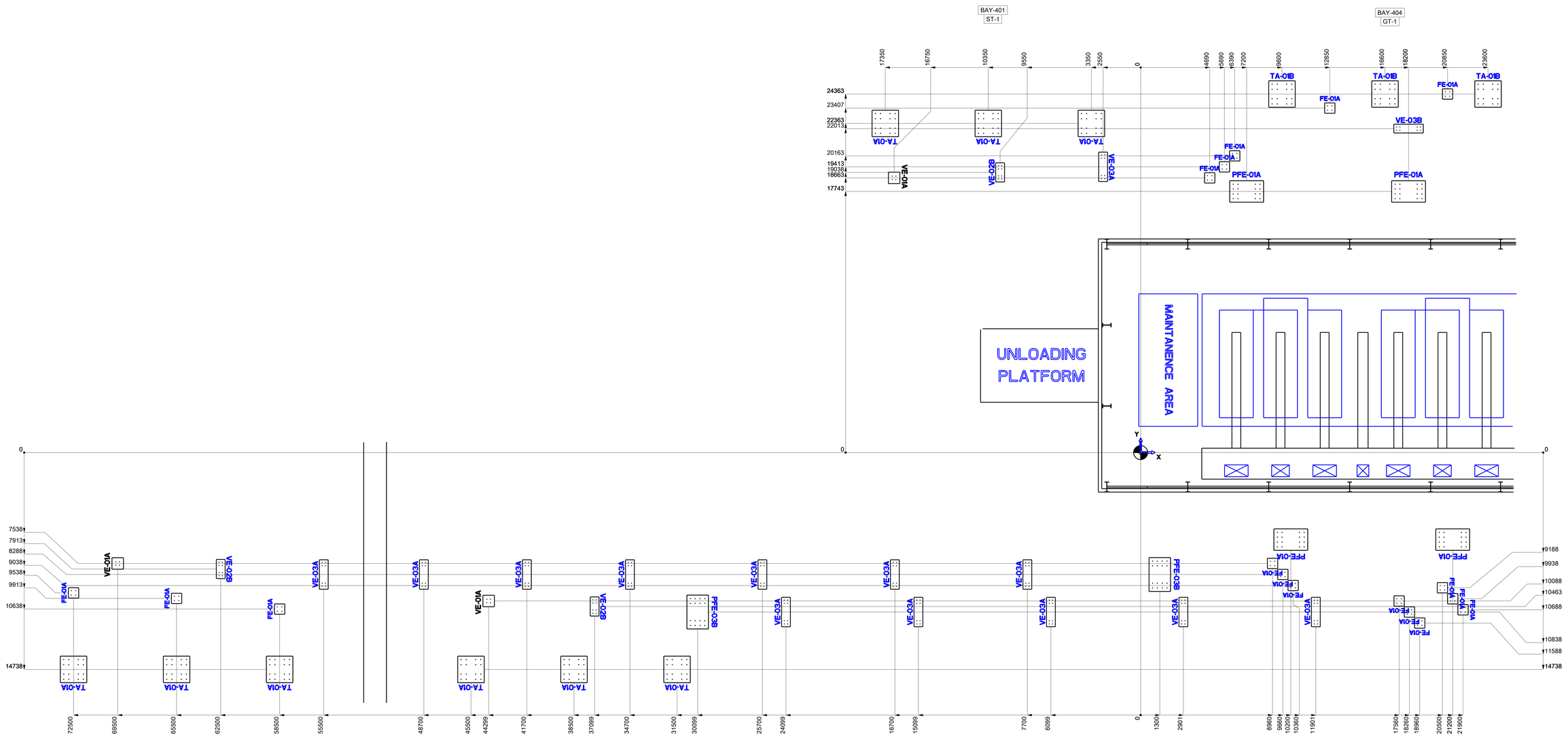
OUTDOOR SUPPORT STRUCTURE PEDESTAL DETAILS

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Created: Vigneshraj V			29/02/2024
Reviewed: ---			---
Approved: RAMU NATARAJAN			29/02/2024 //

T&D INDIA LTD | Sheet: 5/15 | Product type: T155-3

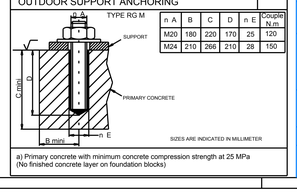
NTPC_THALCHAR 400kV_T155-3
CIVIL WORK DRAWING
GD378

GD53A000725 | Rev. 00



Chemical studs in foundation blocks

OUTDOOR SUPPORT ANCHORING



n A	B	C	D	n E	Couple N.m
M20	180	220	170	25	120
M24	210	266	210	28	150

SIZES ARE INDICATED IN MILLIMETER

a) Primary concrete with minimum concrete compression strength at 25 MPa (No finished concrete layer on foundation blocks)

VENDOR NAME: GE T&D INDIA LTD.
142, Vandalur-Walajabad Road
Padappai, Chennai 601301
Tamilnadu, India

ग्राहक ड्राइंग संख्या / CUSTOMER DRAWING NO.: 4540-001-230-PVE-P-003

ग्राहक / CUSTOMER: एन टी पी सी लिमिटेड
N T P C LIMITED

परियोजना / PROJECT: TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW)

भारत हेवी इलेक्ट्रिकल्स लिमिटेड
BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION BUSINESS GROUP
नोएडा (उ.प्र.)/NOIDA (U.P.)

GROUP CODE: M

		नाम NAME	हस्ताक्षर SIGNATURE	दिनांक DATE
तैयारकर्ता / DRN		LJ		
डिजाइनकर्ता / DES		RN		
जांचकर्ता / CHD		MS		
अनुमोदनकर्ता / APP		SR		

शीर्षक / TITLE: CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION

डिज़ाइन / DES	स्केल / SCALE: –	ड्राइंग संख्या / DRAWING NO.	GD53A000725
हस्ताक्षर / SIGN			
दिनांक / DATE		शीट / SHEET 5 OF 15	पुनरीक्षण / REV 00

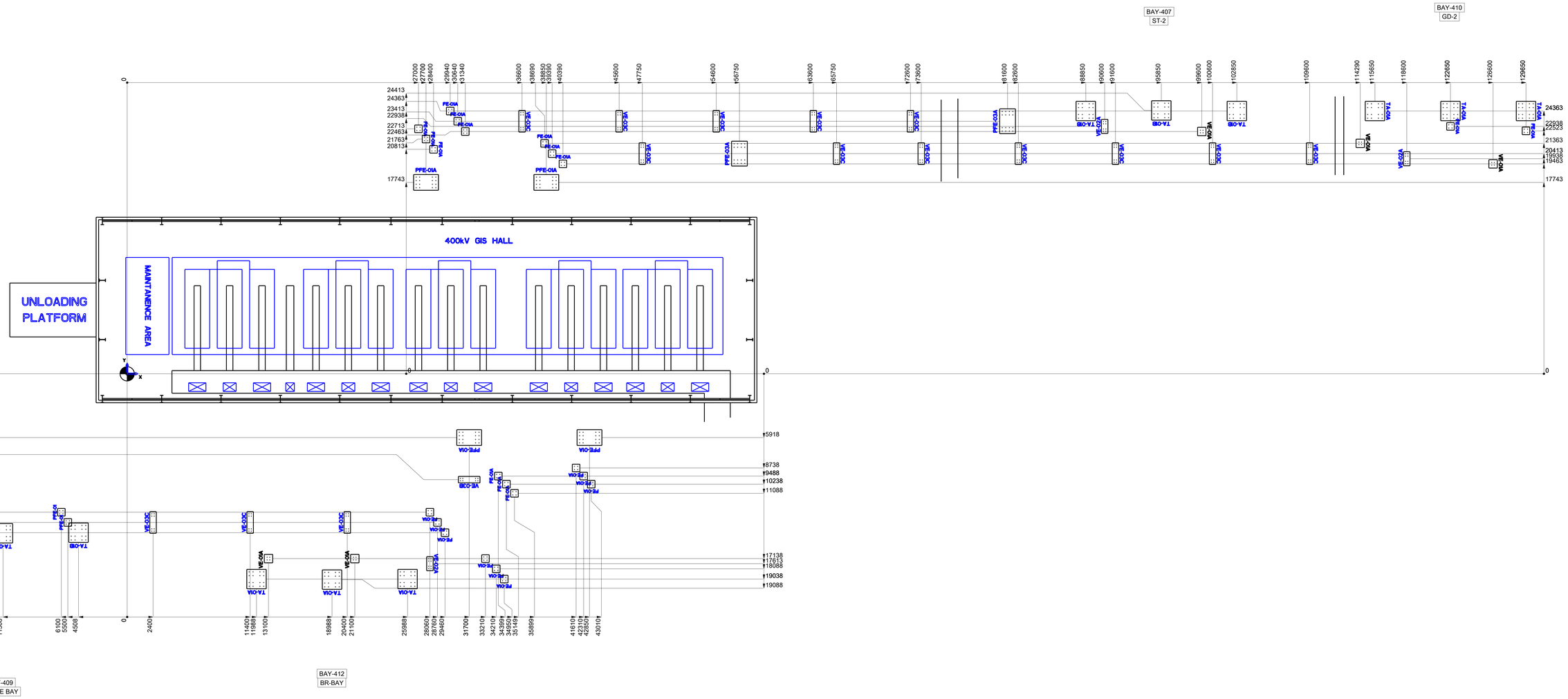
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it must not be used directly or indirectly in any way detrimental to the interest of BHEL
D:\dsjobs\GD378_Shell_NTPC_THALCHAR_400kV_T155-3\GD53A000725\GD53A000725.layout.dwg
यह दस्तावेज़ भेल की संपत्ति है इसका कोई भी प्रयोग भेल के हितों के विरुद्ध नहीं होना चाहिये
इसका उपयोग भेल के अनुबंध या करार के अंतर्गत ही करना है अन्यथा भेल को क्षतिपूर्ति की दावा करने का अधिकार होगा

फरस्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि॰ मी॰ में हैं/ALL DIMENSIONS ARE IN MM
GD53A000725 DRAWING NO.
ड्राइंग संख्या
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OUTDOOR SUPPORT STRUCTURE PEDESTAL DETAILS

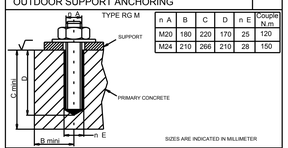
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Reviewed: ---			---
Approved: RAMU NATARAJAN			29/02/2024
T&D INDIA LTD	Sheet: 6/15	Product type: T155-3	

NTPC_THALCHAR 400kV_T155-3
CIVIL WORK DRAWING
GD378
GD53A000725 Rev. 00



Chemical studs in foundation blocks

OUTDOOR SUPPORT ANCHORING



n A	B	C	D	n E	Couple N.m
M20	180	220	170	25	120
M24	210	266	210	28	150

SIZES ARE INDICATED IN MILLIMETER

a) Primary concrete with minimum concrete compression strength at 25 MPa (No finished concrete layer on foundation blocks)

VENDOR NAME: GE T&D INDIA LTD.
142, Vandalur-Walajabad Road
Padappai, Chennai 601301
Tamilnadu, India

ग्राहक ड्राइंग संख्या CUSTOMER DRAWING NO.: 4540-001-230-PVE-P-003

ग्राहक CUSTOMER: एन टी पी सी लिमिटेड / N T P C LIMITED

परियोजना PROJECT: TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW

भारत हैवी इलेक्ट्रिकल्स लिमिटेड / BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION BUSINESS GROUP
नोएडा (उ॰प्र॰) / NOIDA (U.P.)

	नाम NAME	हस्ताक्षर SIGNATURE	दिनांक DATE
तैयारकर्ता DRN	LJ		
डिजाइनकर्ता DESN	RN		
जाँचकर्ता CHD	MS		
अनुमोदनकर्ता APPD	SR		

शीर्षक TITLE: CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION

ड्राइंग संख्या / DRAWING NO.: GD53A000725

शीट SHEET 6 OF 15 पुनरीक्षण REV. 00

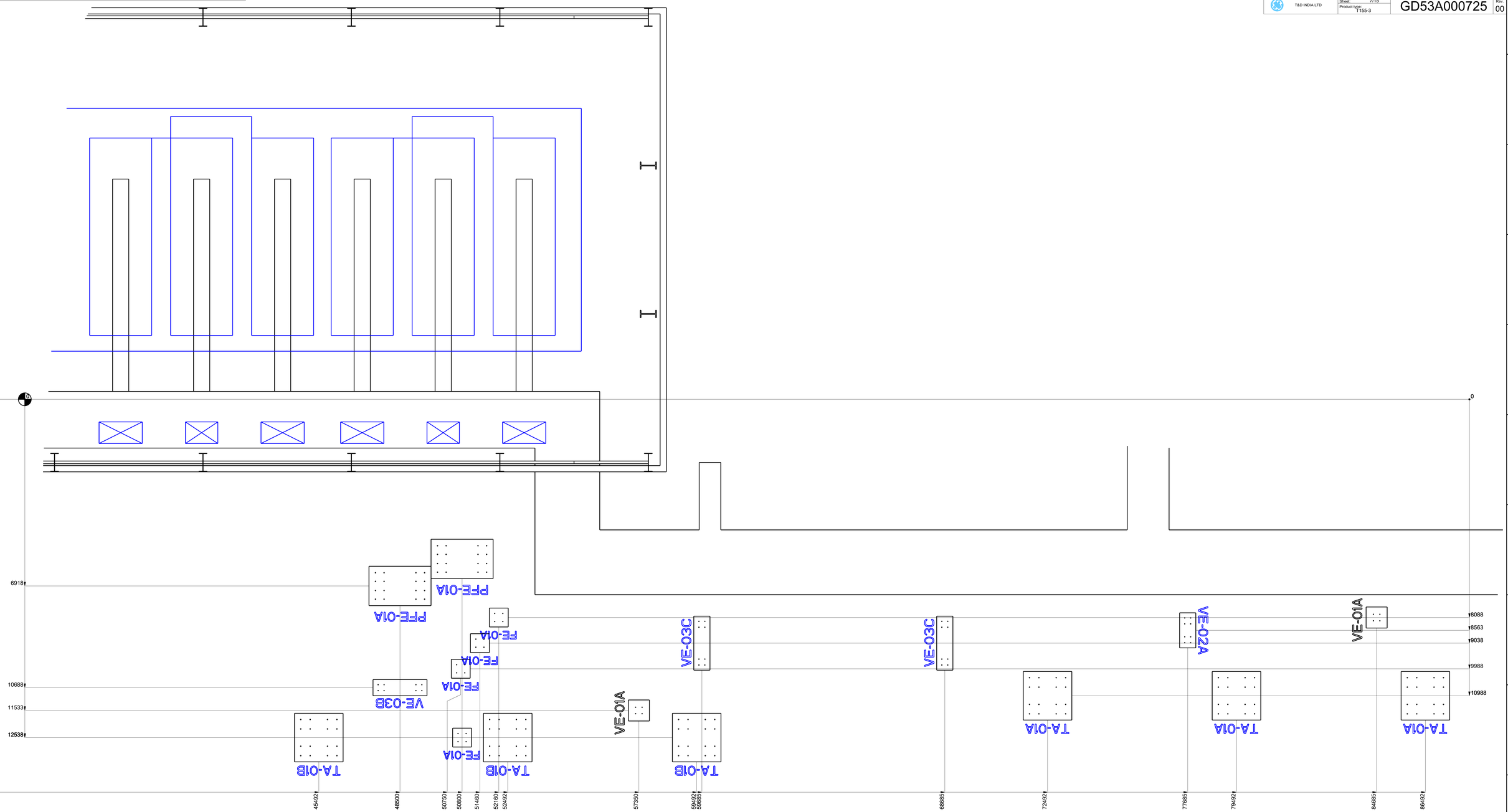
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FORMAT SIZE A0

फरस्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि॰ मी॰ मे है/ALL DIMENSIONS ARE IN MM
GD53A000725 ON SHEET NO.
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OUTDOOR SUPPORT STRUCTURE PEDESTAL DETAILS

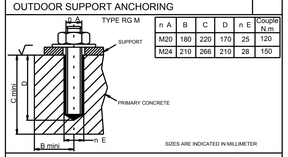
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Reviewed: ---	---
Approved: RAMU NATARAJAN	29/02/2024
T&D INDIA LTD	Sheet: 7/15
Product type: T155-3	

NTPC_THALCHAR 400kV_T155-3
CIVIL WORK DRAWING
GD378
//
GD53A000725
Rev. 00



Chemical studs in foundation blocks

OUTDOOR SUPPORT ANCHORING



n A	B	C	D	n E	Couple N.m
M20	180	220	170	25	120
M24	210	266	210	28	150

SIZES ARE INDICATED IN MILLIMETER

a) Primary concrete with minimum concrete compression strength at 25 MPa (No finished concrete layer on foundation blocks)

VENDOR NAME: GE T&D INDIA LTD.
142, Vandalur-Walajabad Road
Padappai, Chennai 601301
Tamilnadu, India

ग्राहक ड्राइंग संख्या / CUSTOMER DRAWING NO.: 4540-001-230-PVE-P-003

ग्राहक / CUSTOMER: एन टी पी सी लिमिटेड
N T P C LIMITED

परियोजना / PROJECT: TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW)

भारत हेवी इलेक्ट्रिकल्स लिमिटेड
BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION BUSINESS GROUP
नोएडा (उ॰प्र॰) / NOIDA (U.P.)

DEPT CODE		नाम NAME	हस्ताक्षर SIGNATURE	दिनांक DATE
M	तैयारकर्ता / DRN.	LJ		
	डिजाइनकर्ता / DES.	RN		
	जांचकर्ता / CHD.	MS		
	अनुमोदनकर्ता / APPD.	SR		

शीर्षक / TITLE: CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION

डिज़ाइन DEPT.	स्केल SCALE: –
ड्राइंग संख्या / DRAWING NO.	GD53A000725
शीट SHEET	7 OF 15
पुनरीक्षण REV.	00

फ़ार्मैट साइज़ A0
FORMAT SIZE A0

GD53A000725 NO. DRAWING / छापेखाना

BUILDING, CB & LCC DIMENSION MARKING DETAILS

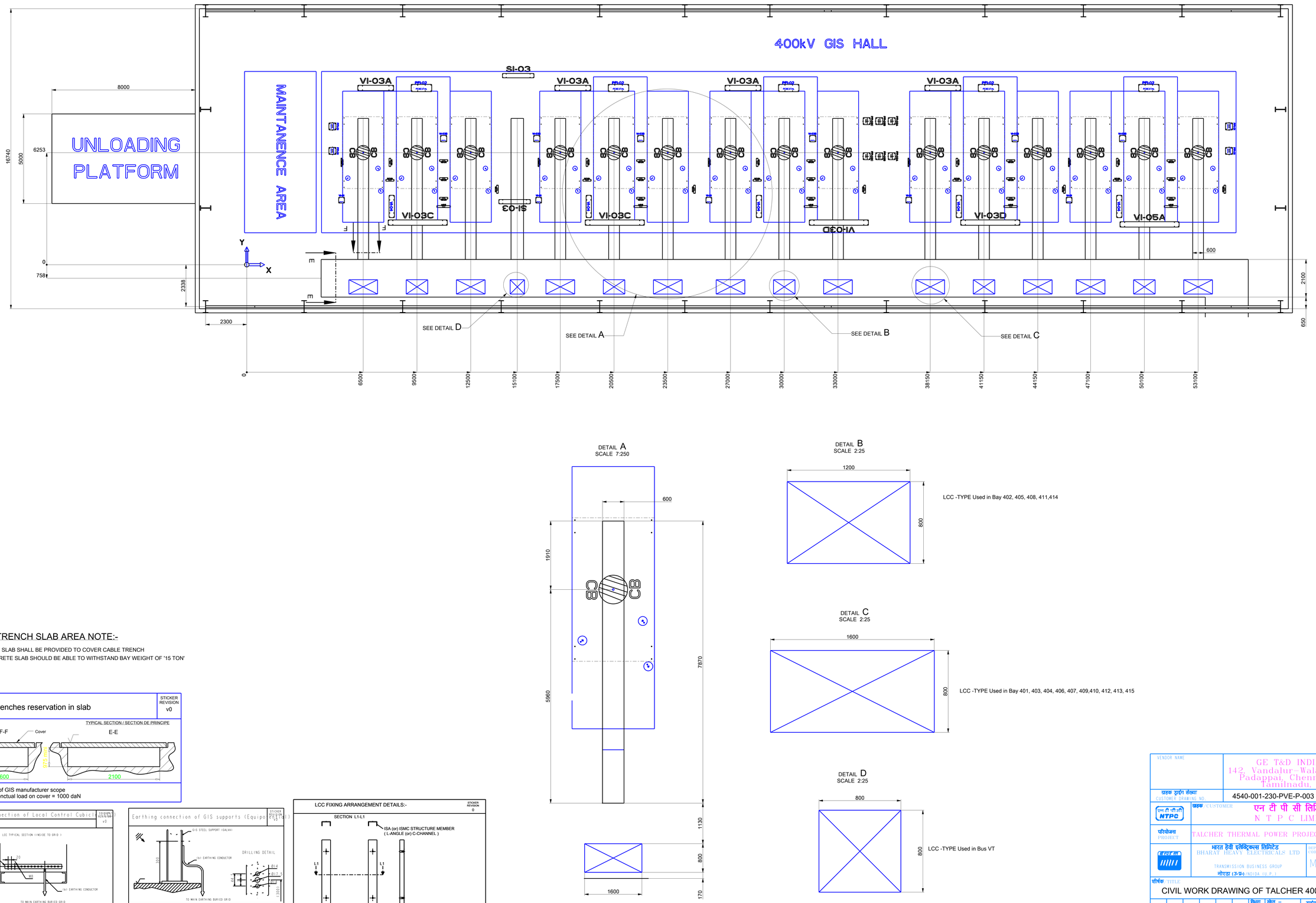
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Created: Vigneshraj V			29/02/2024
Reviewed: ---			---
Approved: RAMU NATARAJAN			29/02/2024 //

T&D INDIA LTD

NTPC_THALCHAR 400kV_T155-3
CIVIL WORK DRAWING
GD378

Sheet: 8/15
Product type: T155-3

GD53A000725 Rev. 00



DETAIL A
SCALE 7:250

DETAIL B
SCALE 2:25

LCC -TYPE Used in Bay 402, 405, 408, 411,414

DETAIL C
SCALE 2:25

LCC -TYPE Used in Bay 401, 403, 404, 406, 407, 409,410, 412, 413, 415

DETAIL D
SCALE 2:25

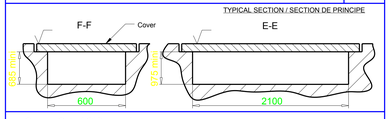
LCC -TYPE Used in Bus VT

CABLE TRENCH SLAB AREA NOTE:-

1. CONCRETE SLAB SHALL BE PROVIDED TO COVER CABLE TRENCH
2. THE CONCRETE SLAB SHOULD BE ABLE TO WITHSTAND BAY WEIGHT OF '15 TON'

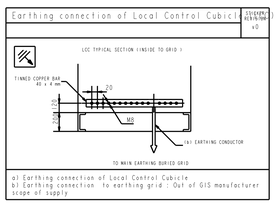
LV cable trenches reservation in slab — STICKER REVISION v0

TYPICAL SECTION / SECTION DE PRINCIPE



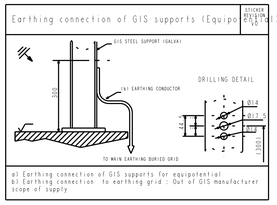
a) Cover : Out of GIS manufacturer scope
b) Maximum ponctual load on cover = 1000 daN

Earthing connection of Local Control Cubicle (Equipotential) — STICKER REVISION v0



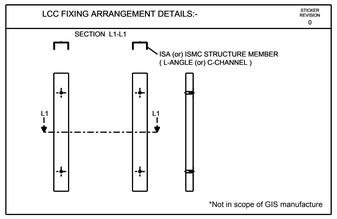
a) Earthing connection of Local Control Cubicle
b) Earthing connection to earthing grid : Out of GIS manufacturer scope of supply

Earthing connection of GIS supports (Equipotential) — STICKER REVISION v0



a) Earthing connection of GIS supports for equipotential
b) Earthing connection to earthing grid : Out of GIS manufacturer scope of supply

LCC FIXING ARRANGEMENT DETAILS:- — STICKER REVISION 0



*Not in scope of GIS manufacture

VENDOR NAME	GE T&D INDIA LTD. 142, Vandalur-Walajabad Road Padappai, Chennai 601301 Tamilnadu, India
ग्राहक ड्राइंग संख्या CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003
ग्राहक / CUSTOMER	एन टी पी सी लिमिटेड N T P C LIMITED
परियोजना PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW
	भारत हैवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ॰प्र॰) / NOIDA (U.P.)

SHEET CODE		नाम NAME	हस्ताक्षर SIGNATURE	दिनांक DATE
M	तैयारकर्ता / DRN	LJ		
	डिजाइनकर्ता / DSGN	RN		
	जांचकर्ता / CHD	MS		
	अनुमोदनकर्ता / APPD	SR		

शीर्षक TITLE
CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION

विभाग DEPT.	स्केल – SCALE:	ड्राइंग संख्या / DRAWING NO.	GD53A000725
हस्ताक्षर SIGN			
दिनांक DATE		शीट SHEET 8 OF 15	पुनरीक्षण REV. 00

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यह प्रलेख भारत हैवी इलेक्ट्रिकल्स लिमिटेड की संपत्ति है
इसका उपयोग प्रत्यक्ष या अप्रत्यक्ष रूप से किसी भी तरह से कंपनी के हित के प्रतिकूल नहीं होना चाहिये

फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि.मी. में हैं/ALL DIMENSIONS ARE IN MM
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इसका उपयोग सीधे या अप्रत्यक्ष रूप से किसी भी तरह से BHEL के हितों के अहितकर नहीं होना चाहिए।

Scale: 1:10	Unit: mm	Format: A0	D. Authority: CHT	NTPC_THALCHAR 400kV_T155-3	
EC Nbr: -----		Q Level: --	Local Unit: CHT	CIVIL WORK DRAWING	
Created: Vigneshraj V			29/02/2024	GD378	
Reviewed: ---				---	
Approved: RAMU NATARAJAN			29/02/2024	//	
T&D INDIA LTD		Sheet: 9/15		GD53A000725	Rev. 00
		Product type: T155-3			

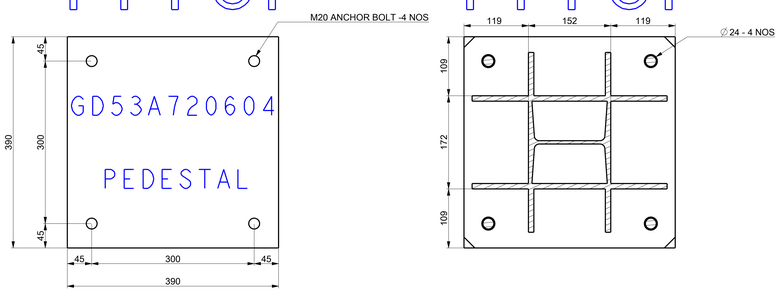
INDOOR PEDESTAL DETAILS

FOUNDATION

PPI-01

BASE PLATE

PPI-01

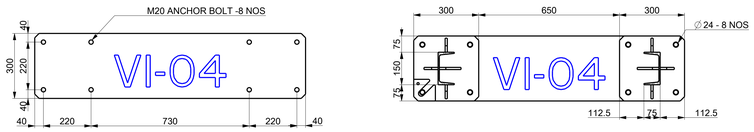


FOUNDATION

VI-04

BASE PLATE

VI-04

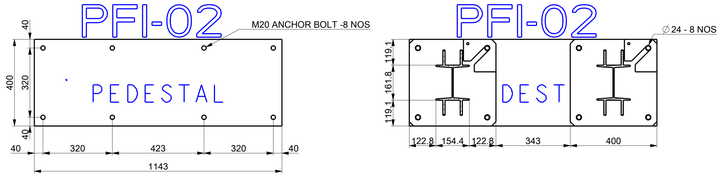


FOUNDATION

PFI-02

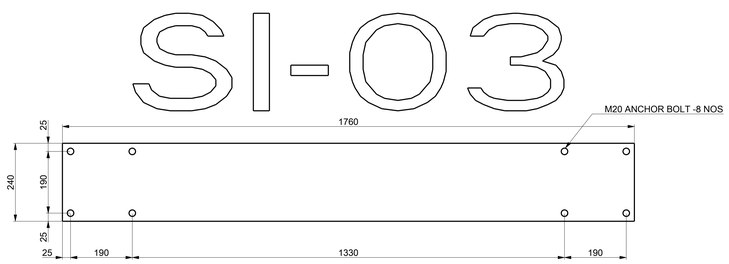
BASE PLATE

PFI-02



FOUNDATION

SI-03

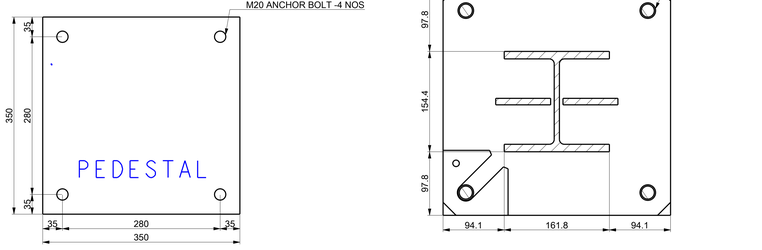


FOUNDATION

VI-03B

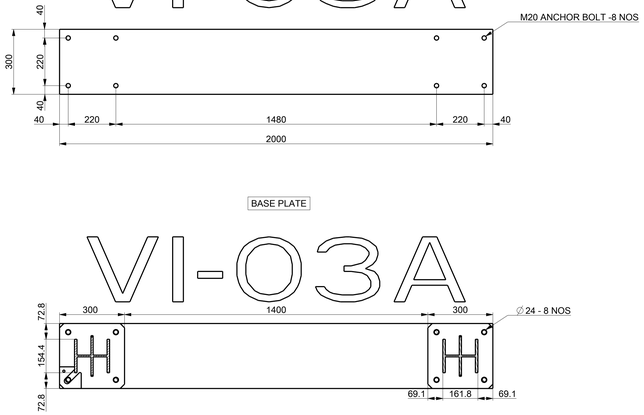
BASE PLATE

VI-03B



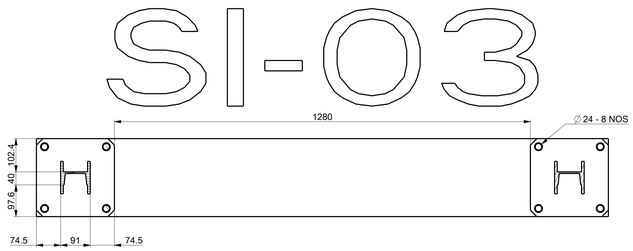
FOUNDATION

VI-03A



BASE PLATE

SI-03

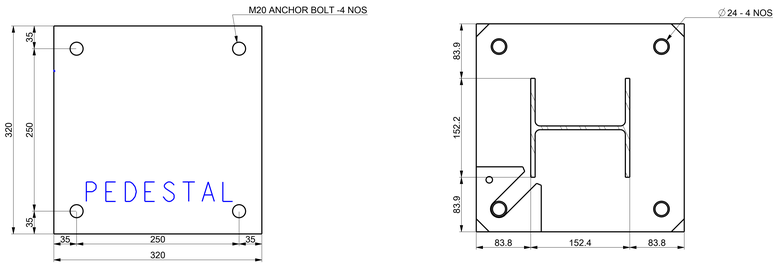


FOUNDATION

VI-01

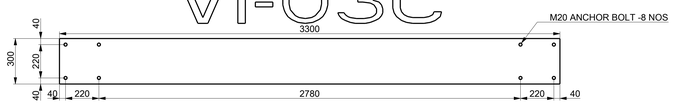
BASE PLATE

VI-01



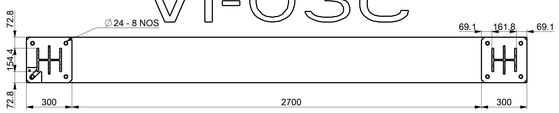
FOUNDATION

VI-03C



BASE PLATE

VI-03C

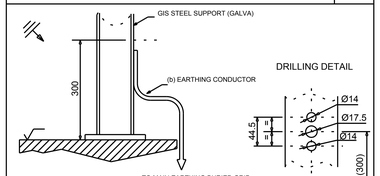


SAME FOUNDATION AND STRUCTURE BASE PLATE ARE USED IN VI-03D & VI-05A

SAME FOUNDATION AND STRUCTURE BASE PLATE ARE USED IN PFI-02A, PFI-02B & PFI-02C

Earthing connection of GIS supports (Equipotential)

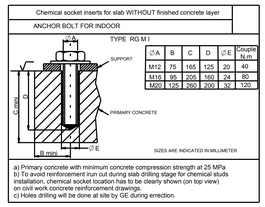
STICKER REVISION v0



a) Earthing connection of GIS supports for equipotential
b) Earthing connection to earthing grid : Out of GIS manufacturer scope of supply

Chemical socket inserts for slab WITHOUT finished concrete layer

ANCHOR BOLT FOR INDOOR



∅A	B	C	D	∅E	Couple N.m
M12	75	165	125	20	40
M16	95	205	160	24	80
M20	125	260	200	32	120

a) Primary concrete with minimum concrete compression strength at 25 MPa
b) To avoid reinforcement irun cut during slab drilling stage for chemical studs installation, chemical socket location has to be clearly shown (on top view) on civil work concrete reinforcement drawings.
c) Holes drilling will be done at site by GE during erection.

VENDOR NAME	GE T&D INDIA LTD. 142, Vandalur-Walajabad Road Padappai, Chennai 601301 Tamilnadu, India
ग्राहक ड्राईंग संख्या / CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003
ग्राहक / CUSTOMER	एन टी पी सी लिमिटेड N T P C LIMITED
परियोजना / PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW)
	भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ.प्र.)/NOIDA (U.P.)

DEPT CODE		नाम NAME	हस्ताक्षर SIGNATURE	दिनांक DATE
M	विरचनकर्ता DRN	LJ		
	डिजाइनकर्ता DESN	RN		
	जाँचकर्ता CHD	MS		
	अनुमोदनकर्ता APPD	SR		

शीर्षक / TITLE: CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION

डिज़ाइन DES.	स्केल SCALE: --	ड्राईंग संख्या / DRAWING NO.	GD53A000725
हस्ताक्षर SIGN		शीट SHEET 9 OF 15	पुनरीक्षण REV. 00
दिनांक DATE			

फॉर्मेट साइज़ A0
FORMAT SIZE A0

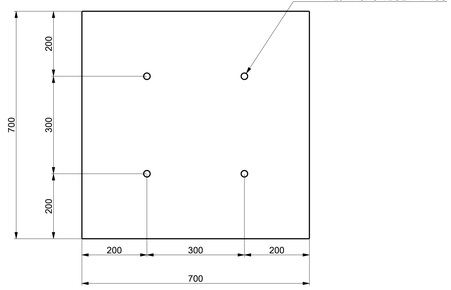
फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि॰ मी॰ मे है/ALL DIMENSIONS ARE IN MM
GD53A000725 /09AM/80/ NO. ड्राइंग संख्या
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Scale: 1:14	Unit:mm	Format: A0	D. Authority: CHT	NTPC_THALCHAR 400kV_T155-3	
EC Nbr: -----	Q Level: --		Local Unit: CHT	CIVIL WORK DRAWING	
Created: Vigneshraj V			29/02/2024	GD378	
Reviewed: ---			---		
Approved: RAMU NATARAJAN			29/02/2024	//	
T&D INDIA LTD		Sheet: 10/15	Product type: T155-3	GD53A000725	Rev. 00

OUTDOOR PEDESTAL DETAILS

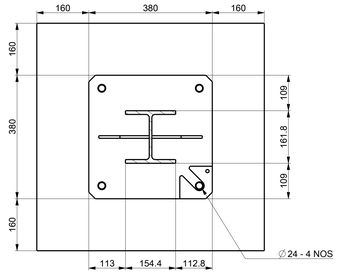
PFE-01

FOUNDATION



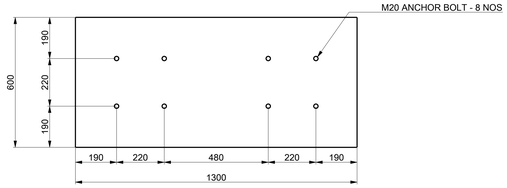
PFE-01

BASE PLATE



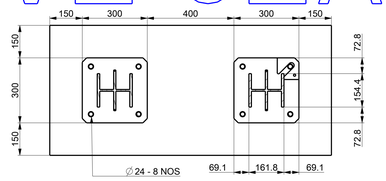
VE-02A

FOUNDATION



VE-02A

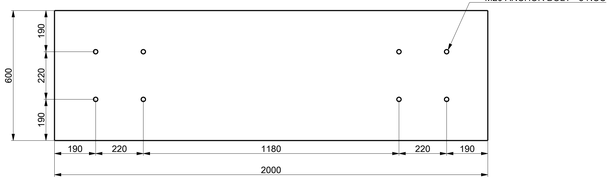
BASE PLATE



SAME FOUNDATION AND STRUCTURE BASE PLATE ARE USED IN VE-02B

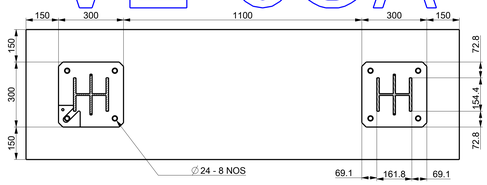
VE-03A

FOUNDATION



VE-03A

BASE PLATE



SAME FOUNDATION AND STRUCTURE BASE PLATE ARE USED IN VE-03B, VE-03C

FE-01A

FOUNDATION

FE-01A

BASE PLATE

VE-01A

FOUNDATION

VE-01A

BASE PLATE

PFE-01A

FOUNDATION

PFE-01A

BASE PLATE

SAME FOUNDATION AND STRUCTURE BASE PLATE ARE USED IN PFE-03A, PFE-03B

Chemical studs in foundation blocks

OUTDOOR SUPPORT ANCHORING

n A	B	C	D	n E	Couple N.m
M20	180	220	170	25	120
M24	210	266	210	28	150

SIZES ARE INDICATED IN MILLIMETER

a) Primary concrete with minimum concrete compression strength at 25 MPa
(No finished concrete layer on foundation blocks)

Earthing connection of GIS supports (Equipotential)

STICKER REVISION v0

a) Earthing connection of GIS supports for equipotential
b) Earthing connection to earthing grid : Out of GIS manufacturer scope of supply

VENDOR NAME	GE T&D INDIA LTD. 142, Vandalur-Walajabad Road Padappai, Chennai 601301 Tamilnadu, India
ग्राहक ड्राइंग संख्या CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003
ग्राहक / CUSTOMER	एन टी पी सी लिमिटेड N T P C LIMITED
परियोजना PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW)
	भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ॰प्र॰) / NOIDA (U.P.)

MAPP CODE		नाम NAME	हस्ताक्षर SIGNATURE	दिनांक DATE
M	तैयारकर्ता / DRN	LJ		
	डिजाइनकर्ता / DESN	RN		
	जांचकर्ता / CHD	MS		
	स्वीकारकर्ता / APPD	SR		

शीर्षक TITLE: CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION

| | | | | |

फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि॰ मी॰ मे हैALL DIMENSIONS ARE IN MM
GD53A000725 /DRAWING NO.
शीट्स SHEETS

Scale: 1:14	Unit:mm	Format: A0	D. Authority:CHT
EC Nbr: -----		Q Level: --	Local Unit: CHT
Created: Vigneshraj V			29/02/2024
Reviewed: ---			---
Approved: RAMU NATARAJAN			29/02/2024

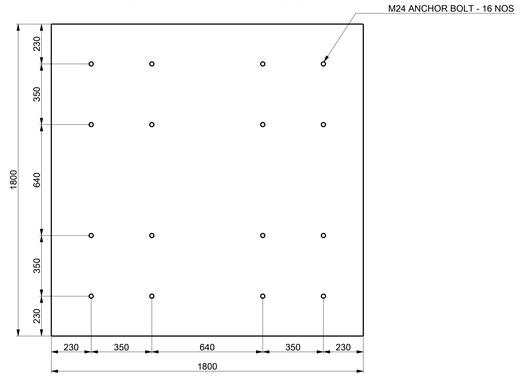
T&D INDIA LTD

NTPC_THALCHAR 400kV_T155-3
CIVIL WORK DRAWING
GD378
Sheet: 11/15
Product type: T155-3
GD53A000725
Rev. 00

OUTDOOR PEDESTAL DETAILS

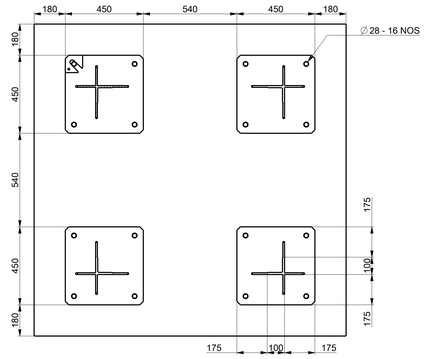
FOUNDATION

TA-01A



BASE PLATE

TA-01A

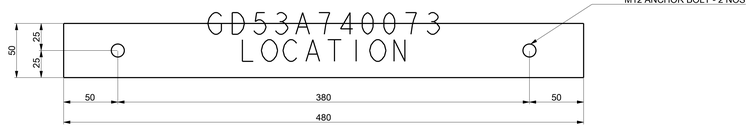


SAME FOUNDATION AND STRUCTURE BASE PLATE ARE USED IN TA-01B

FOUNDATION

CAT-02B

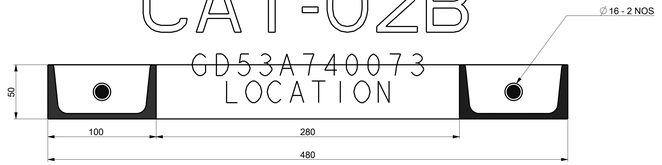
GD53A740073
LOCATION



BASE PLATE

CAT-02B

GD53A740073
LOCATION



CAT WALK PEDESTAL DETAILS

FOUNDATION

CAT-02A

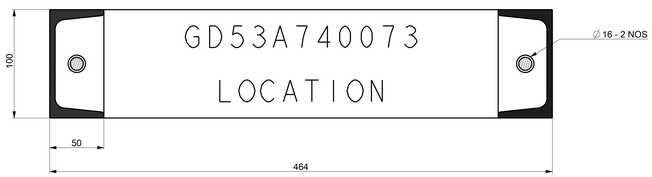
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LOCATION



BASE PLATE

CAT-02A

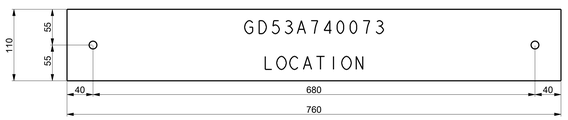
GD53A740073
LOCATION



FOUNDATION

LAD-02

GD53A740073
LOCATION



BASE PLATE

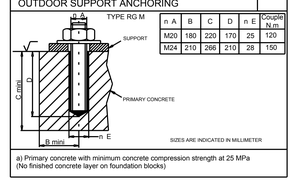
LAD-02

GD53A740073
LOCATION



Chemical studs in foundation blocks

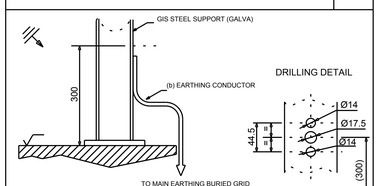
OUTDOOR SUPPORT ANCHORING



	n A	B	C	D	n E	Couple N.m
M20	180	220	170	25	120	
M24	210	266	210	28	150	

a) Primary concrete with minimum concrete compression strength at 25 MPa
(No finished concrete layer on foundation blocks)

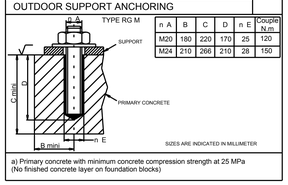
Earthing connection of GIS supports (Equipotential) — STICKER REVISION v0



a) Earthing connection of GIS supports for equipotential
b) Earthing connection to earthing grid : Out of GIS manufacturer scope of supply

Chemical studs in foundation blocks

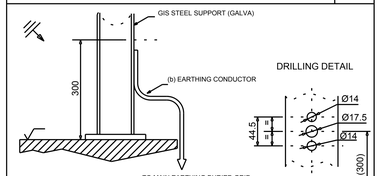
OUTDOOR SUPPORT ANCHORING



	n A	B	C	D	n E	Couple N.m
M20	180	220	170	25	120	
M24	210	266	210	28	150	

a) Primary concrete with minimum concrete compression strength at 25 MPa
(No finished concrete layer on foundation blocks)

Earthing connection of GIS supports (Equipotential) — STICKER REVISION v0



a) Earthing connection of GIS supports for equipotential
b) Earthing connection to earthing grid : Out of GIS manufacturer scope of supply

VENDOR NAME: GE T&D INDIA LTD.
142, Vandalur-Walajabad Road
Padappai, Chennai 601301
Tamilnadu, India

ग्राहक ड्राईंग संख्या CUSTOMER DRAWING NO.: 4540-001-230-PVE-P-003

ग्राहक / CUSTOMER: एन टी पी सी लिमिटेड
N T P C LIMITED

परियोजना PROJECT: TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW)

भारत हेवी इलेक्ट्रिकल्स लिमिटेड
BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION BUSINESS GROUP
नोएडा (उ॰प्र॰) /NOIDA (U.P.)

DEPT CODE		नाम NAME	हस्ताक्षर SIGNATURE	दिनांक DATE
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	डिजाइनकर्ता DES	RN		
	जाँचकर्ता CHD	MS		
	अनुमोदनकर्ता APP	SR		

शीर्षक TITLE: CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION

ड्राईंग संख्या / DRAWING NO.: GD53A000725

शीट SHEET 11 OF 15 पुनरीक्षण REV. 00

स्केल SCALE: – डेटाक DCAC

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कॉपीराइट और गोपनीय
इस प्रलेख में दी गई जानकारी भारत हेवी इलेक्ट्रिकल्स लिमिटेड की संपत्ति है
इसका उपयोग प्रत्यक्ष या अप्रत्यक्ष रूप से किसी भी तरह से कंपनी के हितों के प्रतिकूल नहीं होना चाहिये

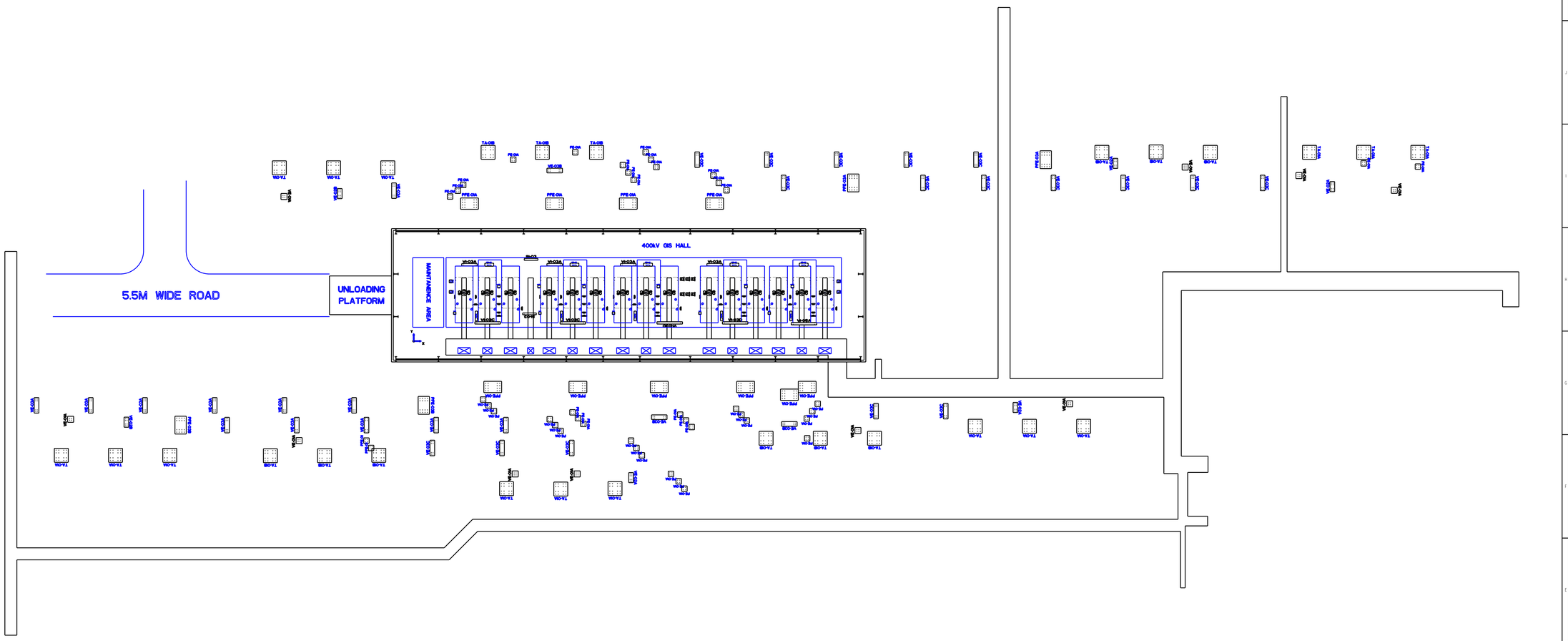
फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि॰ मी॰ में हैं/ALL DIMENSIONS ARE IN MM
ड्राइंग नं॰/DRAWING NO. GD53A000725

OVERALL LAYOUT

Scale: 1:540000	Unit: mm	Format: A0	D. Authority: CHT
EC Nbr: -----		Q Level: --	Local Unit: CHT
Created: Vigneshraj V			29/02/2024
Reviewed: ---			---
Approved: RAMU NATARAJAN			29/02/2024

T&D INDIA LTD

NTPC_THALCHAR 400kV_T155-3
CIVIL WORK DRAWING
GD378
Sheet: 12/15
Product type: T155-3
GD53A000725
Rev. 00



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ग्राहक ड्राइंग संख्या / CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003
ग्राहक/CUSTOMER	एन टी पी सी लिमिटेड N T P C LIMITED
परियोजना / PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW
	भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ॰प्र॰)/NOIDA (U.P.)

DEPT CODE		नाम/NAME	हस्ताक्षर/SIGNATURE	दिनांक/DATE
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	डिजाइनकर्ता/DES	RN		
	परीक्षणकर्ता/CHD	MS		
	अनुमोदनकर्ता/APPD	SR		

शीर्षक / TITLE
CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION

विभाग DEPT.	स्केल SCALE --	ड्राइंग संख्या / DRAWING NO.	GD53A000725
हस्ताक्षर SIGN		शीट SHEET 12 OF 15	पुनरीक्षण REV. 00
दिनांक DATE			

फॉर्मेट साइज A0
FORMAT SIZE A0

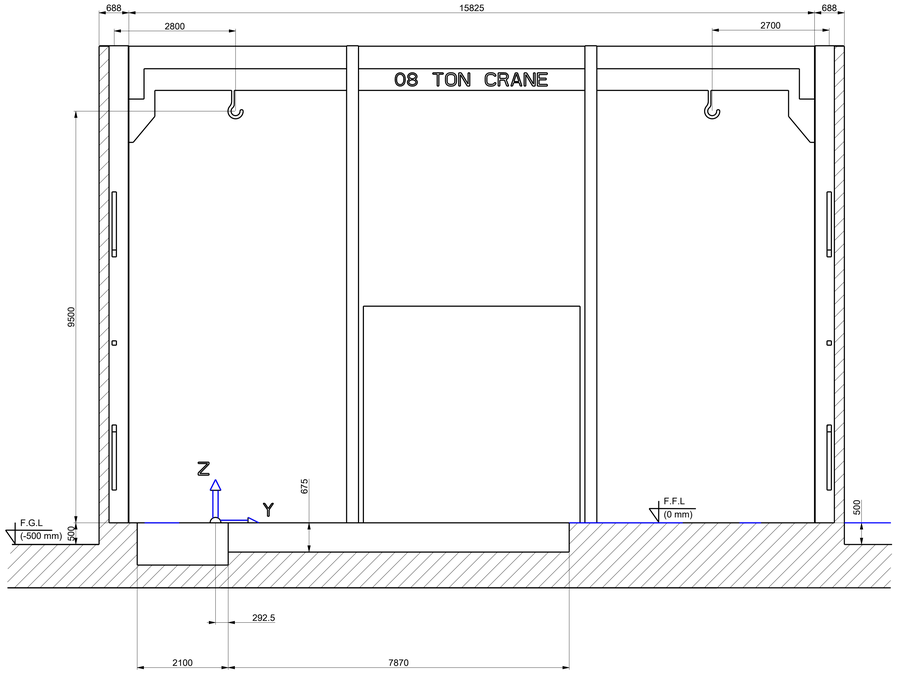
फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि॰ मी॰ मे है/ALL DIMENSIONS ARE IN MM
GD53A000725 NO. DRAWING
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इसका उपयोग प्रत्यक्ष या अप्रत्यक्ष रूप से किसी भी तरह से भेल के हितों के लिए नुकसानदेह नहीं होना चाहिये

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EC Nbr: -----	Q Level: --	Local Unit: CHT	CIVIL WORK DRAWING
Created: Vigneshraj V		29/02/2024	GD378
Reviewed: ---			---
Approved: RAMU NATARAJAN		29/02/2024	//
T&D INDIA LTD	Sheet: 13/15	Product type: T155-3	GD53A000725 Rev. 00

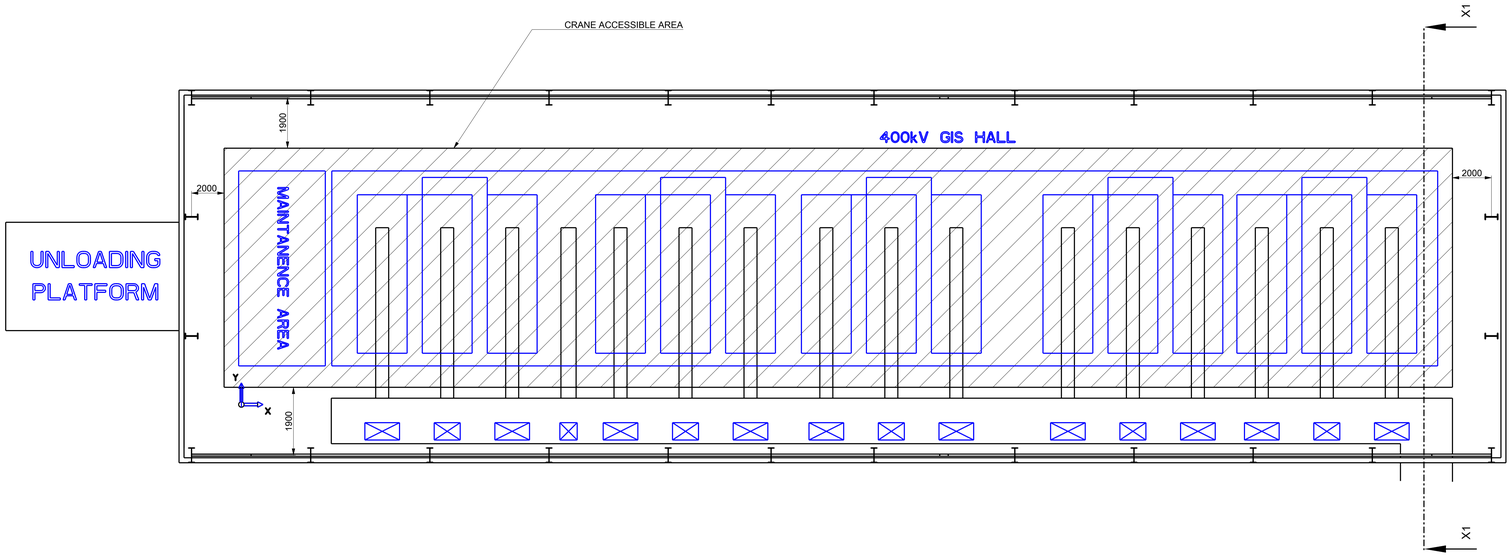
ELEVATION

SECTION VIEW

SECTION X1-X1
SCALE 1:50



TOP VIEW



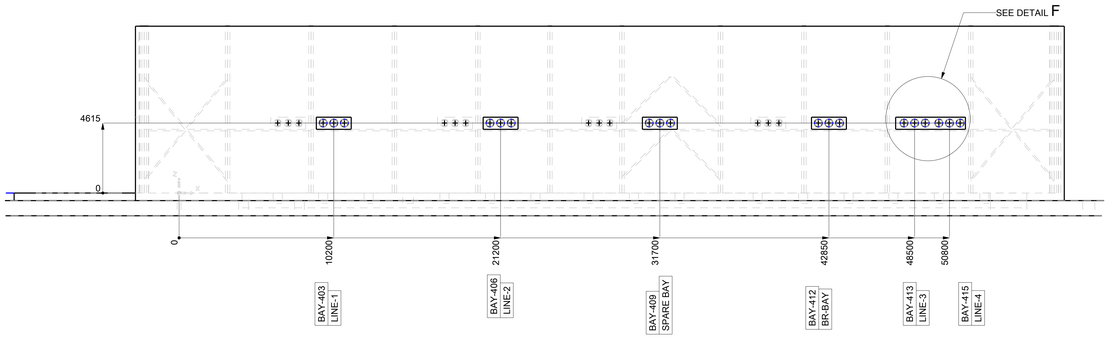
VENDOR NAME	GE T&D INDIA LTD. 142, Vandalur-Walajabad Road Padappai, Chennai 601301 Tamilnadu, India
ग्राहक ड्राइंग संख्या CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003
ग्राहक / CUSTOMER	एन टी पी सी लिमिटेड N T P C LIMITED
परियोजना PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW
भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ॰प्र॰)/NOIDA (U.P.)	MAP'S CODE M तैयारकर्ता/DRN LJ डिजाइनकर्ता/DESN RN जाँचकर्ता/CHD MS अनुमोदनकर्ता/APPD SR
शीर्षक TITLE	CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION
विभाग DEPT. / डिजाइनर DESN. / दिनांक DATE	स्केल – SCALE –
ड्राइंग संख्या / DRAWING NO.	GD53A000725
शीट SHEET 13 OF 15	पुनरीक्षण REV. 00

फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि॰ मी॰ मे है/ALL DIMENSIONS ARE IN MM
ड्राइंग संख्या/DRAWING NO. GD53A000725

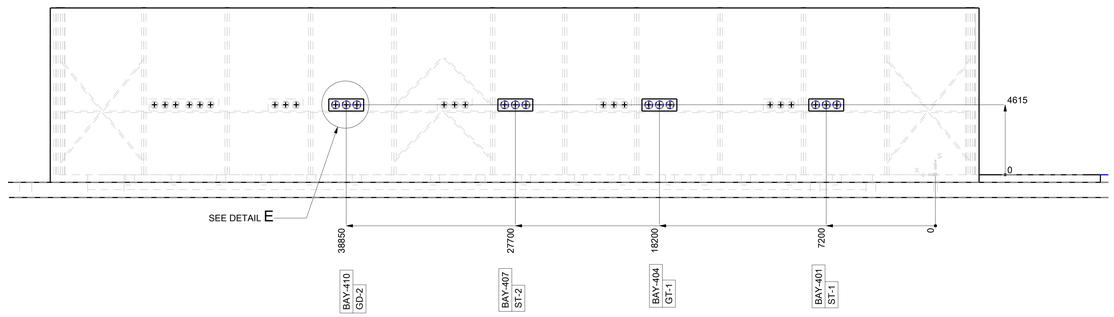
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Created: Vigneshraj V		29/02/2024	GD378
Reviewed: ---		---	---
Approved: RAMU NATARAJAN		29/02/2024	//
T&D INDIA LTD	Sheet: 14/15	Product type: T155-3	GD53A000725 | Rev. 00

WALL CUTOUT DETAILS

VIEW X-X

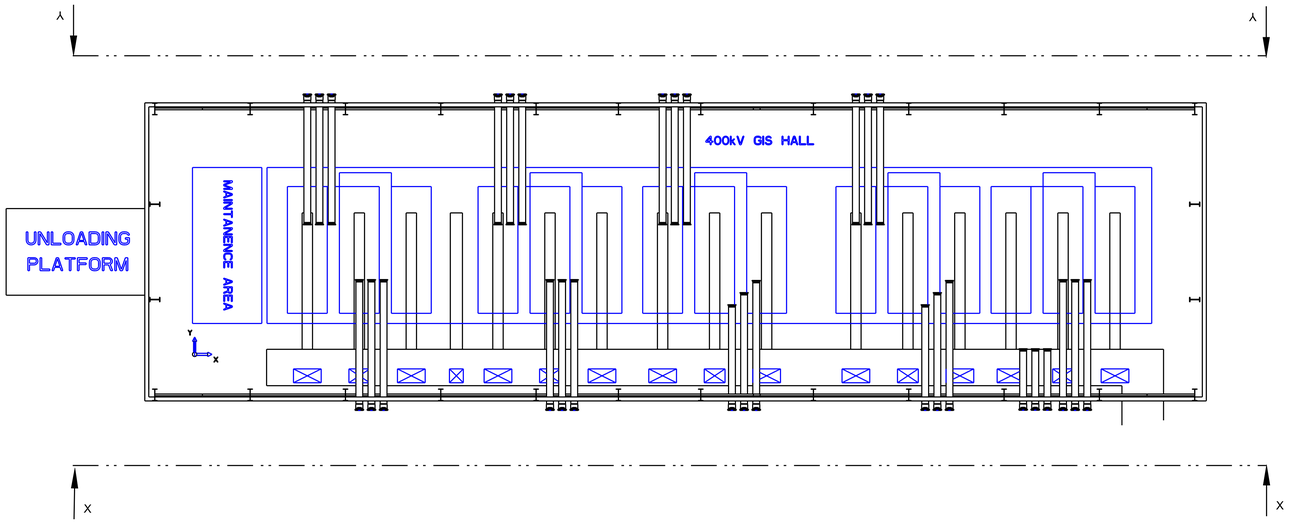


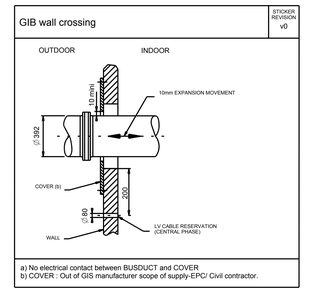
VIEW Y-Y



DETAIL E
SCALE 1:20

DETAIL F
SCALE 1:20





VENDOR NAME	GE T&D INDIA LTD. 142, Vandalur-Walajabad Road Padappai, Chennai 601301 Tamilnadu, India
ग्राहक ड्राईंग संख्या CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003
ग्राहक/CUSTOMER	एन टी पी सी लिमिटेड N T P C LIMITED
परियोजना PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW
भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ॰प्र॰)/NOIDA (U.P.)	DEPT CODE: M ड्राइंग/DRN: LJ डिजाइन/DES: RN जाँचकर्ता/CHD: MS अनुमोदनकर्ता/APP: SR
शीर्षक/TITLE	CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION
ड्राईंग संख्या / DRAWING NO.	GD53A000725
शीट SHEET	14 OF 15
पुनरीक्षण REV	00

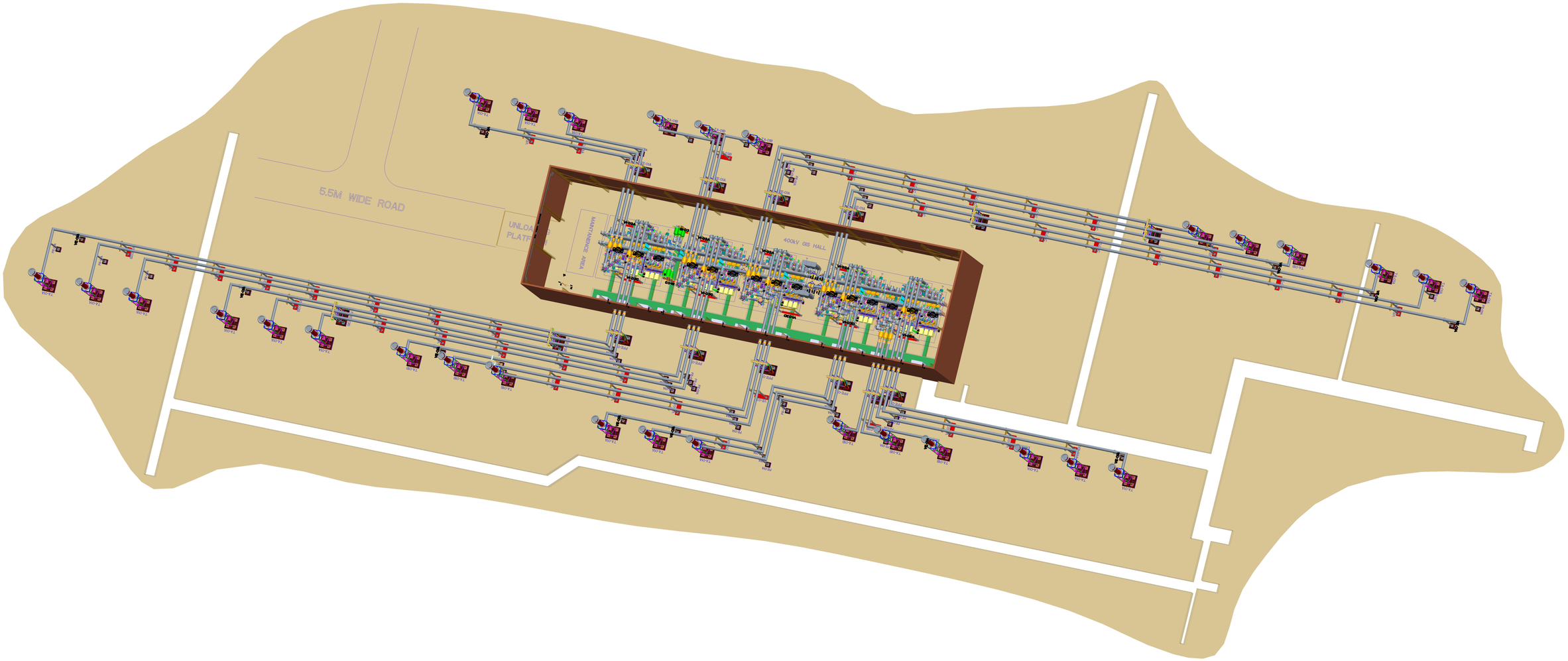
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फरस्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि॰ मी॰ मे है/ALL DIMENSIONS ARE IN MM
GD53A000725 /DRAWING NO.
प्रारूप न्यूनतम

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Approved: RAMU NATARAJAN		29/02/2024	//
T&D INDIA LTD	Sheet: 15/15	Product type: T155-3	GD53A000725 Rev. 00

NTPC_THALCHAR 400kV_T155-3
CIVIL WORK DRAWING

3D VIEW



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VENDOR NAME	GE T&D INDIA LTD. 142, Vandalur-Walajabad Road Padappai, Chennai 601301 Tamilnadu, India
ग्राहक ड्राइंग संख्या CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003
ग्राहक/CUSTOMER	एन टी पी सी लिमिटेड N T P C LIMITED
परियोजना PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW
भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ॰प्र॰)/NOIDA (U.P.)	SHEET TYPE: M तैयारकर्ता/DRN: LJ डिजाइनकर्ता/DES: RN जाँचकर्ता/CHD: MS स्वीकृतकर्ता/APP: SR नाम NAME / हस्ताक्षर SIGNATURE / दिनांक DATE
शीर्षक TITLE	CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION
	ड्राइंग संख्या / DRAWING NO. GD53A000725
डिज़ाइन DES. / हस्ताक्षर SIGN / दिनांक DATE	स्केल – SCALE –
शीट SHEET 15 OF 15	पुनरीक्षण REV. 00

प्रारूप आकार A0
FORMAT SIZE A0

फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि॰ मी॰ में है/ALL DIMENSIONS ARE IN MM
GD53A000725 NO. DRAWING
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Created:	Vigneshraj V	29/02/2024	GD378
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Approved:	RAMU NATARAJAN	29/02/2024	//

T&D INDIA LTD | Sheet: 1/15 | Product type: T155-3

NTPC_THALCHAR 400kV_T155-3
CIVIL WORK DRAWING
GD53A000725 | Rev. 00

Recommendations for basement

STICKER REVISION v0

Cable trays under basement are out of GIS manufacturer scope of supply

Travelling crane

STICKER REVISION 0

a) For the minimum requirements regarding the travelling crane for GIS erection and maintenance purposes, as maximum load to be lifted, the minimun height of the lifting hook in upper position, and the minimum travels (lengthways and to the sides), please refer to layout drawing No: GD53A000704

Floor & walls treatment recommendation

STICKER REVISION v0

a) Finishes schedule of wall and floor of GIS room:
All surfaces must be dustless,
- Wall : surface smooth, clean and washable
- Floor : surface smooth, clean and dust free

b) Out of GIS manufacturer scope of supply

Minimum Concrete Compression Strength

STICKER REVISION v0

fck28 = 30 MPa

a) Valid for (Indoor) building primary concrete slabs AND (Outdoor) concrete foundation blocks

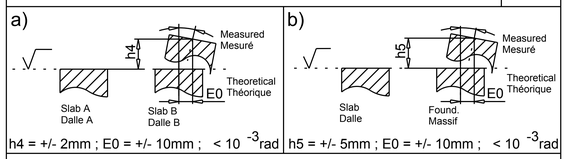
Recommendations for customer-provided earthing

STICKER REVISION v0

a) Refer to document No: GD53A460054

CW movements AFTER GIS erection (h4, h5, , , E0)

STICKER REVISION v0



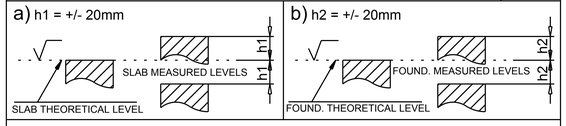
h4 = +/- 2mm ; E0 = +/- 10mm ; < 10 $^{-3}$rad

h5 = +/- 5mm ; E0 = +/- 10mm ; < 10 $^{-3}$rad

a) Maximum relative movement of two GIS slabs at expansion joint (if applicable)
b) Maximum relative movement of GIS slab and outdoor foundations (further to settling effect) (if applicable)

h1 & h2 CW altitude differences (theoretical vs actual)

STICKER REVISION v0



a) The difference (h1) between the actual level and the theoretical level of the GIS slab must not exceed +/- 20mm
b) The difference (h2) between the actual level and the theoretical level of the outdoor foundations must not exceed +/- 20mm

$O_{x.y}$: GIS reference pin

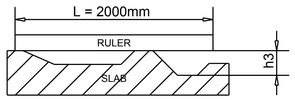
STICKER REVISION v0



a) Out of GIS manufacturer scope of supply.
b) This GIS reference pin has to be indicated ($O_{1.1}$, $O_{1.2}$, ...) and sized on Civil Work realization drawings.
c) GIS reference pin has to be set in concrete and shall be accessible and visible during the complete lifetime of the substation.
d) This GIS reference pin is used to define the main X & Y GIS horizontal axis (indoor and outdoor).

$h3_{slab}$: Flatness Tolerance for GIS slab

STICKER REVISION v0

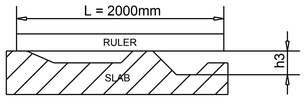


With $h3_{slab}$ < 5 mm

a) Flatness tolerance of GIS slab must not exceed 5mm under a 2000mm ruler.

$h3_{found}$: Flatness Tolerance for GIS Outdoor foundations

STICKER REVISION v0



With $h3_{found}$ < 5 mm

a) Flatness tolerance of outdoor foundation blocks must not exceed 5mm under a 2000mm ruler.
b) Concrete foundation block top heads must be finished "smooth and neat"

SURFACE FINISH(INSIDE BUILDING)

STICKER REVISION v0

INSIDE BUILDING SURFACE FINISH:-
Epoxy Coating Recommended by GE

General tolerance

STICKER REVISION v0

a) Unless specified, all dimensions are in millimeters.
b) Unless specified, general tolerance is +/- 10 mm.

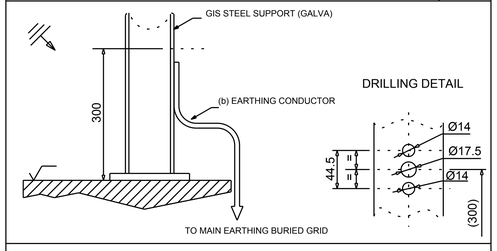
GIS Slab expansion joint

STICKER REVISION v0

a) Introduction of additionnal expansion joint or modification in location compared with this one recommended in this document : shall be submitted to approval of GIS manufacturer

Earthing connection of GIS supports (Equipotential)

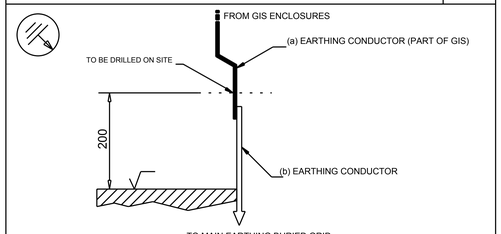
STICKER REVISION v0



a) Earthing connection of GIS supports for equipotential
b) Earthing connection to earthing grid : Out of GIS manufacturer scope of supply

Earthing connection of GIS enclosures (Icc)

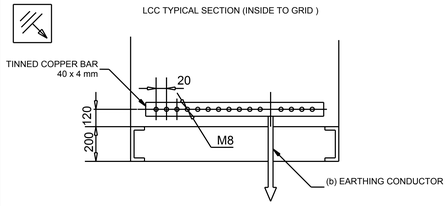
STICKER REVISION v0



a) Earthing connection of GIS enclosures with short-circuit carrying capability
Earthing conductor (part of GIS)
Material: Aluminium
Section: 100 x 10 mm
b) Earthing connection to earthing grid : Out of GIS manufacturer scope of supply

Earthing connection of Local Control Cubicle (LCC)

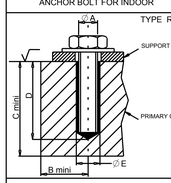
STICKER REVISION v0



a) Earthing connection of Local Control Cubicle
b) Earthing connection to earthing grid : Out of GIS manufacturer scope of supply

Chemical socket inserts for slab WITHOUT finished concrete layer

ANCHOR BOLT FOR INDOOR



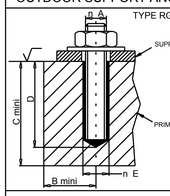
ØA	B	C	D	ØE	Couple N.m
M12	75	165	125	20	40
M16	95	205	160	24	80
M20	125	260	200	32	120

SIZES ARE INDICATED IN MILLIMETER

a) Primary concrete with minimum concrete compression strength at 25 MPa
b) To avoid reinforcement irun cut during slab drilling stage for chemical studs installation, chemical socket location has to be clearly shown (on top view) on civil work concrete reinforcement drawings.
c) Holes drilling will be done at site by GE during erection.

Chemical studs in foundation blocks

OUTDOOR SUPPORT ANCHORING



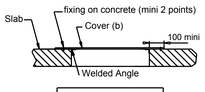
n A	B	C	D	n E	Couple N.m
M20	180	220	170	25	120
M24	210	266	210	28	150

SIZES ARE INDICATED IN MILLIMETER

a) Primary concrete with minimum concrete compression strength at 25 MPa
(No finished concrete layer on foundation blocks)

Obstruction of GIS slab holes

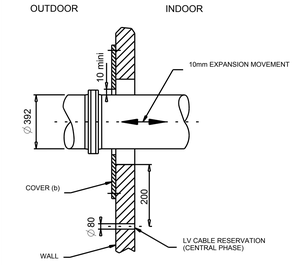
STICKER REVISION v0



For holes in GIS slab for which depth is over 1.20 m :
a) GE recommends obstructing these holes with a metallic cover leveled with slab, and rigidly fixed on the slab with screws.An example sheme is given hereafter.
b) This mettalic cover must be designed to support a total mass of 1000 kg. This maximal weight must appear on the cover
c) Its fixation screws must be at minimum distance of 100 mm from all GIS fixation holes defined in this document.
d) Out of GIS manufacturer scope of supply

GIB wall crossing

STICKER REVISION v0



a) No electrical contact between BUSDUCT and COVER
b) COVER : Out of GIS manufacturer scope of supply-EPC/ Civil contractor.

SUMMARY

PAGE	DESCRIPTION
1	- Civil works tolerances - Concrete qualities - Reference pins - Connection to the earthing circuit - Limits of supply
2	- Loads array - Circuit-breaker dynamic loads
3 - 4	- Indoor support structure and cat walk pedestal marking details
5 - 7	- Outdoor support structure pedestal marking details
8	- CB marking & LCC details
9 - 11	- Indoor Pedestal Details - Outdoor Pedestal Details - Catwalk Pedestal Details
12	Overall view
13	ELEVATION
14	WALL CUTOUT DETAILS
15	3D VIEW

REV6		Name		Name			Name
		Date		Date			Date
REV5		Name		Name			Name
		Date		Date			Date
REV4		Name		Name			Name
		Date		Date			Date
REV3		Name		Name			Name
		Date		Date			Date
REV2		Name		Name			Name
		Date		Date			Date
REV1		Name		Name			Name
		Date		Date			Date
REV0	FIRST SUBMITTION	Name VIGNESH		Name RAMU			Name MURUGAN
		Date 28.02.24		Date 28.02.24			Date 29.02.2024
REV.	DESCRIPTION	DRAWN		REVIEW	ELE	CIVIL	MECH	APPROVED

REFR. DRG. NO. | DESCRIPTION

VENDOR NAME: GE T&D INDIA LTD.
142, Vandalur-Walajabad Road
Padappai, Chennai 601301
Tamilnadu, India

ग्राहक ड्राइंग संख्या CUSTOMER DRAWING NO.: 4540-001-230-PVE-P-003

NTPC | ग्राहक CUSTOMER: एन टी पी सी लिमिटेड N T P C LIMITED

परियोजना PROJECT: TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW)

BHEL | भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION BUSINESS GROUP
नोएडा (उ॰प्र॰) /NOIDA (U.P.)

DEPT. CODE: M

	नाम NAME	हस्ताक्षर SIGNATURE	दिनांक DATE
तैयारकर्ता /DRN	LJ		
डिजाइनकर्ता /DSGN	RN		
जाँचकर्ता /CHD	MS		
अनुमोदनकर्ता /APPD	SR		

शीर्षक / TITLE: CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION

विभाग DEPT. — खोल SCALE: —

ड्राइंग संख्या / DRAWING NO.: GD53A000725

रेवांक REV. NO.: 00

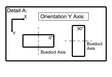
शीट SHEET: 1 OF 15

फॉर्मेट साइज FORMAT SIZE A0

फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि॰ मी॰ में है/ALL DIMENSIONS ARE IN MM
GD53A000725 /DRAWING NO.
शीर्षक देखिए
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The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED and is not to be used directly or indirectly in any way detrimental to the interest of the company. इस दस्तावेज़ पर जानकारी भेल प्रोप्राइटरी सिद्धांत के तहत है
इसका उपयोग प्रत्यक्ष या अप्रत्यक्ष रूप से किसी भी तरह से कंपनी के हितों को नुकसान पहुंचाने के लिये नहीं किया जाएगा।
D:\dgjrnl\GD378_BHEL_NTPC_THALCHAR_400kV_T155-3\GD53A000725_GD378.dgnyrl_Fri Feb 09 11:12:51 2024_GD53A0...

Scale: 1:40	Unit: mm	Format: A0	D. Authority: CHT	NTPC_THALCHAR 400kV_T155-3	
EC Nbr: -----	Q Level: --		Local Unit: CHT	CIVIL WORK DRAWING	
Created: Vigneshraj V			29/02/2024	GD378	
Reviewed: ---			---		
Approved: RAMU NATARAJAN			29/02/2024	//	
T&D INDIA LTD		Sheet: 2/15		GD53A000725	Rev. 00
		Product type: T155-3			

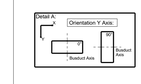
LOAD TABLE - FFL SUPPORT STRUCTURES





DETAIL NAME	FOUNDATION NAME	ORIENTATION Y AXIS (DETAIL A)	DEAD LOAD						Wind pressure loads in X direction on equipment wind speed = 50 m/s						Wind pressure loads in Y direction on equipment normal wind speed =50 m/s						Thermal loads Indoor Tmin = 0 C Outdoor Tmin = 0 C Indoor Tmax = 50 C Outdoor Tmax = 50 C						Short circuit loads Ik = 50kA						Seismic Loads ZONE - III Seismic acceleration According to 1893 - 2002																	
																															following X direction						following Y direction						following Z direction					
			Fx (kN)	Fy (kN)	Fz (kN)	Mx (kN.m)	My (kN.m)	Mz (kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)
GD53S72Z001	CB	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	2	0	5	1.8	0	-	-	-	-	-	-	5	0	0	0	10	0	0	24	0	48	0	0	0	0	12	0	0	0
GD53A721329	VI-03B	-	-	-	-4.8	1.4	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	0.8	1.7	-	-	-	-	-	-	-	-	0.2	0.3	2.1	0.7	0.6	-	-	0.3	3.4	0.6	-	-	-	0.2	0.8	0.3	-	-
GD53A721291	PFI-02	-	0	0	0	0.33	0.33	0	0	0.44	0.11	0.66	-	-	-	0.33	0.88	0.77	0.11	-	2.09	0.92	1.15	0.51	2.42	-	-	-	-	-	-	-	0.11	0.22	0.99	0.44	0.22	-	0.22	0.77	1.76	0.62	0.33	-	-	0.11	0.33	0.11	0.11	-
GD53A720604	PPI-01	-	0.59	0	12.72	0	0.44	0	-0.62	0	-3.03	0	-0.53	0	-0.12	0	0.95	0	-0.1	0	3.73	0	0.01	-0.01	-3.26	0	0	0	0.02	0	0	0	0.01	0	0.03	0	0	0	0	0	0.02	0	0	0	0	0.03	0	0	0
GD53A721233	SI-03	-	0.29	-0.08	6.66	-0.12	-0.08	0	0.01	0	-0.01	0	0	0	-0.02	0.01	0.02	0.01	0	0	39.59	2.52	-49.8	3.1	-10.1	-0.04	0	0	0	0	0	0	2.9	3	3.17	3.66	0.41	0	1.06	2.46	1.21	2.96	0.15	0.01	0.33	0.37	3.36	0.45	0.05	0
GD53A721331 GD53A721332 GD53A721333 GD53A721334	VI-03A VI-03C VI-03D VI-05A	-	-0.43	6.2	0	0.01	0	0.65	0.53	6.47	0	0.01	0	-0.87	-0.44	6.4	0	0.01	0	0.67	-0.28	-7.23	0	0.01	0	-0.34	-0.43	6.24	0	0.01	0	0.65	0.05	0.33	0.04	0.11	0	0.09	0	0	0	0	0	0	0.02	0.42	0.46	1.8	0	0.04
GD53A720534 GD53A720535 GD53A720536	PFI-02A PFI-02B PFI-02C	-	-0.4	6.01	1.87	1.99	0	0.51	-0.07	4.84	0.12	0.17	0	-0.08	-0.13	4.84	0.12	0.17	0	0.11	-4.52	4.32	2.2	2.35	0	4.55	-0.13	4.85	0.12	0.17	0	0.11	0.01	0	0	0	0	0	0	6.49	3.83	4.05	3.25	0	0	0	0	0	1.79	0
GD53A721288	VI-01	-	1.8	7.39	0.001	-0.037	-0.001	-0.374	1.2	0	0.5	0	3.2	0	0.002	0	0.5	0	0.004	0	0.312	-0.881	-0.001	-0.065	-0.001	-0.724	0	0	0	0	0	0	1.531	2.325	0.18	0.304	0.001	2.263	0.257	0.665	0.124	0.209	0	0.232	1.393	2.314	0.135	0.227	0.001	1.977
GD53A721254	VI-04	-	-0.088	10.281	0.037	0.04	0.004	-0.22	1	0	1.1	0	5.2	0	0.1	0	1.3	0	0.2	0	-0.027	-3.353	-0.384	-0.468	0.002	0.163	0	0	0	0	0	0	0.097	1.204	0.103	0.124	0.004	0.185	0.148	0.386	0.016	0.019	0.006	0.213	0.108	2.236	0.271	0.328	0.005	0.309

LOAD TABLE - FGL SUPPORT STRUCTURES





DETAIL NAME	FOUNDATION NAME	ORIENTATION Y AXIS (DETAIL A)	DEAD LOAD						Wind pressure loads in X direction on equipment normal wind speed = 50 m/s						Wind pressure loads in Y direction on equipment normal wind speed = 50 m/s						Thermal loads Indoor Tmin = 0 C Outdoor Tmin = 0 C Indoor Tmax = 50 C Outdoor Tmax = 50 C						Short circuit loads Ik = 50kA						Seismic Loads ZONE - III Seismic acceleration According to 1893 - 2002																	
																															following X direction						following Y direction						following Z direction					
			Fx (kN)	Fy (kN)	Fz (kN)	Mx (kN.m)	My (kN.m)	Mz (kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)	Fx (+/- kN)	Fy (+/- kN)	Fz (+/- kN)	Mx (+/- kN.m)	My (+/- kN.m)	Mz (+/- kN.m)
GD53A721292 GD53A721344 GD53A721345	PFE-01A PFE-01B PFE-01C	-	-	-	-0.24	0.17	-0.06	-	-9.30	-0.95	1.30	0.59	-2.12	-0.15	-0.40	-4.53	2.70	1.04	-0.25	-0.15	1.93	1.91	0.96	-1.08	-3.36	11.90	-	-	-	0.10	0.20	-	7.00	2.20	0.50	13.50	45.50	4.80	2.30	6.70	0.50	41.80	15.00	2.30	0.30	0.20	1.20	1.20	1.80	0.50
GD53A721384 GD53A721385 GD53A721347	FE-01A VE-02 PFE-01	-	-	-	-19.90	0.40	0.40	-	3.20	-	0.70	0.10	5.20	-	0.50	-	0.40	-	0.80	-	3.10	-	1.10	-	0.20	5.00	-	-	-	-	-	-	-	1.40	-	0.40	0.10	2.20	-	0.60	-	0.30	0.10	1.00	-	0.10	0.40	0.10	0.10	-
GD53A721336 GD53A721346 GD53A721342	VE-03A VE-03B VE-03C	-	0.185	0.359	5.814	-0.017	-0.021	0.003	-1.641	0.04	-8.737	0.077	0.246	0.014	0.665	-10.19	38.741	-1.14	0.348	-0.125	-0.241	-5.25	13.558	-0.498	0.221	0.063	0.007	-0.028	0.199	-0.003	-0.001	0	1.553	3.211	17.378	0.793	0.554	0.056	2.545	8.75	30.36	2.201	0.999	0.156	0.703	0.566	7.511	0.145	0.245	0.011
GD53A721337 GD53A721341	VE-01A VE-01B	-	0.006	-0.02	6.004	-0.043	-0.028	0	-1.772	0.012	0.392	0.033	3.667	0.001	0.017	-1.872	4.154	-3.835	0.04	0	-0.038	-1.009	-4.018	-2.65	0.082	-0.002	-0.002	0.004	-0.083	0.013	0.002	0	1.665	1.003	4.173	2.665	4.565	0.004	0.253	2.071	8.396	3.433	0.605	0.005	0.216	0.186	2.045	0.463	0.363	0.001
GD53A721340	TA-01B	-	-0.092	-0.091	5.247	-0.029	0.025	0.001	-3.799	0.342	16.019	-0.117	0.167	-0.059	-1.1	-6.019	26.226	-1.54	0.398	-0.095	3.326	-2.453	-14.104	-0.72	-0.893	-0.064	-0.4897	-0.0343	4.0714	-0.0217	-0.125	-0.0076	7.188	5.938	42.09	1.482	1.806	0.116	4.776	8.453	52.205	2.177	1.237	0.131	0.261	0.307	1.981	0.079	0.067	0.005
GD53A721338	TA-01A	-	-	-	3.61	0.03	-0.01	-	-6.88	2.3	3.3	0.43	1.32	-0.15	0.6	0.33	3.1	0.13	3.3	2.8	1.93	1.91	0.96	1.08	-1.08	-0.7	0.2	0.4	0.1	5.5	2.1	0.4	3.4	4.5	0.6	31.5	21.4	2.6	1.8	2.4	0.4	6.6	1.5	1.2	0.2	0.2	0.4	0.5	1.1	0.1

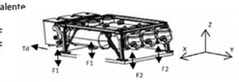
T155-CB3 : Circuit breaker dynamic loads - Frame HEB140 (3 phases)
T155-CB3 : Charges dynamiques du disjoncteur - Charpente HEB140 (3 phases)

		Case 1	Case 2
F1, F2 (kN)	Vertical load F1 (kN)	+ 44	- 44
	Vertical load F2 (kN)	- 9	+ 9
Td (kN)	Horizontal load (Y direction)	± 12	± 12

F1 and F2 are for one foot

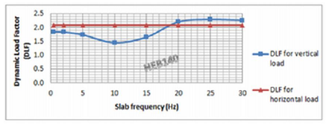
Static equivalent load
Charge statique équivalente

Fs1 = F1 x DLF
Fs2 = F2 x DLF
Ts = Td x DLF



It must be added to the dead load of the CB for combination of loads
(refer to ... in "Static loads" table").

Elle doit être ajoutée à la charge de poids propre du CB pour combinaison de charges
(voir ... dans le tableau "Charges statiques").



Nota: a safety factor of 1.3 is already applied on DLF curve for taking into account measuring divergences

NOTE:
Load table parameters :
1.) Min. Temperature '-20' deg C, Max Temperature +50 deg C
2.) Seismic Zone = Zone - III

VENDOR NAME	GE T&D INDIA LTD. 142, Vandalur-Walajabad Road Padappai, Chennai 601301 Tamilnadu, India
ग्राहक ड्राइंग संख्या CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003
NTPC ग्राहक / CUSTOMER	एन टी पी सी लिमिटेड N T P C LIMITED
परियोजना PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW)
BHEL भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ॰प्र॰) / NOIDA (U.P.)	DEPT CODE: M विभागाध्यक्ष / DEPT. HEAD: LJ डिजाइनकर्ता / DESIGN: RN परीक्षकर्ता / CHD: MS अनुमोदनकर्ता / APPD: SR
शीर्षक / TITLE	CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION
विभाग DEPT. / स्केल SCALE: – / ड्राइंग संख्या / DRAWING NO.	GD53A000725
इंजीनियर ENGR. / ड्राफ्टर DRAFT. / दिनांक DATE	शीट SHEET 2 OF 15 / पुनरीक्षण REV. 00

फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि॰ मी॰ में है/ALL DIMENSIONS ARE IN MM
ड्राइंग संख्या GD53A000725 ON SHEET/09

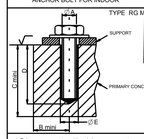
INDOOR CB MARKING DIMENSION, SUPPORT STRUCTURE AND CAT WALK PEDESTAL DETAILS

Scale: 1:40	Unit: mm	Format: A0	D. Authority: CHT	NTPC_THALCHAR 400kV_T155-3
EC Nbr: ------		Q Level: ++	Local Unit: CHT	CIVIL WORK DRAWING
Created: Vigneshraj V			29/02/2024	GD378
Reviewed: ---			---	
Approved: RAMU NATARAJAN			29/02/2024	//
T&D INDIA LTD		Sheet: 3/15	Product type: T155-3	GD53A000725 Rev. 00

Chemical socket inserts for slab WITHOUT finished concrete layer

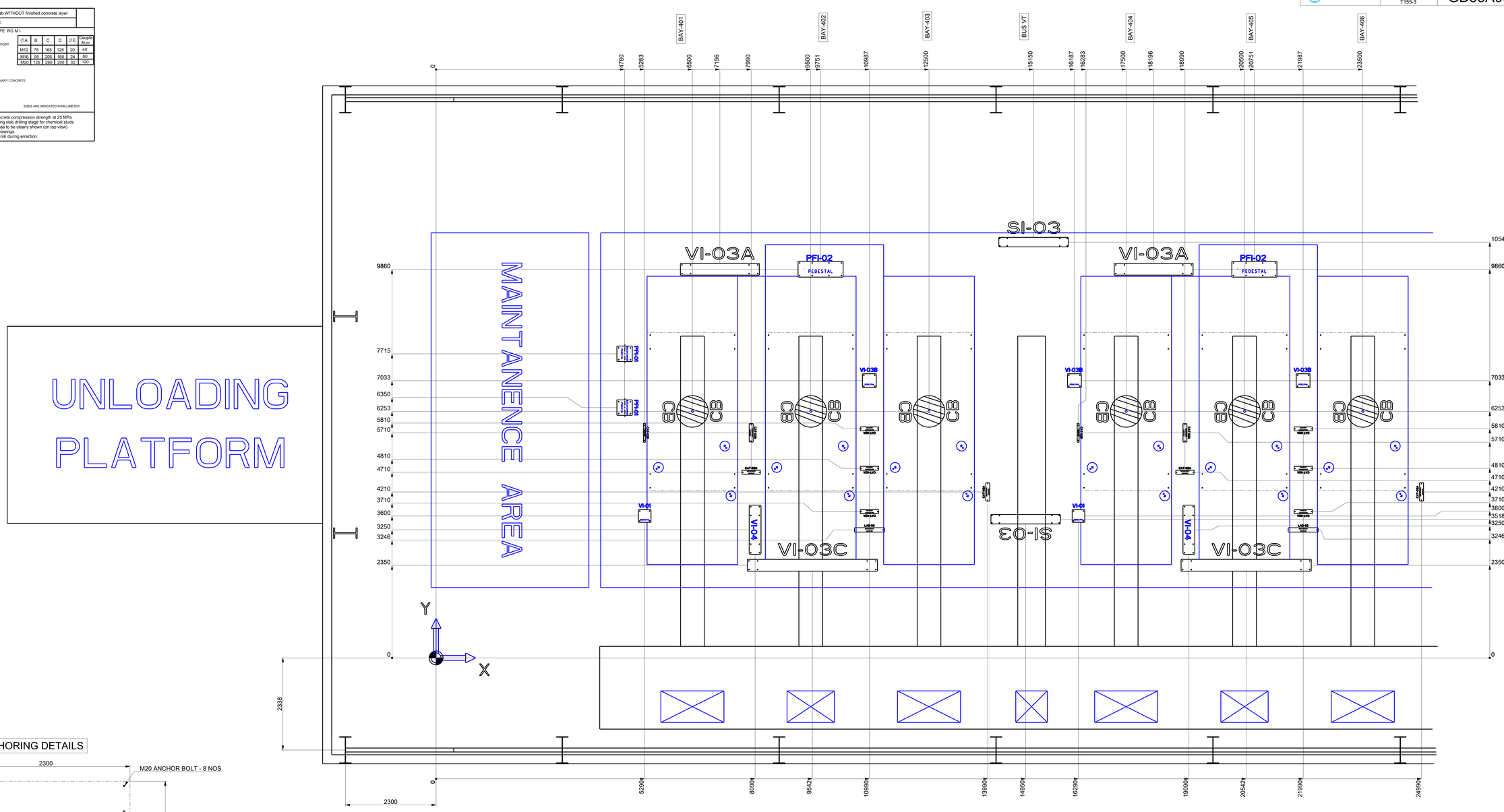
ANCHOR BOLT FOR INDOOR

TYPE RG M I

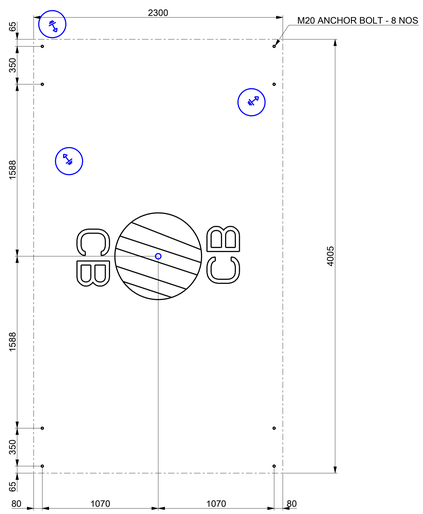


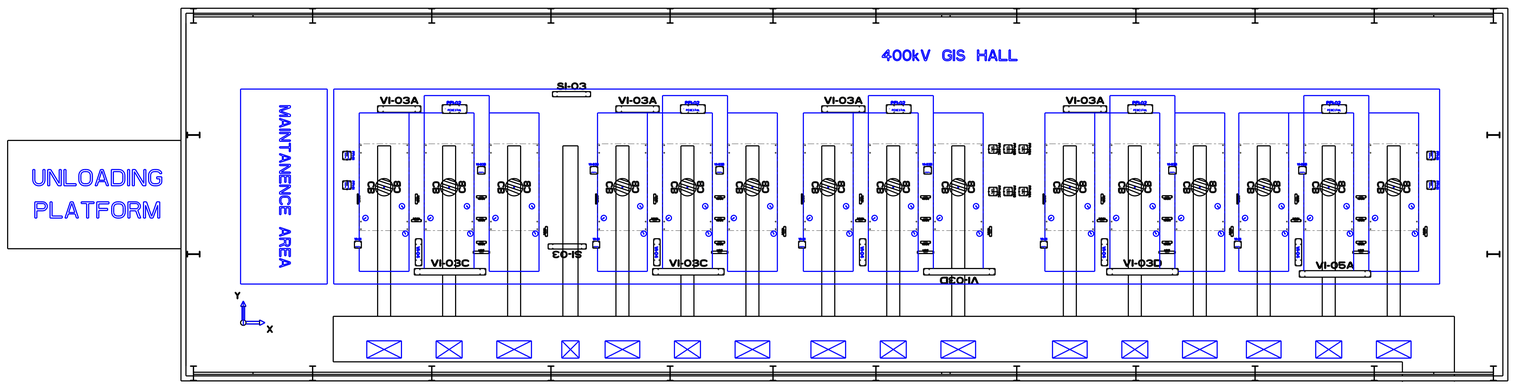
ØA	B	C	D	ØE	Couple N.m
M12	75	165	125	20	40
M16	95	205	160	24	80
M20	125	260	200	32	120

a) Primary concrete with minimum concrete compression strength at 25 MPa
b) To avoid reinforcement irun cut during slab drilling stage for chemical studs installation, chemical socket location has to be clearly shown (on top view) on civil work concrete reinforcement drawings.
c) Holes drilling will be done at site by GE during erection.



CB ANCHORING DETAILS





VENDOR NAME	GE T&D INDIA LTD. 142, Vandalur-Walajabad Road Padappai, Chennai 601301 Tamilnadu, India
ग्राहक ड्राइंग संख्या / CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003
ग्राहक / CUSTOMER	एन टी पी सी लिमिटेड N T P C LIMITED
परियोजना / PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW
	भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ॰प्र॰) / NOIDA (U.P.)
शीर्षक / TITLE	CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION
ड्राइंग संख्या / DRAWING NO.	GD53A000725
शीट / SHEET	3 OF 15
पुनरीक्षण / REV.	00

	नाम NAME	हस्ताक्षर SIGNATURE	दिनांक DATE
तैयारकर्ता / DRN	LJ		
डिजाइनकर्ता / DES	RN		
जाँचकर्ता / CHD	MS		
अनुमोदनकर्ता / APP	SR		

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इस दस्तावेज़ पर दी गई जानकारी का स्वामित्व भेल के पास है। इसका प्रयोग प्रत्यक्ष या अप्रत्यक्ष रूप से किसी भी तरह से भेल के हितों के प्रतिकूल नहीं होना चाहिए।
D:\dgjobs\GD53A000725_BHEL_NTPC_THALCHAR_400kV_T155-3\GD53A000725_4DV3W_Layout.drw
फॉर्मेट साइज़ A0 FORMAT SIZE A0

फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि॰ मी॰ मे है/ALL DIMENSIONS ARE IN MM
GD53A000725 /09MW60 NO
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Scale: 1:40	Unit: mm
EC Nbr: -----	Format: A0
Created: Vigneshraj V	Q Level: --
Reviewed: ---	D. Authority: CHT
Approved: RAMU NATARAJAN	Local Unit: CHT
T&D INDIA LTD	29/02/2024
	29/02/2024

	//
Sheet: 4/15	
Product type: T155-3	

NTPC_THALCHAR 400kV_T155-3
CIVIL WORK DRAWING
GD378
GD53A000725
Rev. 00

INDOOR CB MARKING DIMENSION, SUPPORT STRUCTURE AND CAT WALK PEDESTAL DETAILS

BAY-407 BAY-408 BAY-409 SA BAY-410 BAY-411 BAY-412 BAY-413 BAY-414 BAY-415

25783 27000 27696 28490 30000 30251 31587 33000 34600 35300 36000 36933 38150 38850 39640 41150 41401 42887 44150 45883 47100 48390 48887 50100 50351 53100 54824

400kV GIS HALL

VI-03A PFI-02 PEDESTAL VI-03A PFI-02 PEDESTAL PFI-02 PEDESTAL

VI-03B VI-01 VI-04 VI-03D VI-05A PFI-02A PFI-02B PFI-02C PFI-01 CAT-02A CAT-02B LAD-02 VED-LV3

9860 8013 7033 6253 6054 5810 5710 4810 4710 4210 3710 3600 3250 3246 2350 2250 0

25790 28590 31490 33050 34490 36950 39750 41500 42640 45640 45900 48700 50390 51590 54590

Chemical socket inserts for slab WITHOUT finished concrete layer						
ANCHOR BOLT FOR INDOOR						
TYPE: RG M I						
∅A	B	C	D	∅E	Couple N.m.	
M12	75	165	125	20	40	
M16	95	205	160	24	80	
M20	125	260	200	32	120	

SUPPORT, PRIMARY CONCRETE, C min, D, B min, ∅E

SIZES ARE INDICATED IN MILLIMETER

a) Primary concrete with minimum concrete compression strength at 25 MPa
b) To avoid reinforcement inrun cut during slab drilling stage for chemical studs installation, chemical socket location has to be clearly shown (on top view) on civil work concrete reinforcement drawings.
c) Holes drilling will be done at site by GE during erection.

VENDOR NAME: GE T&D INDIA LTD.
142, Vandalur-Walajabad Road
Padappai, Chennai 601301
Tamilnadu, India

ग्राहक ड्राईंग संख्या / CUSTOMER DRAWING NO.: 4540-001-230-PVE-P-003

ग्राहक / CUSTOMER: एन टी पी सी लिमिटेड / N T P C LIMITED

परियोजना / PROJECT: TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW)

भारत हेवी इलेक्ट्रिकल्स लिमिटेड / BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION BUSINESS GROUP
नोएडा (उ॰प्र॰) / NOIDA (U.P.)

DEPT CODE: M

	नाम / NAME	हस्ताक्षर / SIGNATURE	दिनांक / DATE
तैयारकर्ता / DRN	LJ		
डिजाइनकर्ता / DSN	RN		
जाँचकर्ता / CHD	MS		
अनुमोदनकर्ता / APPD	SR		

शीर्षक / TITLE: CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION

विभाग / DEPT.: --- स्केल / SCALE: ---
हस्ताक्षर / SIGN
दिनांक / DATE

ड्राईंग संख्या / DRAWING NO.: GD53A000725
शीट / SHEET 4 OF 15 पुनरीक्षण / REV. 00

फॉर्मेट साइज A0
FORMAT SIZE A0

फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि॰ मी॰ मे है/ALL DIMENSIONS ARE IN MM
GD53A000725 ON SHEET NO.
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COPY RIGHT AND CONFIDENTIAL/ कॉपीराइट और गोपनीय
यह दस्तावेज भारत हेवी इलेक्ट्रिकल्स लिमिटेड (भेल) की संपत्ति है
इसका उपयोग भेल के हितों को किसी भी तरह से क्षति पहुंचाने के लिए नहीं किया जाना चाहिए
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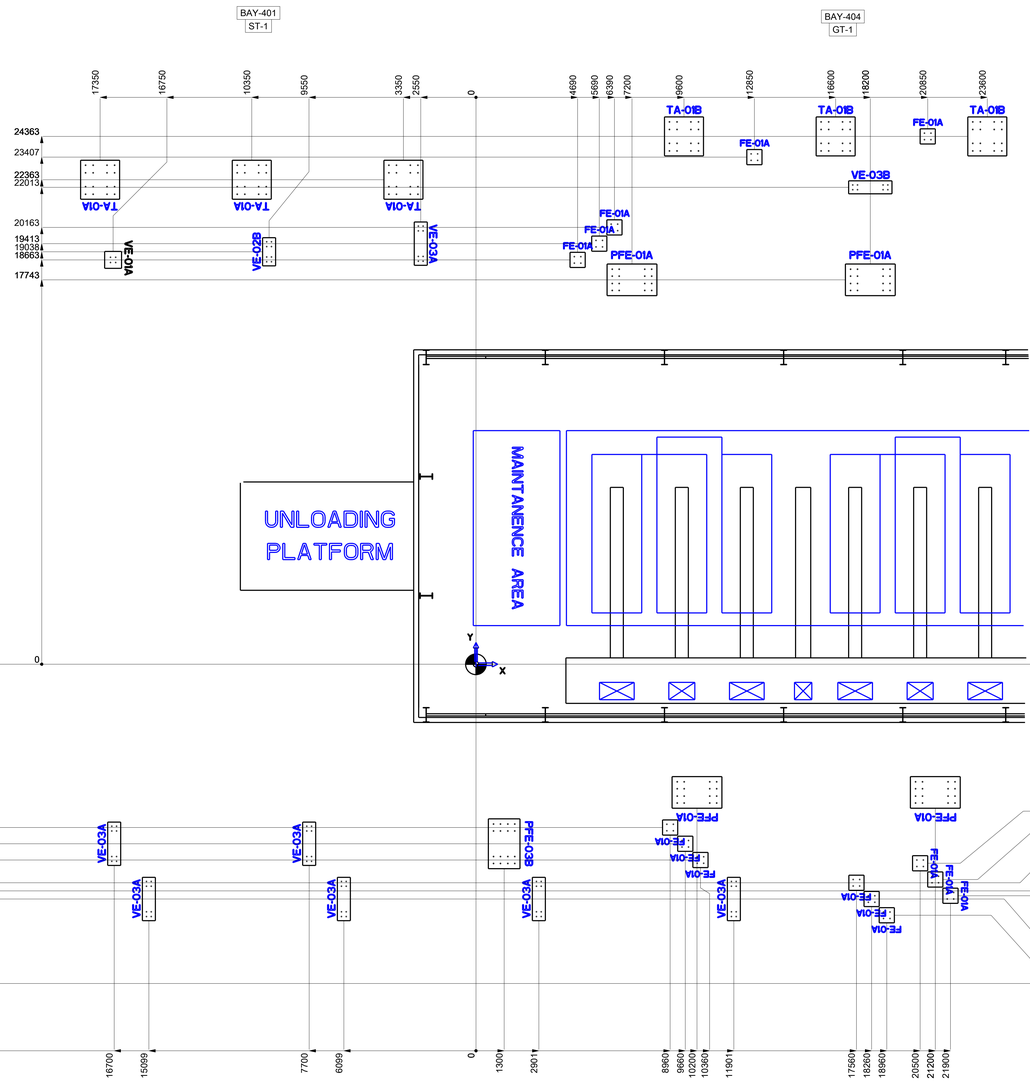
OUTDOOR SUPPORT STRUCTURE PEDESTAL DETAILS

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EC Nbr: -----		Q Level: --	Local Unit: CHT
Created: Vigneshraj V			29/02/2024
Reviewed: ---			---
Approved: RAMU NATARAJAN			29/02/2024

NTPC_THALCHAR 400kV_T155-3
CIVIL WORK DRAWING
GD378

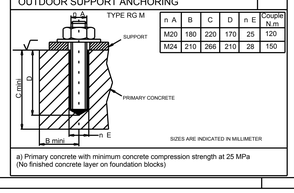
T&D INDIA LTD | Sheet: 5/15 | Product type: T155-3

GD53A000725 | Rev. 00



Chemical studs in foundation blocks

OUTDOOR SUPPORT ANCHORING



n A	B	C	D	n E	Couple N.m
M20	180	220	170	25	120
M24	210	266	210	28	150

SIZES ARE INDICATED IN MILLIMETER

a) Primary concrete with minimum concrete compression strength at 25 MPa
(No finished concrete layer on foundation blocks)

VENDOR NAME: GE T&D INDIA LTD.
142, Vandalur-Walajabad Road
Padappai, Chennai 601301
Tamilnadu, India

ग्राहक ड्राइंग संख्या / CUSTOMER DRAWING NO.: 4540-001-230-PVE-P-003

ग्राहक / CUSTOMER: एन टी पी सी लिमिटेड
N T P C LIMITED

परियोजना / PROJECT: TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW)

भारत हेवी इलेक्ट्रिकल्स लिमिटेड
BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION BUSINESS GROUP
नोएडा (उ॰प्र॰) / NOIDA (U.P.)

	नाम / NAME	हस्ताक्षर / SIGNATURE	दिनांक / DATE
तैयारकर्ता / DRN	LJ		
डिजाइनकर्ता / DESN	RN		
जाँचकर्ता / CHD	MS		
अनुमोदनकर्ता / APPD	SR		

GROUP CODE: M

शीर्षक / TITLE: CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION

विभाग / DEPT. | स्केल / SCALE: – | ड्राइंग संख्या / DRAWING NO.: GD53A000725

हस्ताक्षर / SIGN | दिनांक / DATE

शीट / SHEET 5 OF 15 | पुनरीक्षण / REV. 00

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दस्तावेज़ के गोपनीय
यह दस्तावेज़ भारत हेवी इलेक्ट्रिकल्स लिमिटेड की संपत्ति है
इसका उपयोग उस व्यक्ति के लिये ही किया जाना है जिसे यह भारत हेवी इलेक्ट्रिकल्स लिमिटेड द्वारा दिया गया है

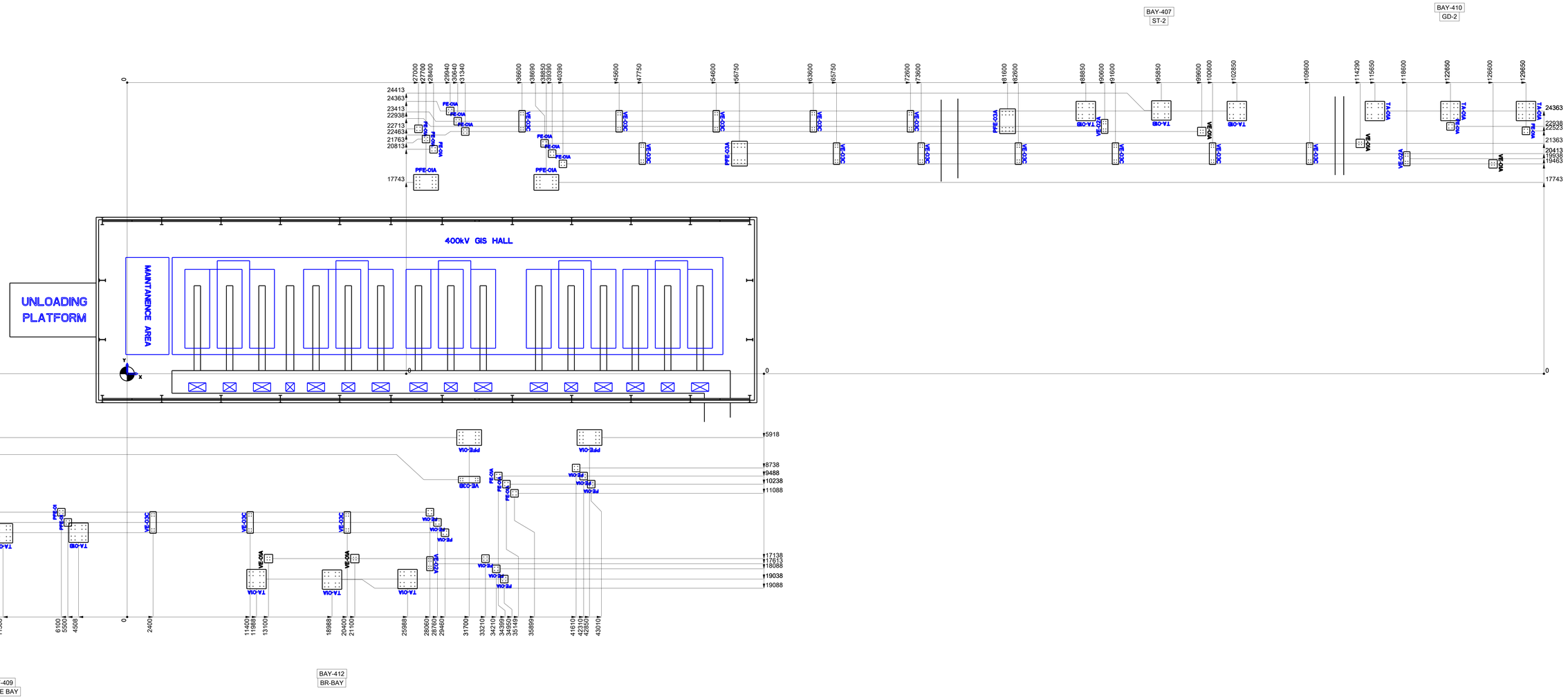
प्रारूप संख्या GD53A000725 /09MW69/ NO.

OUTDOOR SUPPORT STRUCTURE PEDESTAL DETAILS

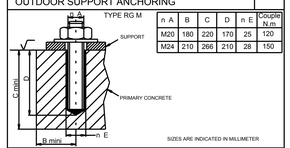
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EC Nbr: -----		Q Level: --	Local Unit: CHT
Created: Vigneshraj V			29/02/2024
Reviewed: ---			---
Approved: RAMU NATARAJAN			29/02/2024
T&D INDIA LTD	Sheet: 6/15	Product type: T155-3	

NTPC_THALCHAR 400kV_T155-3
CIVIL WORK DRAWING
GD378

GD53A000725 Rev. 00



Chemical studs in foundation blocks							
OUTDOOR SUPPORT ANCHORING							
TYPE RG M	n A	B	C	D	n E	Couple N.m	
	M20	180	220	170	25	120	
	M24	210	266	210	28	150	



SIZES ARE INDICATED IN MILLIMETER

a) Primary concrete with minimum concrete compression strength at 25 MPa
(No finished concrete layer on foundation blocks)

VENDOR NAME	GE T&D INDIA LTD. 142, Vandalur-Walajabad Road Padappai, Chennai 601301 Tamilnadu, India
ग्राहक दृष्टांग संख्या CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003
ग्राहक / CUSTOMER	एन टी पी सी लिमिटेड N T P C LIMITED
परियोजना PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW
	भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ॰प्र॰) / NOIDA (U.P.)

	नाम NAME	हस्ताक्षर SIGNATURE	दिनांक DATE
तैयारकर्ता DRN	LJ		
डिजाइनकर्ता DESN	RN		
जांचकर्ता CHD	MS		
अनुमोदनकर्ता APPD	SR		

SHEET STYLE: M

शीर्षक TITLE
CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION

दिनांक DATE	स्केल – SCALE
हस्ताक्षर SIGN	
दिनांक DATE	

दृष्टांग संख्या / DRAWING NO.
GD53A000725

शीट SHEET 6 OF 15 पुनरीक्षण REV. 00

फॉर्मेट साइज़ A0
FORMAT SIZE A0

फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION
सभी माप मि॰ मी॰ मे है/ALL DIMENSIONS ARE IN MM
GD53A000725 ON SHEET NO.
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इस दस्तावेज़ में दी गई जानकारी भेल की संपत्ति है और इसे भेल की लिखित अनुमति के बिना प्रकट या उपयोग नहीं किया जाना चाहिए। यदि यह दस्तावेज़ गलती से प्राप्त हुआ है तो कृपया इसे तुरंत भेल को वापस कर दें।

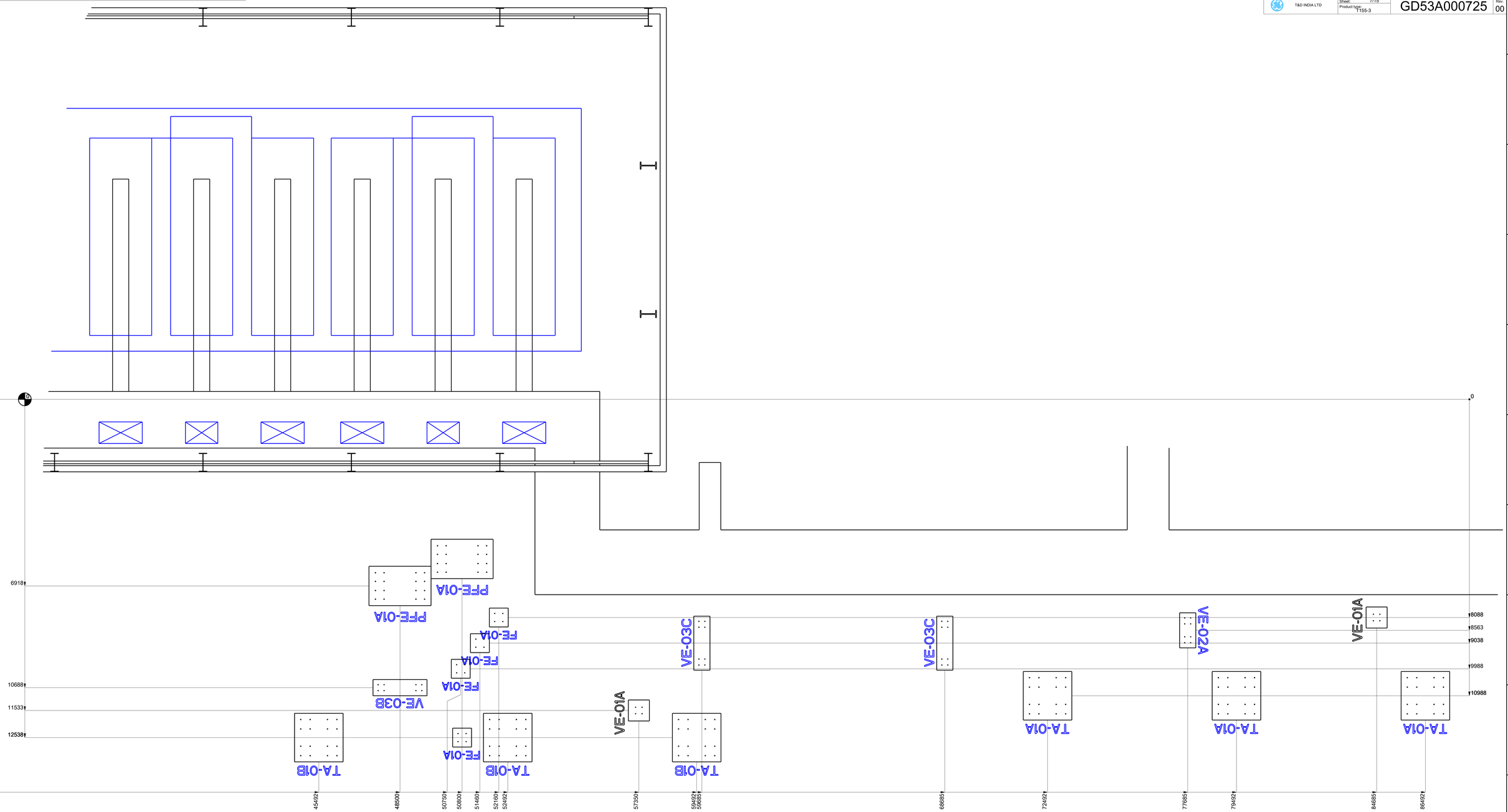
OUTDOOR SUPPORT STRUCTURE PEDESTAL DETAILS

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Local Unit: CHT	
Created: Vigneshraj V	29/02/2024
Reviewed: ---	---
Approved: RAMU NATARAJAN	29/02/2024
T&D INDIA LTD	Sheet: 7/15
Product type: T155-3	

NTPC_THALCHAR 400kV_T155-3
CIVIL WORK DRAWING
GD378
//

GD53A000725

Rev. 00

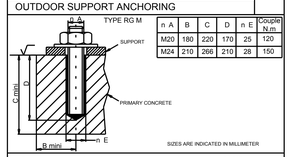


BAY-413
LINE-3

BAY-415
LINE-4

Chemical studs in foundation blocks

OUTDOOR SUPPORT ANCHORING



n A	B	C	D	n E	Couple N.m
M20	180	220	170	25	120
M24	210	266	210	28	150

SIZES ARE INDICATED IN MILLIMETER

a) Primary concrete with minimum concrete compression strength at 25 MPa (No finished concrete layer on foundation blocks)

VENDOR NAME: GE T&D INDIA LTD.
142, Vandalur-Walajabad Road
Padappai, Chennai 601301
Tamilnadu, India

ग्राहक ड्राइंग संख्या / CUSTOMER DRAWING NO.: 4540-001-230-PVE-P-003

ग्राहक / CUSTOMER: एन टी पी सी लिमिटेड
N T P C LIMITED

परियोजना / PROJECT: TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW)

भारत हेवी इलेक्ट्रिकल्स लिमिटेड
BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION BUSINESS GROUP
नोएडा (उ॰प्र॰)/NOIDA (U.P.)

DEPT CODE		नाम NAME	हस्ताक्षर SIGNATURE	दिनांक DATE
M	तैयारकर्ता/DRN.	LJ		
	डिजाइनकर्ता/DES.	RN		
	जांचकर्ता/CHD.	MS		
	अनुमोदनकर्ता/APPD.	SR		

शीर्षक / TITLE: CIVIL WORK DRAWING OF TALCHER 400kV GIS SUBSTATION

डिज़ाइन DEPT.	स्केल SCALE: –
ड्राइंग संख्या / DRAWING NO.	GD53A000725
शीट SHEET	7 OF 15
पुनरीक्षण REV.	00

फॉर्मेट साइज़ A0
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EC Nbr: ----	Q Level: 3
Created: Logeshwar J	12/03/2024
Reviewed: ---	---
Approved: Samikkannu Murugan	12/03/2024
T&D INDIA LTD	Sheet: 1/6
	Product type: T155-3
D. Authority: CHT	
Local Unit: CHT	

NTPC_THALCHAR 400kV_T155-3
GIS EARTHING PLAN
GD378
/

GD53A460054 Rev. 00

DESCRIPTION	
Material : Aluminium	
	Connecting to the general earthing circuit of the substation
	(100X10)mm Al. Flat for main GIS Equipment Earthing
	(100x10)mm Al. Flat for main LCC Equipment Earthing
	2x(100x10) Looping of Enclosure
	2x(100x10) Looping of CB
- RAISER	100x10 Raiser connection

NOTE :
Size of earthing circuit according to IEEE STD 80-2000 recommendation
Hight frequency earthing sholud be taken care during GIS floor condtruction GE main contractor scope.

Note:
1. All outdoor structure has to be Earthed (GE Main contractor scope).
2. All GIS/GIB equipment earthing strip shall be connected to main earth Grid.
3. Earthing raisers need to be provided near to the GIS (GE Main contractor scope).

Reference Documents:-
1. Recommendations for customer provided earthing - H47020185-en_05

REFR. DRG. NO.	DESCRIPTION

REV	DESCRIPTION	DRAWN	REVIEW	ELE	CIVIL	MECH	APPROVED
REV0	FIRST SUBMITTION	LOGESH 12.03.24	RAMU 12.03.24				MURUGAN 12.03.2024

VENDOR NAME: GE T&D INDIA LTD.
142, Vandalur-Walajabad Road
Padappai, Chennai 601301
Tamilnadu, India

ग्राहक ड्राइंग संख्या / CUSTOMER DRAWING NO.: 4540-001-230-PVE-P-003

ग्राहक / CUSTOMER: एन टी पी सी लिमिटेड
N T P C LIMITED

परियोजना / PROJECT: TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW

भारत हेवी इलेक्ट्रिकल्स लिमिटेड
BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION BUSINESS GROUP
नोएडा (उ॰प्र॰) / NOIDA (U.P.)

	नाम NAME	हस्ताक्षर SIGNATURE	दिनांक DATE
तैयारकर्ता / DES	AK		
डिजाइनकर्ता / DES	RN		
जाँचकर्ता / CHD	MS		
अनुमोदनकर्ता / APP	SR		

SHEET TYPE: M

शीर्षक / TITLE: 400kV GIS Earthing Plan

ड्राइंग संख्या / DRAWING NO.: GD53A460054

शीट / SHEET: 01 OF 05 पुनरीक्षण / REV.: 00

डिज़ाइन / DES. / ड्राफ्ट / DRN / टेस / CHK / अनु॰ / APP: — स्केल / SCALE: —

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FORMAT SIZE A0

ON SNIMVSO/ऊपरी दृश्य

फर्स्ट एंगल प्रोजेक्शन/FIRST ANGLE PROJECTION

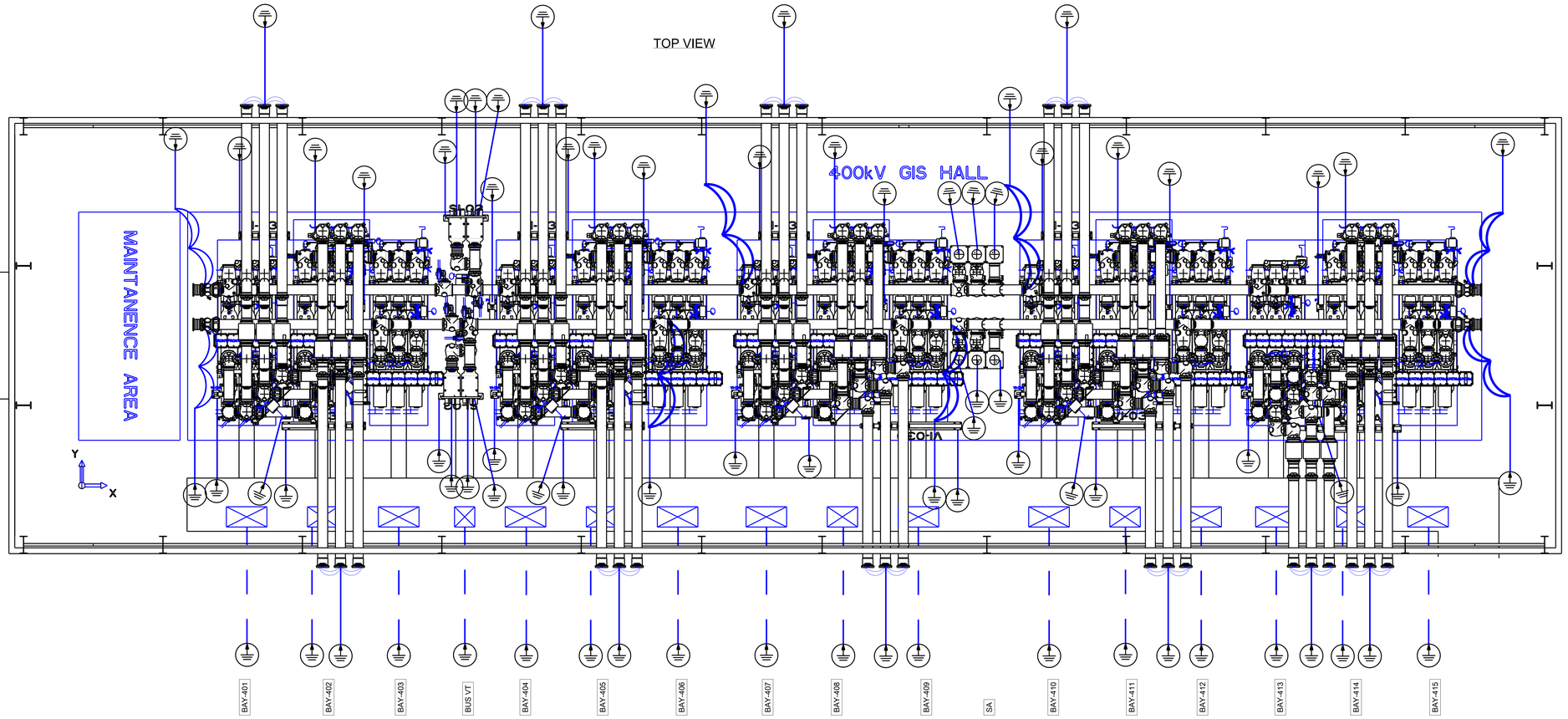
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FLOOR LEVEL EARTHING VIEW

Tolerance: 1890000	Unit: mm	Format: A0	D. Authority: CHT	NTPC_THALCHAR 400kV_T155-3	
EC Nbr:		Q Level: 3	Local Unit: CHT	GIS EARTHING PLAN	
Created: Logeshwar J			12/03/2024	GD378	
Reviewed: ---			---		
Approved: Samikkannu Murugan			12/03/2024	/	
T&D INDIA LTD		Sheet: 2/6		GD53A460054	Rev. 00
		Product type: T155-3			

TOP VIEW



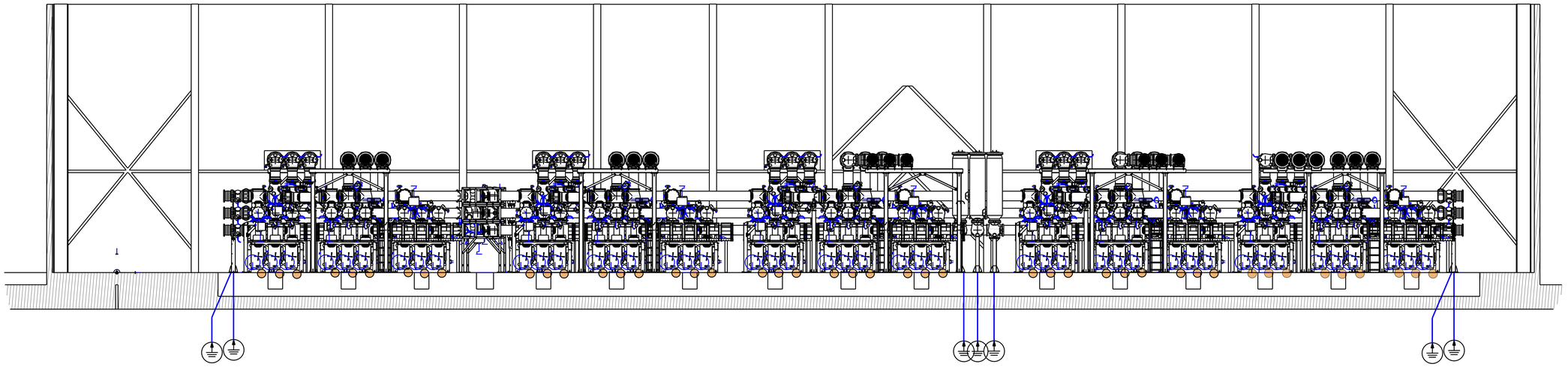
VENDOR NAME	GE T&D INDIA LTD. 142, Vandalur-Walajabad Road Padappai, Chennai 601301 Tamilnadu, India
ग्राहक ड्राइंग संख्या CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003
NTPC	ग्राहक / CUSTOMER: एन टी पी सी लिमिटेड N. T. P. C. LIMITED
परियोजना PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW)
BHEL	भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ॰प्र॰) / NOIDA (U.P.)
DEPT CODE: M	नाम NAME / हस्ताक्षर SIGNATURE / दिनांक DATE चित्रकार DRN: AK डिज़ाइनकर्ता DES: RN जाँचकर्ता CHD: MS स्वीकृतकर्ता APPD: SR
शीर्षक / TITLE	400kV GIS Earthing Plan
डिज़ाइन स्केल DEPT. SCALE: --	ड्राइंग संख्या / DRAWING NO.: GD53A460054
हस्ताक्षर SIGN / दिनांक DATE	शीट SHEET 02 OF 05 / पुनरीक्षण REV. 00

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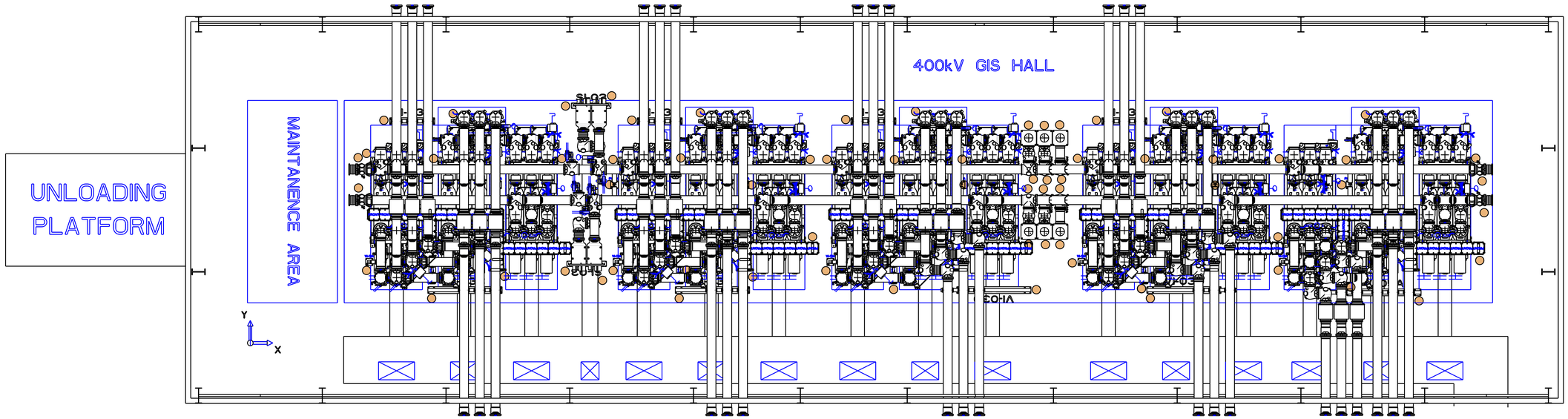
FLOOR LEVEL EARTHING VIEW

Unit: mm	Format: A0	D. Authority: CHT	NTPC_THALCHAR 400kV_T155-3
EC Nbr:	Q Level: 3	Local Unit: CHT	GIS EARTHING PLAN
Created: Logeshwar J		12/03/2024	GD378
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Approved: Samikkannu Murugan		12/03/2024	/
T&D INDIA LTD	Sheet: 3/6	Product type: T155-3	GD53A460054 Rev. 00

FRONT VIEW



TOP VIEW



NOTE:-
- RAISER

S.No	FFL	FGL	Total
Raiser Qty	158	182	340

VENDOR NAME	GE T&D INDIA LTD. 142, Vandalur-Walajabad Road Padappai, Chennai 601301 Tamilnadu, India
ग्राहक ड्राइंग संख्या CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003
ग्राहक / CUSTOMER	एन टी पी सी लिमिटेड N T P C LIMITED
परियोजना PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW
	भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ॰प्र॰) / NOIDA (U.P.)

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	जांचकर्ता / CHD	MS		
	अनुमोदनकर्ता / APPD	SR		

शीर्षक / TITLE: 400kV GIS Earthing Plan

विभाग DEPT.	स्केल – SCALE:	ड्राइंग संख्या / DRAWING NO.	GD53A460054
हस्ताक्षर SIGN		शीट SHEET 02 OF 05	पुनरीक्षण REV. 00
दिनांक DATE			

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ड्राइंग नंबर/DRAWING NO.

GROUND LEVEL EARTHING VIEW

Unit: mm	Format: A0	D. Authority: CHT	NTPC_THALCHAR 400kV_T155-3
EC Nbr:	Q Level: 3	Local Unit: CHT	GIS EARTHING PLAN
Created: Logeshwar J	12/03/2024	---	GD378
Reviewed: ---		---	
Approved: Samikkannu Murugan	12/03/2024	/	
T&D INDIA LTD	Sheet: 4/6	Product type: T155-3	GD53A460054 Rev. 00

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इसका उपयोग सीधे या अप्रत्यक्ष रूप से किसी भी तरह से कंपनी के हितों के विरुद्ध नहीं किया जाएगा

BAY-401
ST-1

BAY-404
GT-1

BAY-403
LINE-1

BAY-406
LINE-2

UNLOADING PLATFORM

MAINTANENCE AREA

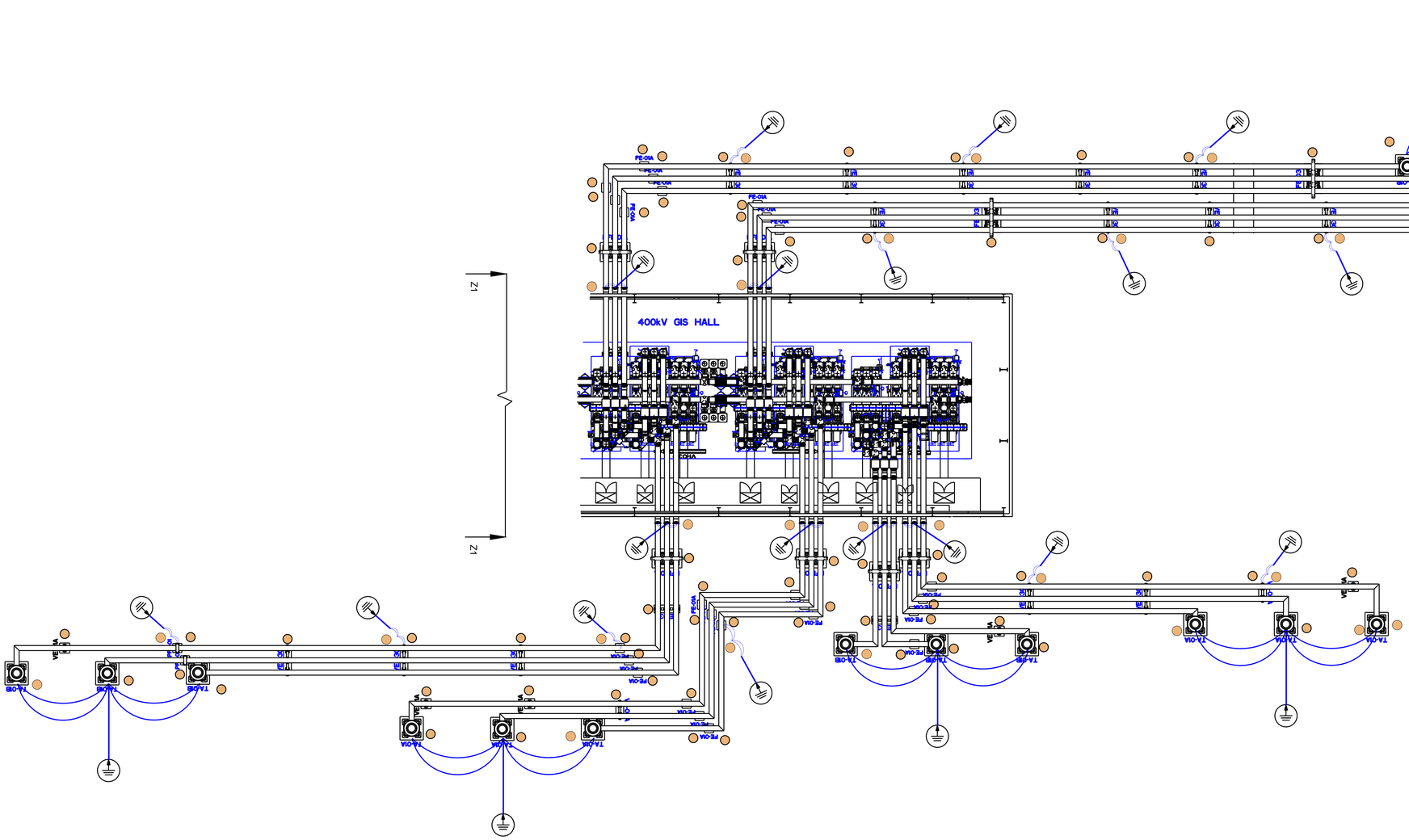
VENDOR NAME	GE T&D INDIA LTD. 142, Vandalur-Walajabad Road Padappai, Chennai 601301 Tamilnadu, India		
ग्राहक ड्राईंग संख्या CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003		
ग्राहक/CUSTOMER	एन टी पी सी लिमिटेड N T P C LIMITED		
परियोजना PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW)		
भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ-प्र)/NOIDA (U.P.)	DEPT CODE M		नाम NAME / हस्ताक्षर SIGNATURE / दिनांक DATE
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		डिज़ाइनकर्ता/DES	RN
		जाँचकर्ता/CHD	MS
		अनुमोदनकर्ता/APP	SR
शीर्षक/TITLE: 400kV GIS Earthing Plan			
	डिज़ाइन SCALE: –	ड्राईंग संख्या / DRAWING NO. GD53A460054	
	हस्ताक्षर SIGN / दिनांक DATE	शीट SHEET 03 OF 05	पुनरीक्षण REV 00

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FORMAT SIZE A0

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GROUND LEVEL EARTHING VIEW

Unit: mm	Format: A0	D. Authority: CHT	NTPC_THALCHAR 400kV_T155-3
EC Nbr: ---	Q Level: 3	Local Unit: CHT	GIS EARTHING PLAN
Created: Logeshwar J	12/03/2024	---	GD378
Reviewed: ---		---	
Approved: Samikkannu Murugan	12/03/2024	/	
T&D INDIA LTD	Sheet: 5/6	Product type: T155-3	GD53A460054 Rev. 00



VENDOR NAME	GE T&D INDIA LTD. 142, Vandalur-Walajabad Road Padappai, Chennai 601301 Tamilnadu, India
ग्राहक ड्राईंग संख्या CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003
NTPC ग्राहक/CUSTOMER	एन टी पी सी लिमिटेड N T P C LIMITED
परियोजना PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW)
भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ-प्र)/NOIDA (U.P.)	DEPT CODE: M डिजाइनकर्ता/DSN: AK ड्रैफ्ट्समैन/DRN: RN जाँचकर्ता/CHD: MS अनुमोदनकर्ता/APP: SR
शीर्षक/TITLE	400kV GIS Earthing Plan
ड्रॉइंग संख्या/DRAWING NO.	GD53A460054
शीट/SHEET 03 OF 05	पुनरीक्षण/REV 00

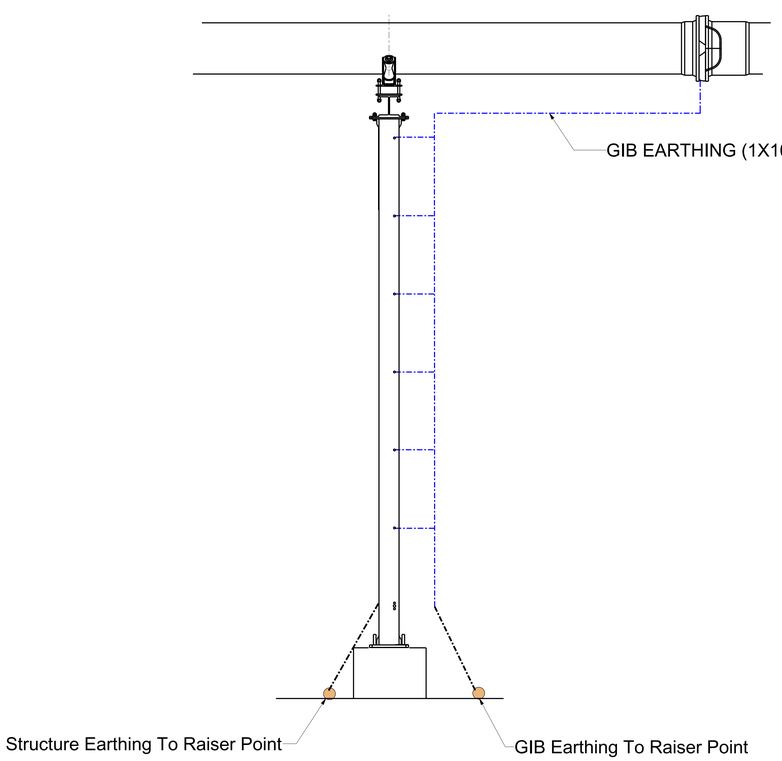
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EARTHING ARRANGEMENT DETAILS

Edit: 1890000	Unit: mm	Format: A0	D. Authority: CHT
EC Nbr:		Q Level: 3	Local Unit: CHT
Created: Logeshwar J		12/03/2024	NTPC_THALCHAR 400kV_T155-3
Reviewed: ---		---	GIS EARTHING PLAN
Approved: Samikkannu Murugan		12/03/2024	GD378
T&D INDIA LTD	Sheet: 6/6	Product type: T155-3	GD53A460054 Rev. 00

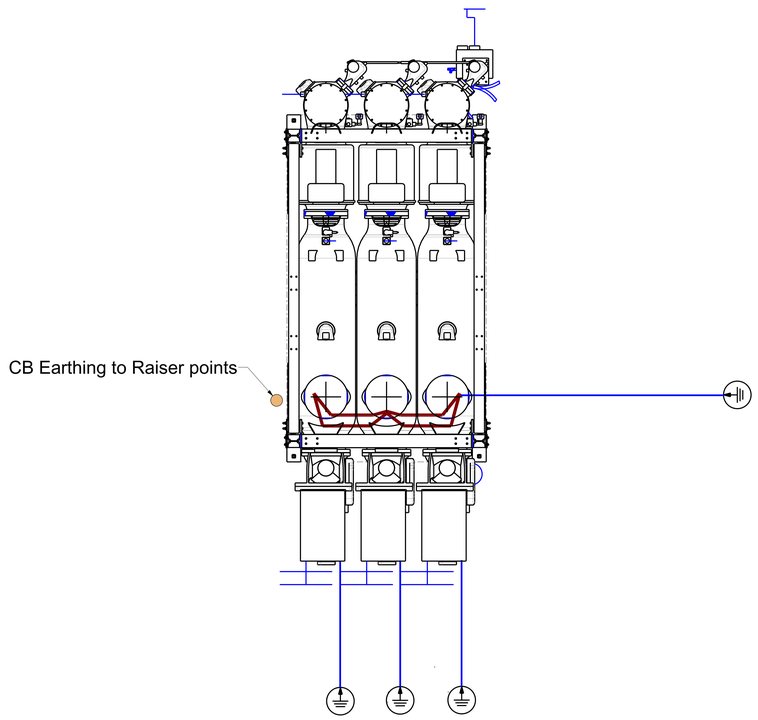
GIB and GIB Structure Earthing



NOTES:-

-All GIB structures shall be earthed to raiser points as indicated above

CB & FK Earthing Arrangement

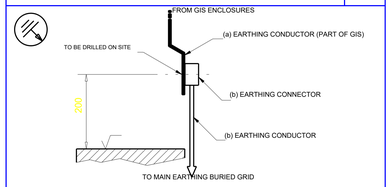


NOTES:-

-All CB and FK mechanisms shall be earthed to raiser points

Earthing connection of GIS enclosures (Icc)

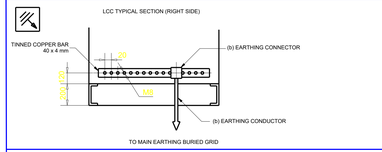
STICKER REVISION v0



a) Earthing connection of GIS enclosures with short-circuit carrying capability
Earthing conductor (part of GIS)
Material: ALUMINIUM
Section: 100x10 mm

Earthing connection of Local Control Cubicle (LCC)

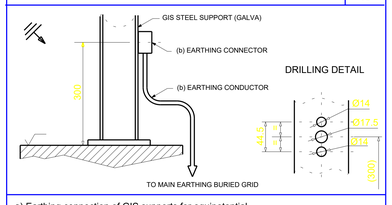
STICKER REVISION v0



a) Earthing connection of Local Control Cubicle
b) GE Main contractor scope

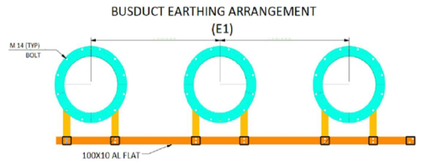
Earthing connection of GIS supports (Equipotential)

STICKER REVISION v0

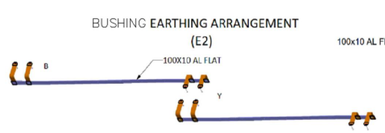


a) Earthing connection of GIS supports for equipotential
b) GE Main contractor scope

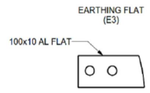
BUSDUCT EARTHING ARRANGEMENT (E1)



BUSHING EARTHING ARRANGEMENT (E2)



EARTHING FLAT (E3)



VENDOR NAME	GE T&D INDIA LTD. 142, Vandalur-Walajabad Road Padappai, Chennai 601301 Tamilnadu, India
ग्राहक ड्राइंग संख्या / CUSTOMER DRAWING NO.	4540-001-230-PVE-P-003
NTPC ग्राहक / CUSTOMER	एन टी पी सी लिमिटेड N T P C LIMITED
परियोजना / PROJECT	TALCHER THERMAL POWER PROJECT STAGE-III (2X660MW)
भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD TRANSMISSION BUSINESS GROUP नोएडा (उ॰प्र॰) / NOIDA (U.P.)	SHAPE CODE: M निरीक्षक DSN: AK डिजाइनकर्ता DES: RN जाँचकर्ता CHD: MS अनुमोदनकर्ता APP: SR नाम NAME / हस्ताक्षर SIGNATURE / दिनांक DATE
शीर्षक / TITLE	400kV GIS Earthing Plan
	ड्राइंग संख्या / DRAWING NO. GD53A460054 शीट / SHEET 05 OF 05 पुनरीक्षण / REV. 00

फॉर्मैट साइज़ A0
FORMAT SIZE A0

SHEET No.	DESCRIPTION
1	LEGEND
2	CIRCUIT BREAKER
3	T-DISCONNECTOR
4	COMPACT DISCONNECTOR
5	TELESCOPIC ENCLOSURE
6	CURRENT TRANSFORMER
7	VOLTAGE TRAMSFORMER
8	ELBOW
9	BUSDUCT
10	CONDUCTOR-D92
11	MONITERING ENCLOSURE
12	DE/ES MECHANISM
13	SF6 AIR BUSHING
14	AXIAL SELF COMPENSATED BELLOW
15	ANGULAR BELLOW
16	INSULATOR (BARRIER)
17	MONITORING DEVICE

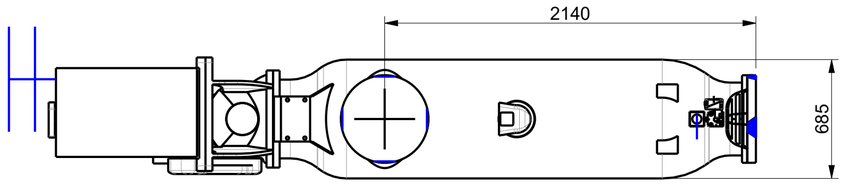
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REFERENCE DRAWING NO.	DESCRIPTION	REV.	DESCRIPTION	DATE	DRAWN	CHECKED			APPROVED	STATUS
		R4		Name						
				Date						
				Sign.						
		R3		Name						
				Date						
				Sign.						
		R2		Name						
				Date						
				Sign.						
		R1	As Per Customer Comments	Name	RAMU	MURUGAN			SENTHIL	
				Date	26-12-23	26-12-23			26-12-23	
				Sign.	RN	MS			SR	
		R0	First Submission	Name	RAMU	MURUGAN			SENTHIL	
				Date	03-07-23	03-07-23			03-07-23	
				Sign.	RN	MS			SR	

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Created: Logeshwar J				26/12/2023	-
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Approved: RAMU NATARAJAN				27/12/2023	
T&D INDIA LTD			Sheet: 1/17		GD53A090034 Rev. 01
			Product type: T155		

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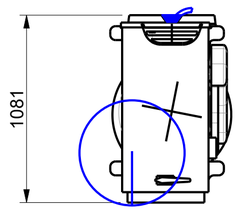
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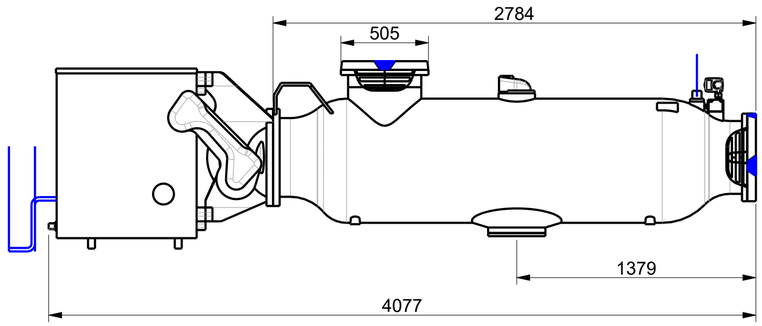
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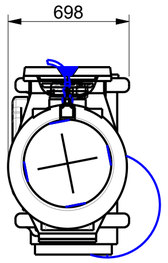
3D VIEW



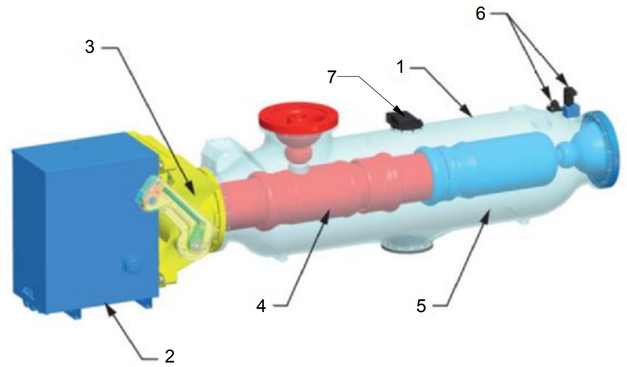
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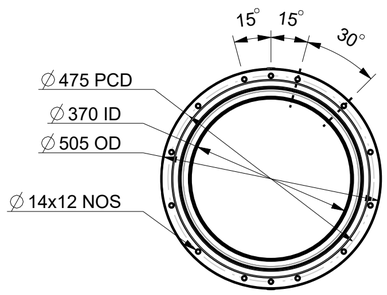
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TRANSPARENT VIEW



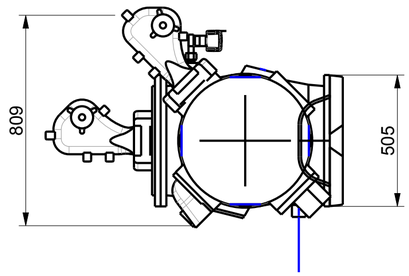
FLANGE DETAILS

1 - An Enclosure
2 - A mechanical operating mechanism
3 - A movement inlet
4 - An active part on the tulip side
5 - An active part on the rod side
6 - Monitoring accessories
7 - Bursting disc

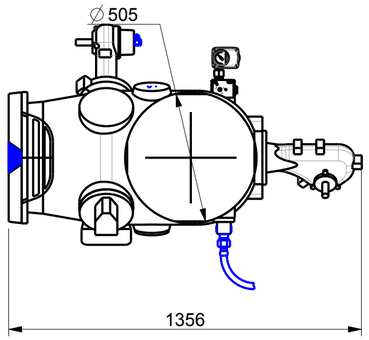
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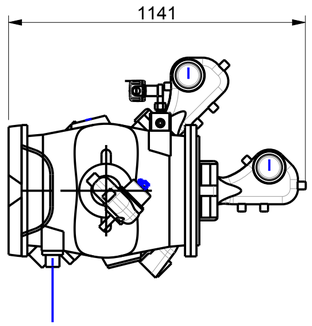
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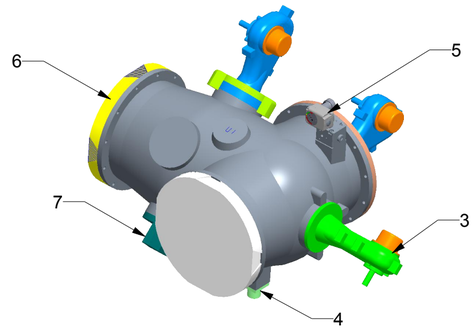
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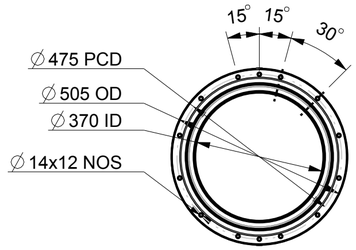


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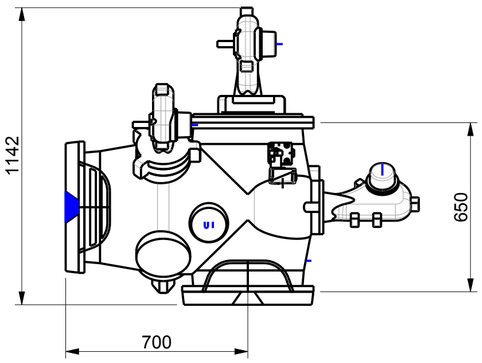


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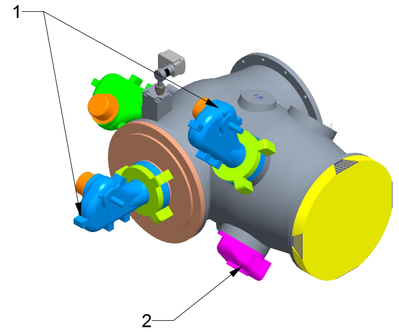


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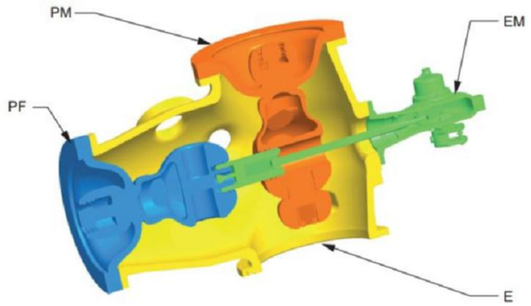
TOP

1 - EARTHING SWITCH DRIVE MECHANISM
2 - BURSTING DISC
3 - DISCONNECTOR OPERATING MECHANISM
4 - EQUIPPED PREFILL VALVE
5 - DENSITY SWITCH MONITOR
6 - INSULATOR
7 - PD SENSOR



3D VIEW

E- An enclosure
EM- A movement input
PM- A moving contact
PF- A fxed contact



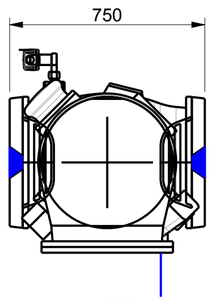
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Created: Logeshwar J				26/12/2023	-
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T&D INDIA LTD			Sheet: 3/17		GD53A090034 Rev. 01
			Product type: T155		

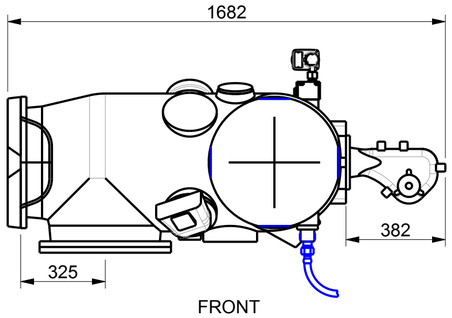
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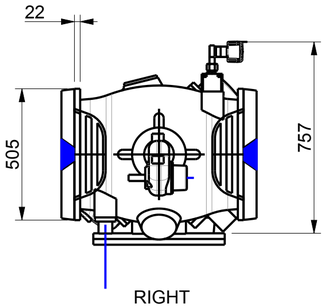
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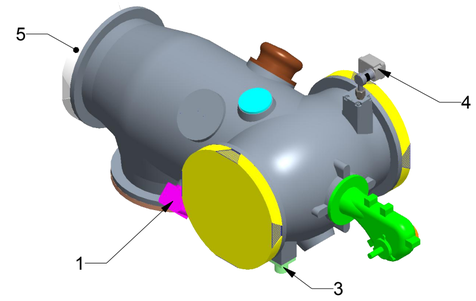
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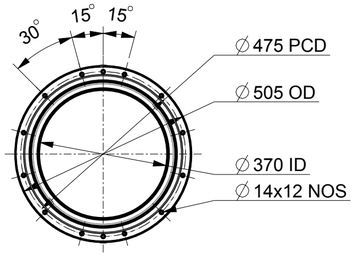


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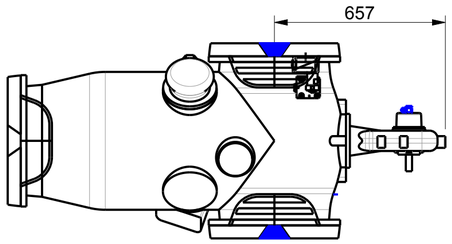


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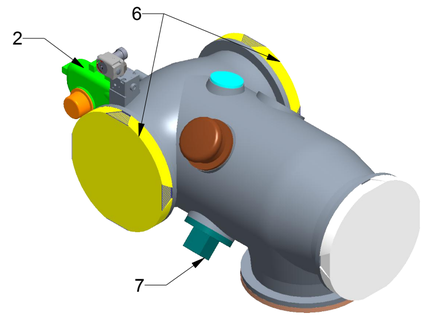




FLANGE DETAILS

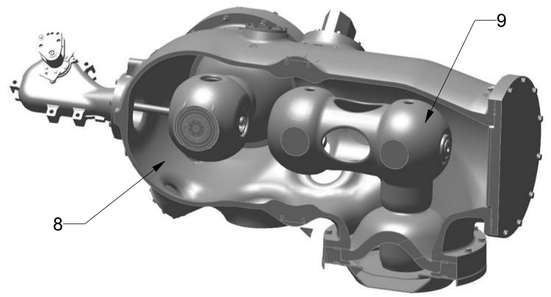


TOP



3D VIEW

1 - BURSTING DISC
2 - DISCONNECTOR OPERATING MECHANISM
3 - EQUIPPED PREFILL VALVE
4 - DENSITY SWITCH MONITOR
5 - OPEN INSULATOR
6 - CLOSED INSULATOR
7 - PD SENSOR
8 - ENCLOSURE
9 - CUNDUCTOR HOLDING SUPPORT



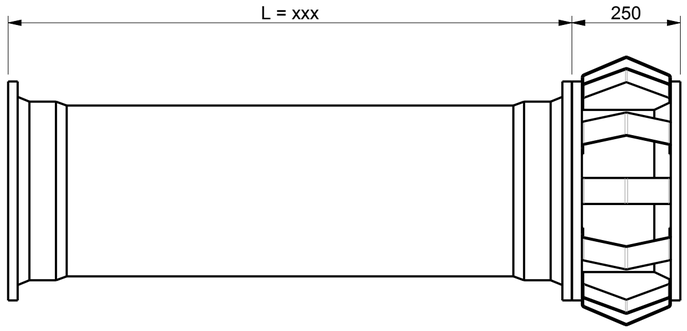
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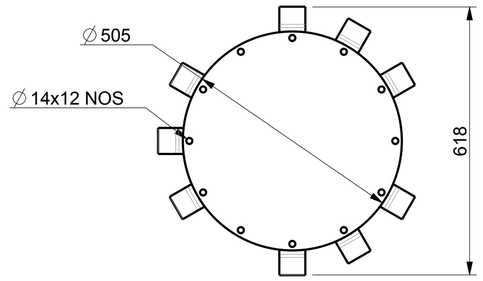
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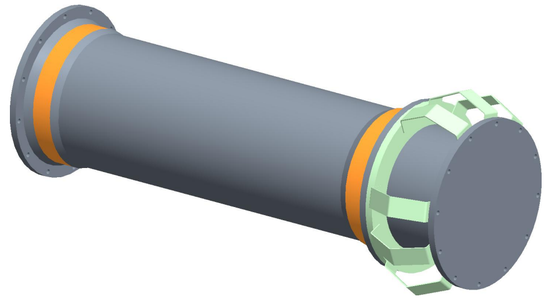
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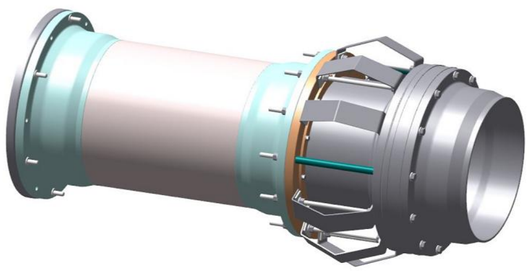


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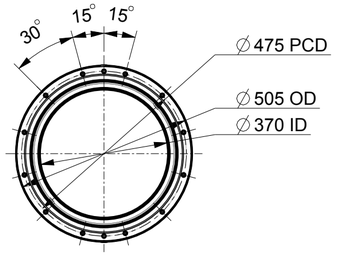


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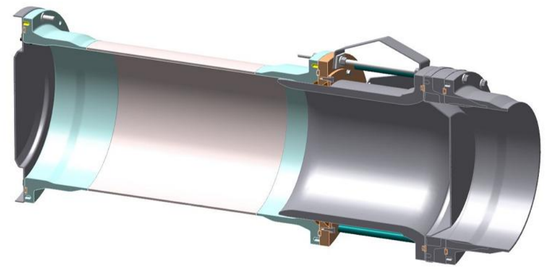




3D VIEW



FLANGE DETAILS



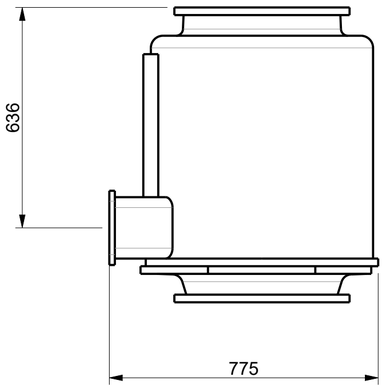
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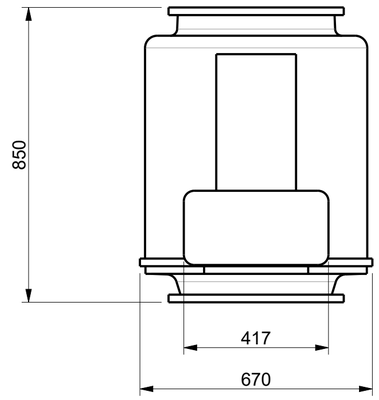
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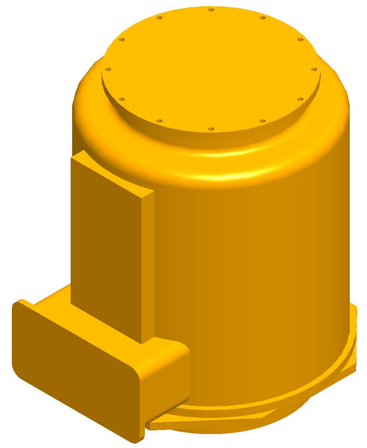
CURRENT TRASFORMER



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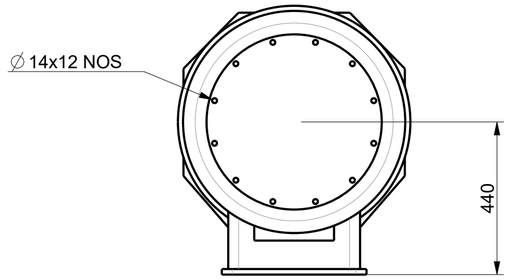


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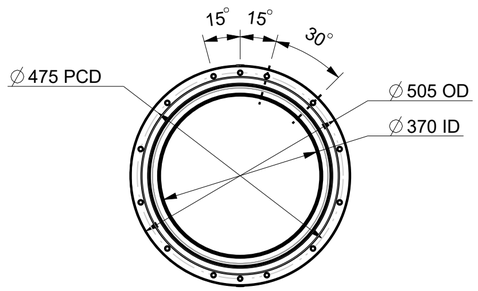


3D VIEW

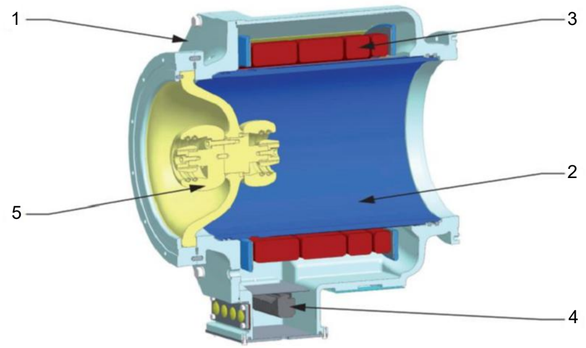
1.The enclosure (E)
2.A chamber(V)
3.The secondary (T)
4.A terminal box (B)
5.A cone assembly (C)



TOP



FLANGE DETAILS

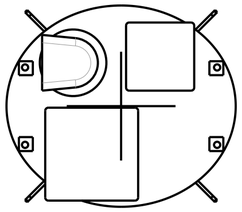


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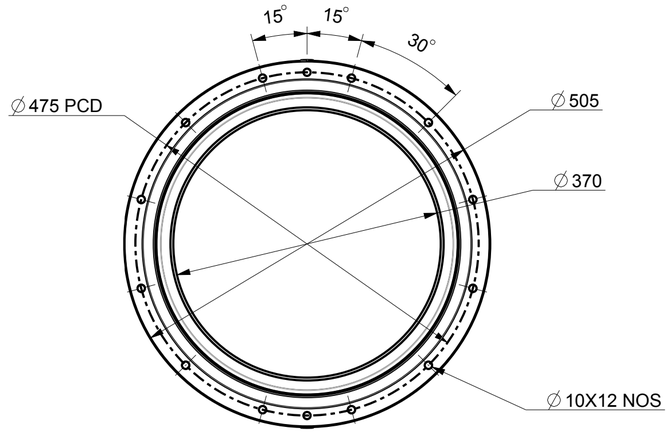
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T&D INDIA LTD			Sheet: 6/17		GD53A090034 Rev. 01
			Product type: T155		

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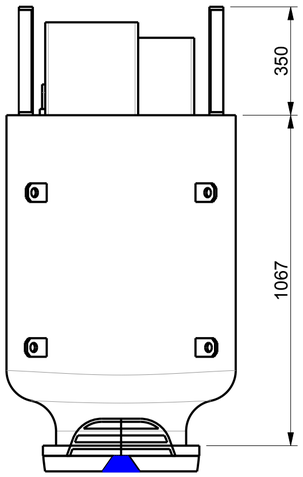
VOLTAGE TRANSFORMER



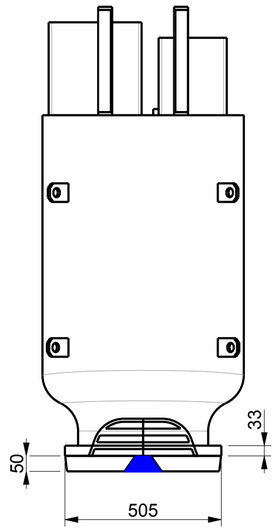
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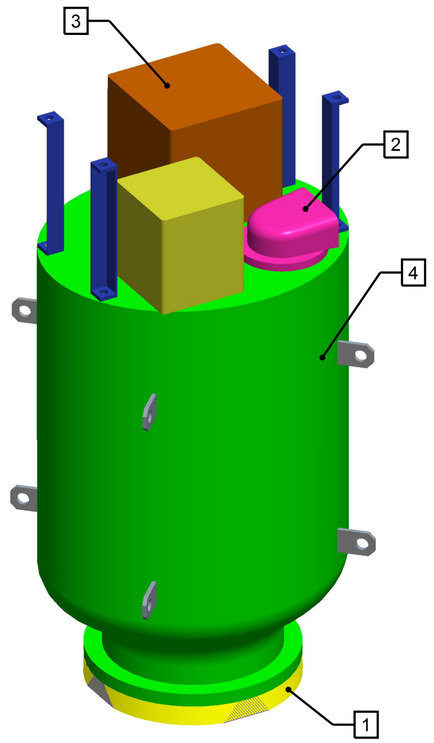
FLANGE DETAILS



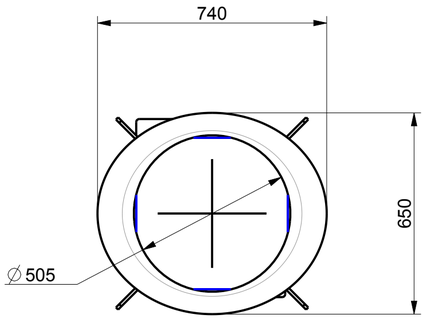
FRONT



RIGHT



3D VIEW



BOTTOM

1-CLOSED INSULATOR
2-BUSTING DISC
3-TERMINAL BOX
4-ENCLOSURE

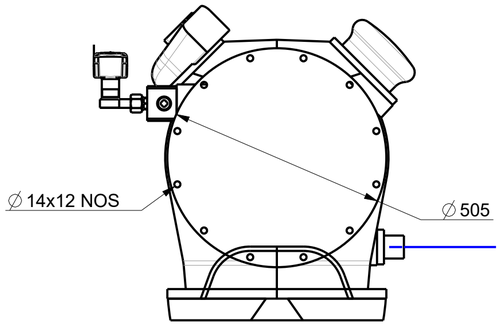
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Reviewed: ---				---	
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T&D INDIA LTD		Sheet: 7/17			GD53A090034 Rev. 01
		Product type: T155			

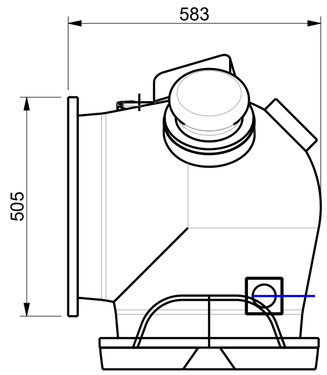
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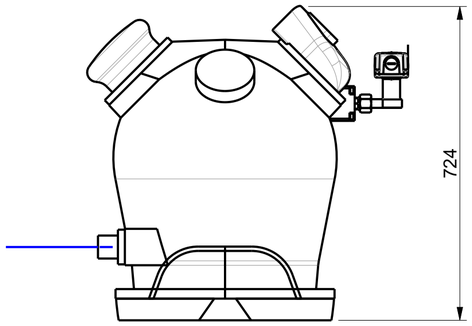
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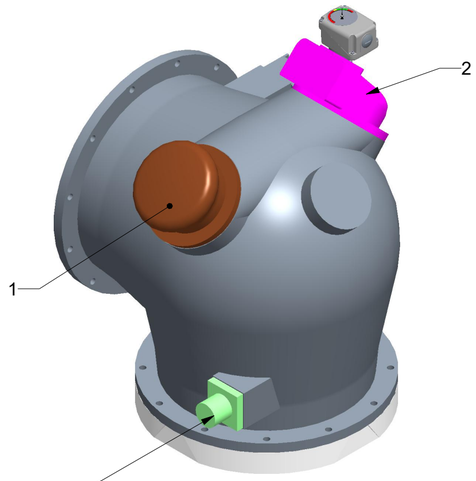
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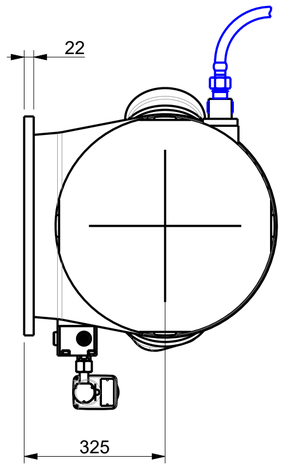
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RIGHT

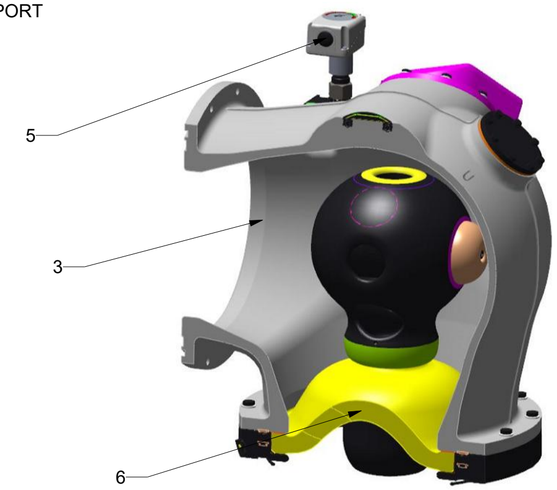


3D VIEW

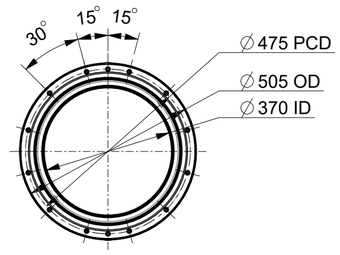


TOP

1 - MOISTURE ABSORBER
2 - BURSTING DISC
3 - CONDUCUTOR HOLDING SUPPORT
4 - EQUIPPED PREFILL VALVE
5 - DENSITY SWITCH MONITOR
6 - INSULATOR



CROSS SECTION



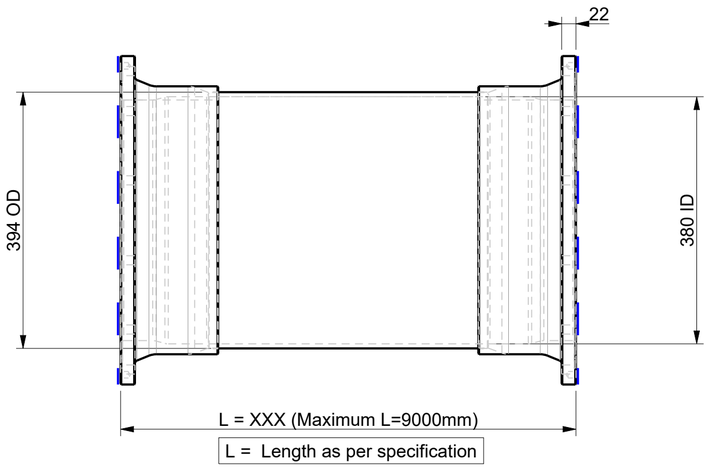
FLANGE DETAILS

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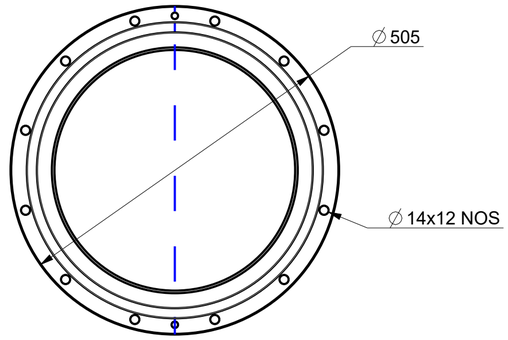
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Reviewed: ---				---	
Approved: RAMU NATARAJAN				27/12/2023	
T&D INDIA LTD			Sheet: 8/17		GD53A090034 Rev. 01
			Product type: T155		

Creo/Pro

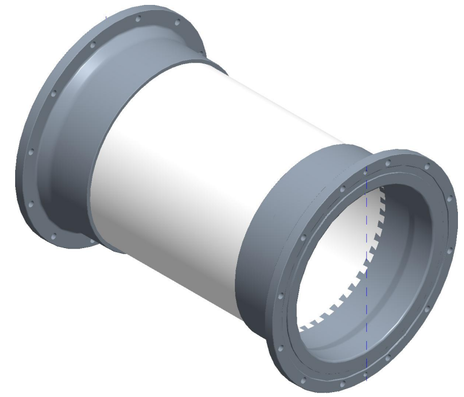
BUSDUCT



FRONT

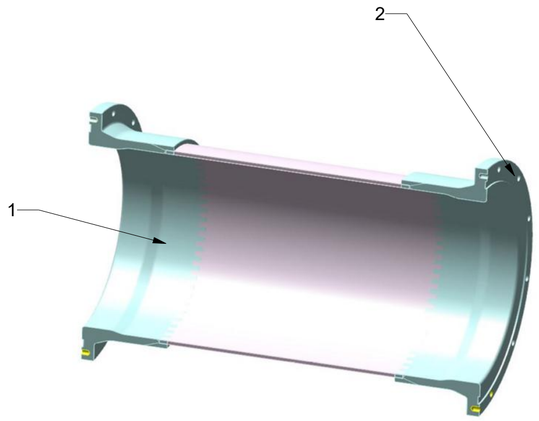


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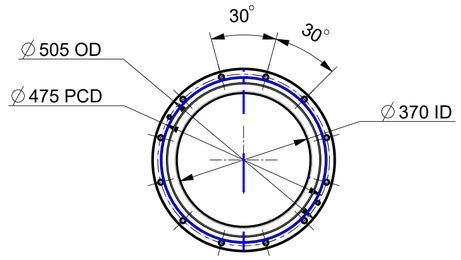


3D VIEW

1 - ENCLOSURE
2 - FLANGE



CROSS SECTION



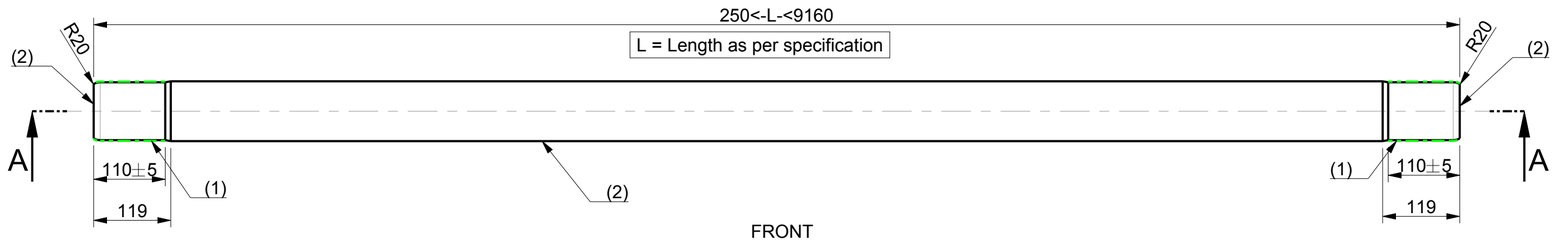
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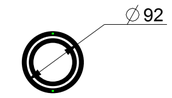
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Reviewed: ---				---	
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Creo/Pro

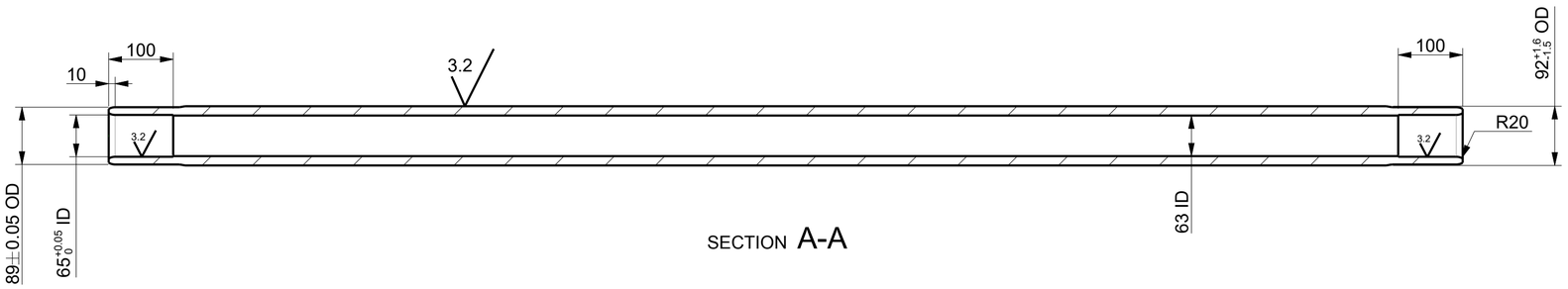
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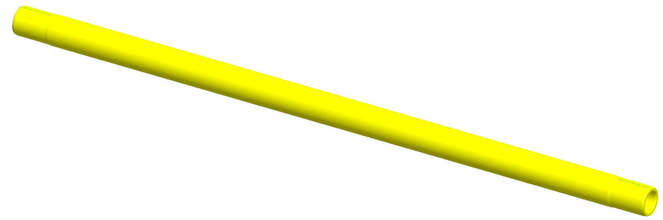
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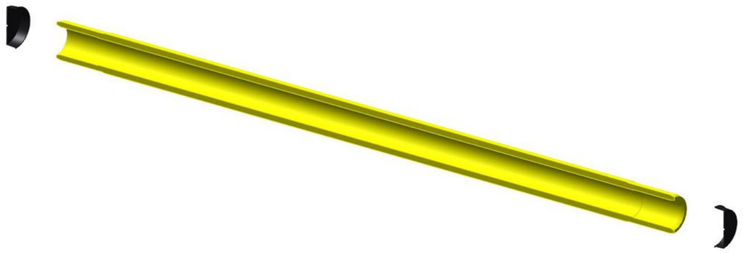
RIGHT



SECTION A-A



3D VIEW



CROSS SECTION

Silver plating	NT0440	Ag10(1)	sur zone on area	(1)
Silver plating	NT0440	allowed	sur zone on area	(2)

Partial covering of the undercoat by the Ag allowed

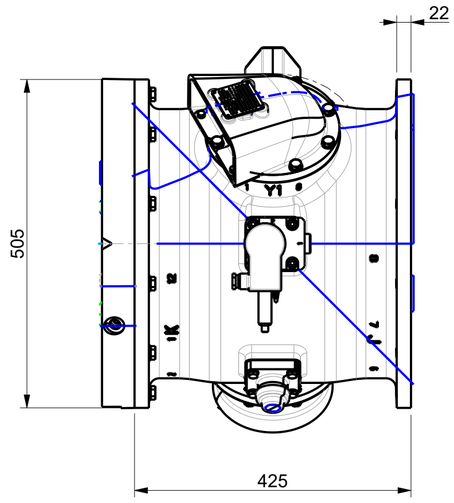
3.2	Tolerance and roughness to get after silverplating

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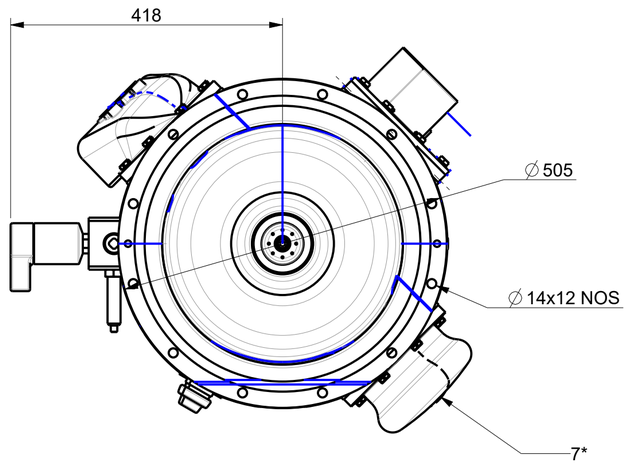
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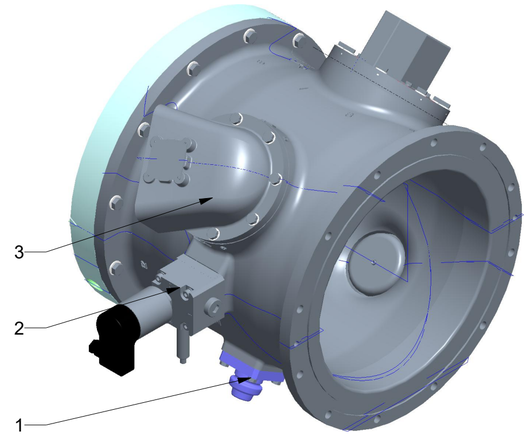
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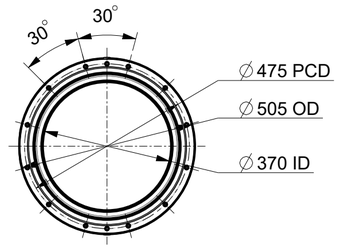
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RIGHT

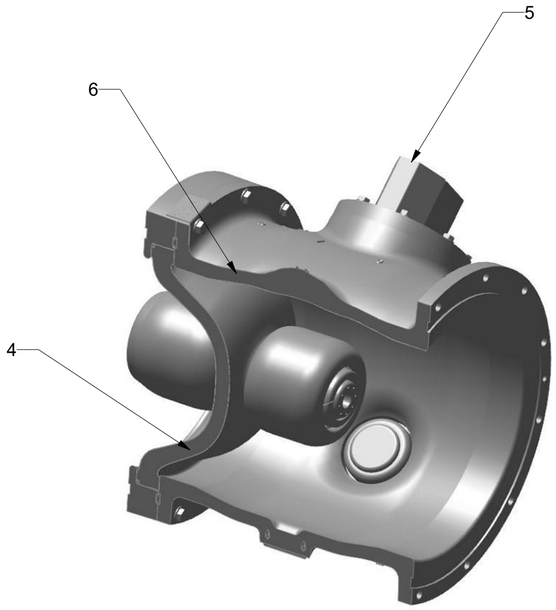


3D VIEW



FLANGE DETAILS

1.EQUIPPED PREFILL VALVE
2.DENSITY SWITCH MONITOR
3.BURSTING DISC
4.INSULATOR
5.PD SENSOR*
6.ENCLOSURE
7. MOISTURE ABSORBER UNIT*



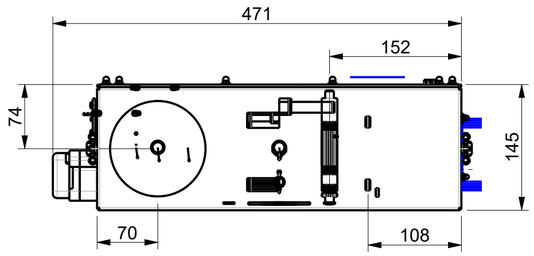
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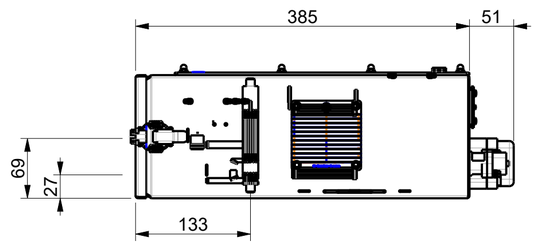
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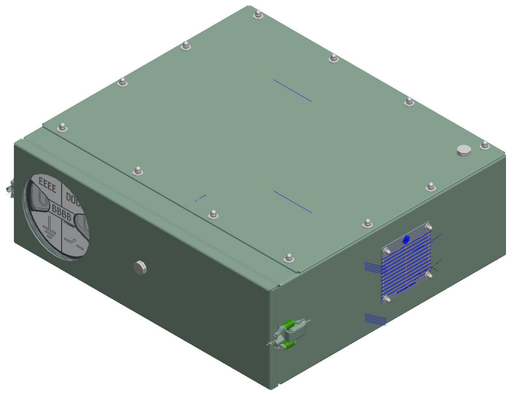
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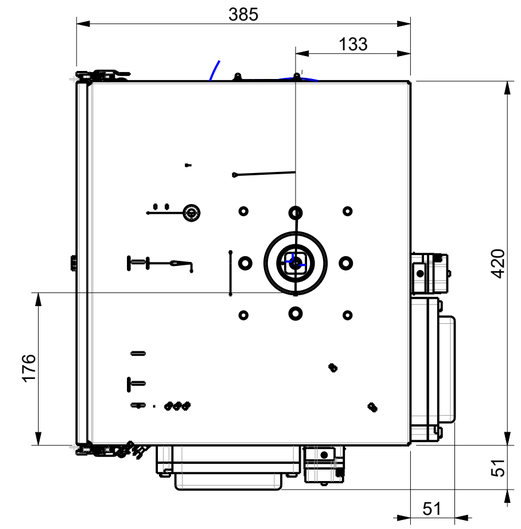
FRONT



RIGHT



3D VIEW



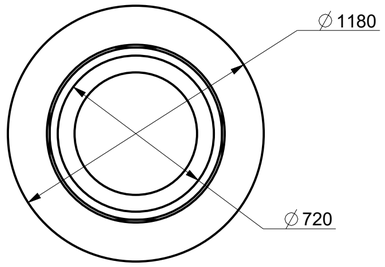
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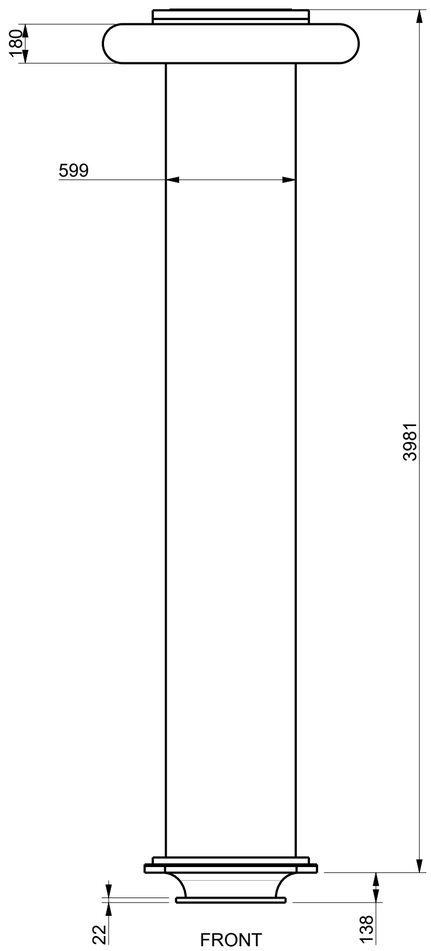
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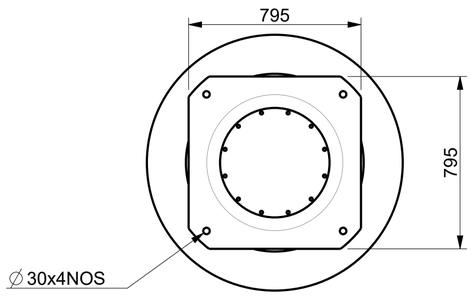
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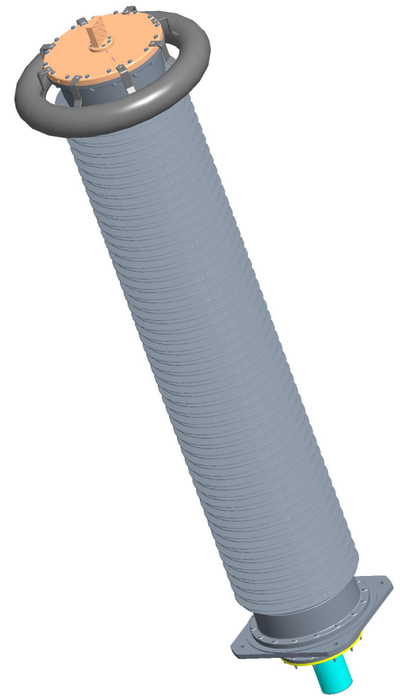
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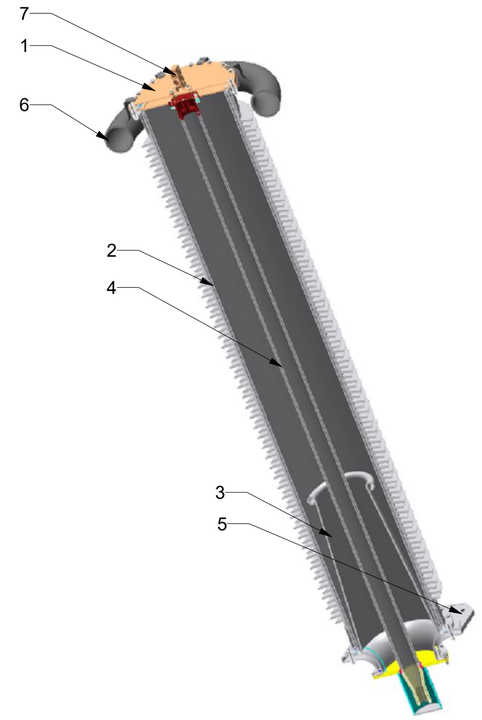
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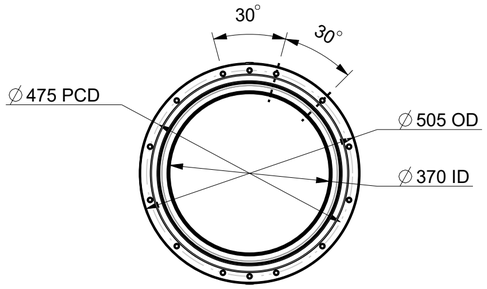


3D VIEW



TRANSPARENT VIEW

1. Cover
2. Composite Cylindrique
3. Interior corona shield
4. Bar
5. Flange
6. Exterior corona shield
7. Power socket



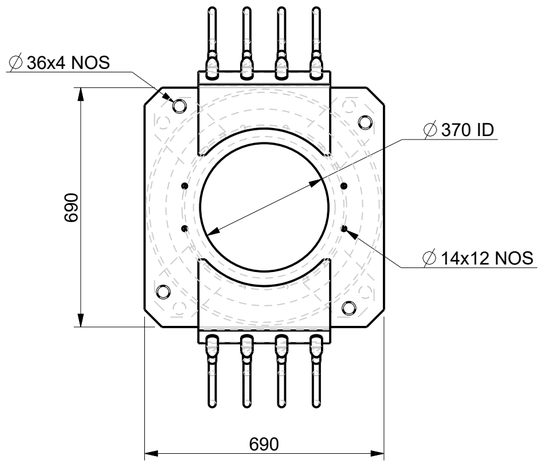
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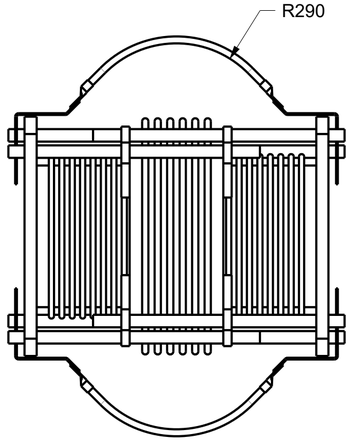
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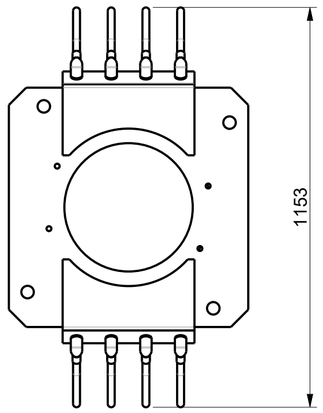
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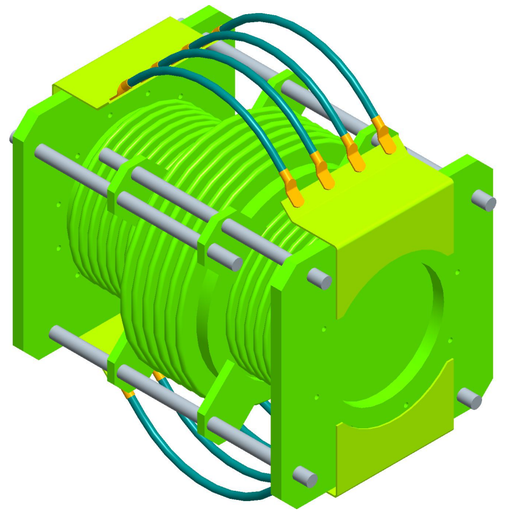
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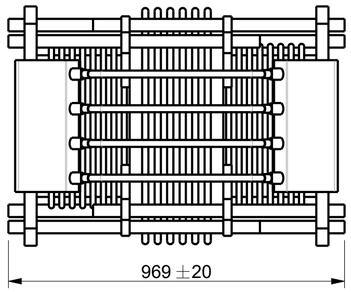
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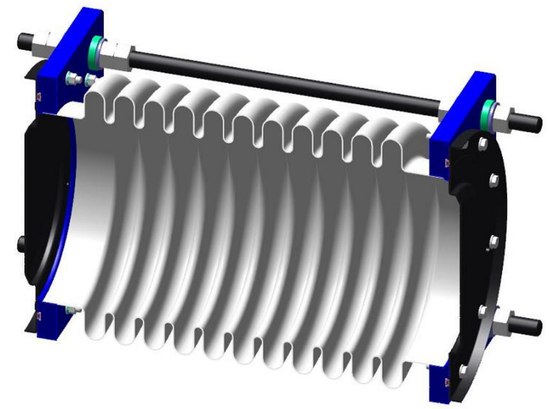
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3D VIEW



TOP



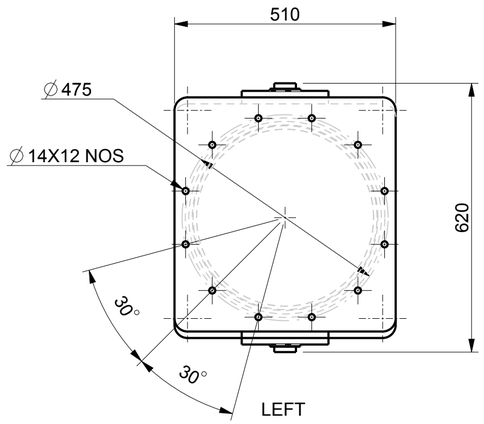
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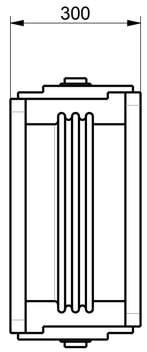
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Approved: RAMU NATARAJAN				27/12/2023	
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			Product type: T155		

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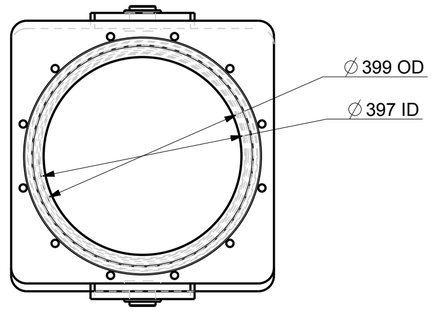
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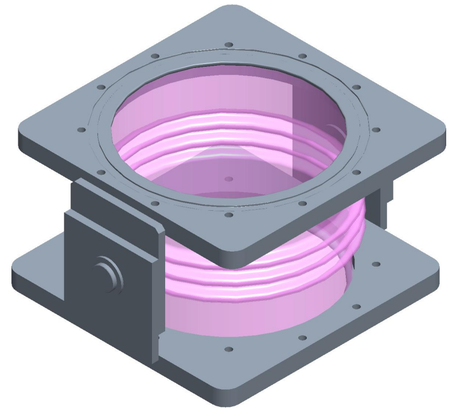
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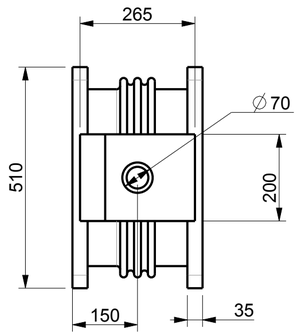
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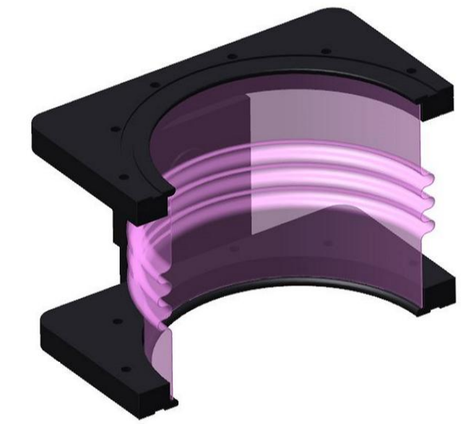
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3D VIEW



TOP



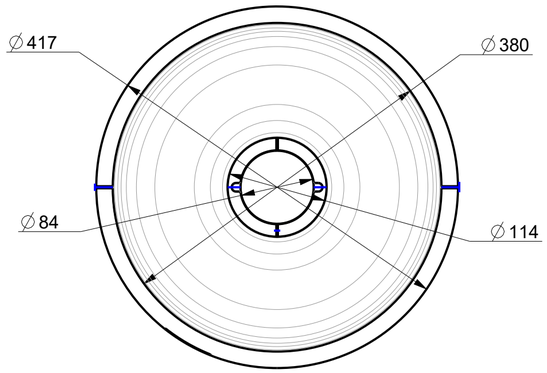
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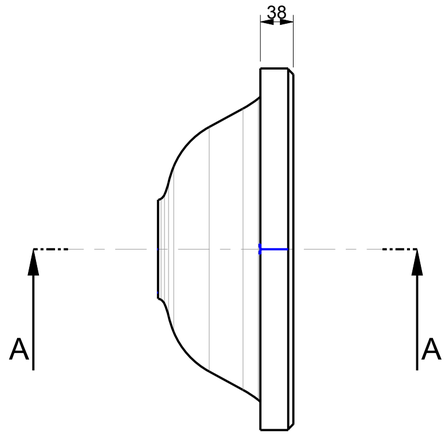
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GAS BARRIER



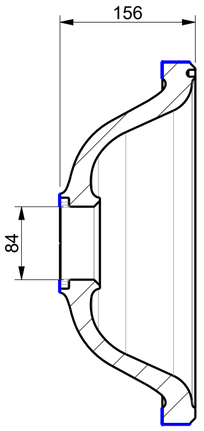
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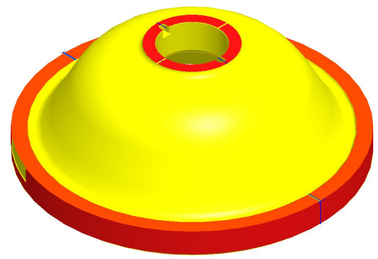
OPEN INSULATOR (SUPPORT BARRIER)





SECTION A-A

CLOSED INSULATOR (SUPPORT BARRIER)



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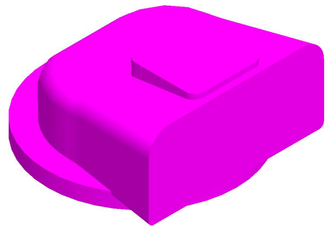
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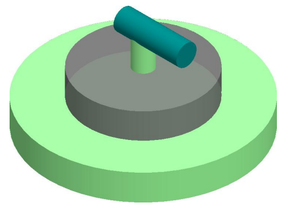
MONITORING DEVICES



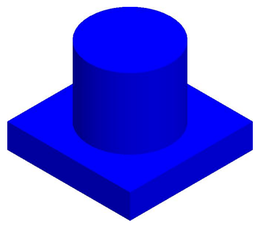
MOISTURE ABSORBER



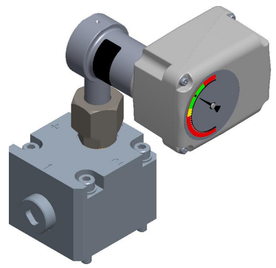
PRESSURE RELIF DEVICE



PARTIAL DISCHARGE SENSOR



VALVE



DENSITY SWITCH

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Annexure-C

Name of Customer : NTPC
Name of Projects : 400kV GIS Switchyard at Talcher TPP

PROCEDURE FOR WELDING OF ALUMINIUM BUSES

A. Recommended welding procedures to insure a sound weld are as follows:

Pure aluminum melts at 660 Deg. C while aluminum alloy melts in the range of 519 Deg. C depending on the alloy content of the particular metal involved. When aluminum alloy are heated there is no change in color. This makes it difficult, if not impossible; to tell metal is near the welding temperature.

The ever present surface oxide films on aluminum have a melting point of 1982 Deg. C. The parent aluminum or aluminum alloy can therefore be melted without fusing the surface oxides. Unless this film is removed, cleanliness of the molten filler metal and the parent metal cannot be completed and both strength and conductivity may be sacrificed. Therefore, it is of prime importance that aluminum oxides be removed from the aluminum alloys before welding is started. In the shielded arc welding method the shielding gas has a tendency to clean the material as welding progresses.

B. CLEANING OF BUSES & FITTINGS:

It is very important to remove all greases and oxides from the surfaces to be welded. This can be accomplished by using a mild alkaline solution or standard degreasing solution. The preferred method is to use a stainless steel wire brush and vigorously scrub the surfaces to be welded. The stainless steel brushes are specified because the stainless steel has fewer tendencies to pick up particles of aluminum.

C. WELDING METHODS

The following types of welding methods for welding aluminum fittings and buses are recommended.

1. TUNGESTEN-ARC WELDING (TIG)

The inert-gas shielded tungsten arc process is widely used for welding aluminum bus fittings. In this process the arc is established between a non-consumable tungsten electrode and the section to be welded. Inert gas envelopes the arc to prevent oxidation during welding.

Hence no flux is required. A bare filler rod supplies filler metal to the weld area. To initiate the arc the tungsten electrode is placed in contact with the component and then withdrawn to establish an arc length of approximately 3/16”. The arc is given a circular motion until the base metal liquefies and the weld puddle is established. Filler metal is added by hand as required. In this process, if more than one pass is required for a sufficient weld, the weld should be wire brushed between passes, to remove any surface dirt or oxides which have accumulated from the previous pass. Since no flux is used the finished weld does not require cleaning. In this process the heat of the tungsten arc is concentrated in a smaller area and is much faster than the conventional type of welding and distortion of the weld is negligible since the heat is concentrated in a small area. In this process, if thickness is greater than 0.5” arc to be welded, pre-heating of parts will increase the arc speed.

2. METALLIC ARC INERT GAS SHIELDED WELDING

MIG welding process combines the advantages of tungsten arc welding with the increased welding speed. Welding can be done from any position and the process can be either manual or automatic, Manual welding techniques are somewhat different from other methods. However, a welder can be trained to use the MIG process with only a few days concentrated training. In the MIG process the bare filler rod is supplied as a coil of bare wire. In the commercially available equipment this wire is added to the weld at predetermined rate by a motor driven feed that can be adjusted to the magnitude of the welding current. In this process as well as the tungsten arc process, gas forms a shield around the arc to prevent oxidation during welding.

Either helium, argon or a mixture of helium and argon are suitable shielding gases. Pure argon is most widely used on the gas arc usually mixed to combine the hotter arc argon. If exceptionally hot arc characteristics are required pure helium can be substituted for the gas mixture. Precaution should be exercised if this substitution is made in that it is very easy to burn through the items that are to be welded with a pure helium atmosphere.

As it is readily apparent, the basic difference between the two types of welding apparatus is the automatic feeding mechanism for the filler wire. In both types of apparatuses the electrode holder and the welding gun can or cannot be cooled by water. If welding currents of more than 125 Amps are required, both methods will have to have water cooling apparatuses to the electrode holder and the welding gun.

D.WELDERS QUALIFICATIONS

No welding should be done until the operator has had experience with welding aluminum alloys by the methods described above, Men with previous experience with in metal welding should be selected for training in welding aluminum for a period of training of not less than one week after which time the man can be considered to be proficient in the use of the equipment and in the welding of aluminum joints. After this period there should be no difficulty experienced in welding aluminum alloys. It is suggested, if practical, that welders should practice on actual fittings or buses before proceeding with the welding of the required job.

The following is the recommended specification for the current fittings wire feeds, gas flows etc. These specifications are of a general nature to the extent that many factors have to be considered such as:

1. Type of equipment used, whether water cooled or not.
2. The size and mass of the piece to be welded.
3. The position of the weld.
4. And most important of all, the operator's skill
5. All persons in the welding area would wear the proper shields. The arc is approximately twice as strong as the standard AC welding arc. Extreme caution should be exercised for the protection of eyes.

ACCEPTANCE STANDARDS FOR NON-DESTRUCTIVE TESTING
LIQUID PENETRANT EXAMINATION OF WELDED JOINTS

a) Evaluation of indications:
- Relevant indications are those which result from mechanical discontinuities.
- Linear indications are those indications in which the length is more than three times with width.
- Rounded indications or indication, which are circular or elliptical with the length less than three times, the width.
- Any questionable or doubtful indications shall be re-tested to verify whether or not actual defects are present.
- Localised surface imperfections, such as may occur from machining marks, surface conditions, may produce similar indications, which are not relevant to detection of unacceptable discontinuities.

b) **Acceptance standards**:
- Linear indications
- Four or more rounded defects with any dimensions more than 1.6 mm in a line separated by 1/16 inch (1.6 mm) or less (edge to edge)

c) Defect removal and repair:

Unacceptable imperfections shall be removed and reexamination made to assure the complete removal. Whenever a defect is removed and subsequent repair by welding is not required, the excavated area shall be blended into the surrounding surface so as to avoid sharp notches, crevices or corners. Where welding is required after removal of a defect, the area shall be cleaned and welding performed in accordance with a qualified welding

procedure, Completed repairs shall be re-examined by the method originally used for detection of the defection.

d) Treatment of imperfections believed non-relevant.

Any indication of an imperfection, which is believed to be non-relevant, shall be regarded as defect unless, on re-evaluation, it is shown by re-examination by the same method or by the use of other non-destructive methods and/ or by surface conditioning that no unacceptable defect is present.

e) Examination of areas form which defects have been removed:

After a defect is thought to have been removed and prior to making weld repairs, the area shall be examined by suitable methods to ensure the defect has been eliminated.

f) Re-examination of repaired areas:

After repairs are made, the repaired areas shall be blended.

ACCEPTANCE STANDARDS FOR NON-DESTRUCTIVE TESTING RADIOGRAPHIC EXAMINATION OF WELDED JOINTS

Radiographic examination shall cover minimum 10% of weld seam and acceptance standard for visual examination and Radiography shall be as follows:

Any of the following imperfections shall not be acceptable.

1. Cracks

2. Zone of incomplete fusion or penetration, which exceed 10% of the weld length of the joint in longitudinal or transverse butt weld, where full penetration is intended by the weld procedure, some lack of penetration acceptable. The total length of weld with lack of penetration shall not exceed 10% of the overall weld length. At no place, shall weld penetration be less than 90% of the thickness of the material. Continuous occurrence of lack of penetration is permitted, but shall not exceed 50 mm in any 500 mm length of weld.

3. Inadequate weld dimensions, root cavity (shrinkage) and incompletely filled groove greater than 10% effective throat thickness.

4. Excess penetration shall be permitted provided it does not exceed 25% of the wall thickness or 4 mm whichever is smaller.

5. Weld reinforcement: Build up in excess of 25% of the effective throat thickness shall be dressed. Any reinforcement shall be substantially symmetrical about the center line of the weld and shall be of smooth contour blending smoothly at the toes with the parent material.

6. Undercutting and overlapping, greater than 10% effective throat thickness.

7. Elongated cavities and/or worm holes exceeding 3 mm dia or equivalent area in length provided the limitations on porosity are met with.

8. Copper, tungsten or oxide inclusions greater than t/1 or 3 mm whichever is smaller.

9. Crater pipes exceeding 2597o effective throat thickness or 3 mm whichever is smaller.

10. Porosity: Scattered porosity not exceeding 0.5% by volume is acceptable. In general, the size of the pores shall not exceed 0.8 mm dia, but occasional 1.6 mm dia pores may be acceptable, provided the following limits are not exceeded.
    a) Where pore size is 0.4 mm or less, up to 150 t pores may be permitted in 1000 mm sq. area of radiograph.

b) Where pore size is 0.8 mm or less, up to 19 t pores may be permitted in 1000 mm. sq. area of radiograph.
c) Where pore sizes are generally 0.8 mm dia or less, but occasional 1.6 mm dia/pores are present, up to 9t pores of 0.8 mm dia may be permitted in 1000 sq. mm area of radiograph, provided the number of pores up to 1.6 mm in dia does not exceed it.
d) However, visible surface porosity> 1mm dia is not acceptable.

Note:

i. In all cases, t+ thickness of the thinnest section of the weld under examination.

ii. Unacceptable weld defects shall be repaired in accordance with the original welding procedure. All repairs shall be 100% inspected in accordance with original testing procedure.

BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DOCUMENT No.	**TB xxx 618 002a**	Rev 04	Prepared	Checked	Appd
TYPE OF DOC.	**TECHNICAL SPECFICATION**	NAME	**BVG**	**PLK**	**RMS**
TITLE		SIGN	-SD-	-SD-	-SD-
	G I HARDWARES	DATE			
		GROUP	**TBEM**		
		W.O. No			
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PROJECT					

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SECTION-2	**STANDARD SPECIFICATION**	**03**
SECTION-3	**PROJECT DETAILS AND GENERAL SPECIFICATION**	**01**
SECTION-4	**GUARANTEED TECHNICAL PARTICULARS (Not Applicable)**	**....**
SECTION-5	**MANUFACTURING QUALITY PLAN (Not Applicable)**	**....**
SECTION-6	**CHECK LIST**	**01**

Rev	Date	Altered	Checked	Approved	
04	18.11.10	BVG	PLK	RMS	Unit wt of hardware added
02	13.4.06.	BVG	PLK	RMS	Eqpt mounting hardwares added.
Distribution				To	
				Copies	

SECTION - 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & QUANTITIES

1.1 SCOPE

The scope of this specification is to specify all details required by a supplier for supply of galvanized hardwares for projects being executed by BHEL on turnkey basis for NTPC, PGCIL, SEBs and other Customers.

1.2 SPECIFIC TECHNICAL REQUIREMENTS

The specific technical requirements shall be as per Standard Technical Specification (Refer Section 2).

1.3 QUANTITIES

The quantities shall be as per attached BOQ.

SECTION - 2

2.0 GENERAL

This section covers the standard technical specification for GI Hardwares.

2.1 BOLTS:

M16 bolts shall be used in all types of structures except equipment mounting/ earthing bolts which shall be as per equipment requirement.

All bolts for member connections in towers, beams & equipment support structures shall conform to IS: 12427 - 2001 and for step bolts shall conform to IS: 10238 – 1982.

The mechanical properties shall conform to property class 5.6 of IS:1367 (part 3) - 1991.

All bolt heads shall have hexagonal shape, the heads being forged out of the solid material truly concentric and square with the shank, which must be perfectly straight.

Fully threaded bolts should not be used.

All bolts shall be threaded with metric standard thread to take the full depth of the nut and permit firm grip of the member.

All bolts shall be hot dip galvanized as per IS: 1367 (Part 13) – 1983.

2.2 NUTS:

All nuts shall conform to IS: 1363 (Part 3) –1992.

The mechanical properties shall conform to property class 5 of IS:1367 (part 6) – 1980.

The nuts shall be capable of being worked with fingers along the entire threaded portion of the bolt with a neat fit capable of developing the full strength of the bolt.

All nuts shall be hot dip galvanized as per IS: 1367 (Part 13) – 1983.

2.3 PLAIN WASHERS:

All plain washers shall be punched washers, A type conforming to IS: 2016-1967.

These shall be hot dip galvanized as per IS: 4759 – 1984.

2.4 SPRING WASHER:

All spring washers shall be of spring steel, positive lock type and conforming to type B of IS: 3063-1972. The thickness of spring washer shall be as specified under:

Bolt Diameter	Thickness of Spring washers
16 mm	3.5 mm
12 mm	2.5 mm

These shall be electro-galvanized as per IS: 1573 – 1986.

2.5 UNIT WEIGHT OF BOLTS I/C NUT, PLAIN AND SPRING WASHERS:

For purpose of payment, following unit weights as indicated below shall be considered.

A.) STANDARD BOLTS I/C ONE NUT UNIT WEIGHTS

S. NO.	TYPE	SIZE OF BOLTS	TOTAL WT (KG)
1	M16	16 ϕ X 35 LG	**0.117**
2	M16	16 ϕ X 40 LG	**0.125**
3	M16	16 ϕ X 45 LG	**0.133**
4	M16	16 ϕ X 50 LG	**0.141**
5	M16	16 ϕ X 55 LG	**0.149**
6	M16	16 ϕ X 60 LG	**0.157**
7	M16	16 ϕ X 65 LG	**0.164**
8	M16	16 ϕ X 70 LG	**0.172**
9	M16	16 ϕ X 75 LG	**0.180**
10	M16	16 ϕ X 80 LG	**0.188**
11	M16	16 ϕ X 85 LG	**0.196**
12	M16	16 ϕ X 90 LG	**0.204**
13	M16	16 ϕ X 95 LG	**0.212**
14	M16	16 ϕ X 100 LG	**0.220**
15	M12	12 ϕ X 35 LG	**0.0620**
16	M12	12 ϕ X 40 LG	**0.0664**
17	M12	12 ϕ X 45 LG	**0.0708**
18	M12	12 ϕ X 50 LG	**0.0753**
19	M12	12 ϕ X 55 LG	**0.0797**
20	M12	12 ϕ X 60 LG	**0.0842**

B.) SPRING WASHER

S. NO.	TYPE	TOTAL WT (KG)
1	3.5mm thk (M16 bolt)	**0.00891**
2	2.5mm thk (M12 bolt)	**0.00382**

C.) For supplies of bolts i/c nuts, plain washers and spring washer other than those listed above, payment shall be made based on unit weights worked out considering theoretical dimensions & density of steel as 7850kg/cum.

2.0 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of Cable Glands. No deviation from the requirements specified in various clauses of this specification shall be allowed.

The actual cable data as guaranteed by the cable supplier will be furnished separately. However, for exact measurements, supplier should contact site for cable samples. The final supply shall be made based on actual cables supplied at site.

2.1 SPECIFIC TECHNICAL REQUIREMENT

Cable shall be terminated using double compression type cable glands. Testing requirements of Cable glands shall conform to BS:6121 and gland shall be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene or better synthetic material and of tested quality.

Required number of packing glands to close unused openings in gland plates shall also be provided.

The glands shall be dust proof, screw on type, shrouded complete with necessary armour clamp and tapered washers etc.

The glands shall have provision for securing armour of the cable separately and shall be provided with earthing tag.

2.2 TEST

All valid test reports as per relevant standard shall be furnished including Proof Torque Test, Tensile Test, Seal Test and Electrical Continuity Test as per BS 6121. Cable glands shall also be tested for dust proof and weather-proof termination. Bidders shall submit valid reports of type tests carried out within five years of bid opening. These reports should have been conducted on identical / similar equipment to those offered. In case less than five years old type test reports OR valid type tests are not furnished, the tests shall be conducted free of charge. No separate type test charges shall be paid.

Annexure-F

Scope of work

The TRANSFORMER / REACTOR tank is boxed up and ready for further operation.

The contractor has to execute the following scope of work: -

1. Vacuuming of TRANSFORMER / REACTOR up to 1 mm of mercury and maintaining for 24hrs. Dry N2 filling up to 2.0 psi for 24hrs duration. Heating of the tank externally to raise the temperature upto 75^0C and continue purging operation till desired dew point is achieved. (3 cycles tentatively estimated). Each cycle will comprise of 24hrs vacuuming and 24hrs heating after nitrogen filling.

2. Oil filing & hot oil circulation to achieve BDV & PPM values.

3. Oil settling , testing and re-commissioning of TRANSFORMER / REACTOR

Infrastructure and facilities required for restoration.

1. Vacuum pump with booster capable of pulling 1mm of hg vacuum

2. 30 Nos. dry N2 cylinders (99.9% pure & -55 deg. Cent. dew point).

3. 50 Nos. industrial finned 2kW heaters with mounting structure 1 feet away from tank wall at 1/3, 2/3 height. Enclosure around TRANSFORMER / REACTOR to prevent heat loss and proper heating of insulation.

4. Dew point meter for dew point measurement cylinders & reactor tank.

5. Filter machine (High VAC)

6. SFRA & Tan delta kit. Low voltage testing instruments.

Testing of Transformer/Reactor

1. IR values of windings & bushings at 5 kV for 60sec/600 sec.
2. Tan delta measurement of windings and HV bushing, neutral bushing at 10kV
3. Ratio test by turn ratio meter & vector group verification.
4. Resistance measurement on all taps of HV winding & LV winding.
5. Measurement of magnetization current of HV& LV windings.
6. Measurement of dew point of N2 used for dry out & that of transformer.
7. BDV test of oil before filling in the tank.
8. BDV, PPM, resistivity & tan delta tests on oil after completion of oil filtration.
9. SFRA measurement of transformer.
10. Functional checks of all TRANSFORMER / REACTOR protections like PRV, buchholz relay etc.
11. Pre-commissioning checks for charging of the TRANSFORMER / REACTOR

NTPC Limited

(A Government of India Enterprise)

TALCHER THERMAL POWER PROJECT

STAGE - III (2x660MW)

PART - D

ERECTION CONDITIONS OF CONTRACT

SECTION – VI

TECHNICAL SPECIFICATION

FOR

EPC PACKAGE

BIDDING DOCUMENT NO.: CS-4540-001A-2

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1.00.00 GENERAL

1.01.00 The following provisions shall supplement the conditions already contained in the other parts of these specifications and documents and shall govern that portion of the work of this contract which is to be performed at site. The erection requirements and procedures not specified in these documents shall be in accordance with the recommendations of the equipment manufacturer, or as mutually agreed to between the Employer and the Contractor prior to commencement of erection work.

1.02.00 The Contractor upon signing of the Contract shall, in addition to a Project Co-ordinator, nominate another responsible officer as his representative at Site suitably designated for the purpose of overall responsibility and co-ordination of the Works to be performed at Site. Such a person shall function from the Site office of the Contractor during the pendency of Contract.

2.00.00 REGULATION OF LOCAL AUTHORITIES AND STATUTES

2.01.00 In addition to the local laws and regulations, the Contractor shall also comply with the Minimum Wages Act and the Payment of Wages Act (both of the Government of India) and the rules made there under in respect of its labour and the labour of its sub-contractors currently employed on or connected with the contract.

2.02.00 All registration and statutory inspection fees, if any, in respect of his work pursuant to this Contract shall be to the account of the Contractor. However, any registration, statutory inspection fees lawfully pay-able under the provisions of the Indian Boiler Regula-tions and any other statutory laws and its amendments from time to time during erection in respect of the plant equipment ultimately to be owned by the Employer, shall be to the account of the Employer. Should any such inspection or registration need to be re-arranged due to the fault of the Contractor or his Sub-Contractor, the additional fees for such inspection and/or registration shall be borne by the Contractor.

3.00.00 WELDING OF PRESSURE PARTS AND HIGH PRESSURE PIPING

The welding of all pressure parts and high pressure piping shall be in accordance with the following requirements:

3.01.00 Qualification of Weld Procedures

Only qualified welding procedures as per ASME Section IX shall be used by contractor at site. Procedure qualification records along with WPS shall be submitted to NTPC for review. Welding procedure shall indicate all essential and non-essential parameters as per ASME Section IX. Makes of welding consumables shall be subject to employer's approval.

3.02.00 Welder's Qualification

Only welders who are qualified in accordance with the latest applicable requirements of the Indian Boiler Regulations, shall be permitted to perform any welding work on the pressure parts and its attachment welding. In addition to such statutory qualification requirements, the welders shall also undergo a satisfactory pre-production qualification test to be conducted by the Contractor at site as per ASME Sec IX in presence of employer's representative(s), prior to performing work under these specifications. The services of an independent testing laboratory shall be retained by the Contractor to perform welder qualification tests for welders.

All the welders carrying out welding at site shall carry an identification badge, which shall indicate the category and the grade of welding for which they have been tested and authorised to carry out welding.

3.03.00 **Records**

Welders performance shall be monitored regularly and record of their performance shall be maintained by contractor in a manner acceptable to the employer. Contractor shall maintain such records including record of procedure qualification & welder qualification and hand-over to the employer at the end of work.

3.04.00 **MARKING**

On completion of each welded joint, the welder shall mark his regularly assigned identification mark near the joint. The welder's identification numbers, inspection stamps or code symbol stamps and any other information shall not be directly stamped on any alloy steel piping. In alloy steel piping, all such information shall be stamped on separate marking plate which shall be tack welded on pipe near the weld.

3.05.00 Welding Equipment for high pressure (Boiler , PCP) -

For GTAW process: HF Welding machines to be used.

For SMAW process: Inverter based welding machine are to be used.

Main contractor to ensure the availability of sufficient nos of welding equipment during the each phase of project construction so as not to impede the progress of the project

4.00.00 HEAT TREATMENT

4.01.00 Heat Treatment -Pre-heating, post-heating and post-weld heat treatment operations of all welds, shall be performed in accordance with the requirements of applicable code and WPS . Local post weld heat treatments shall be adopted only in cases where it is normally impracticable to subject the entire assembly as such for stress relieving operations. Heating may be by means of electric induction coils or electric resistance coils as acceptable to employer. Oxyacetylene flame heating or exothermic chemical heating methods will not be permitted. Complete recording of the temperatures through out the stress relieving cycle of the material and the weld subjected to heat treatment shall be made by means of chartless recorder / IIOT sensors duly password protected with a connectivity to remote server /Cloud . All hardware and software required to meet above intent shall be in the scope of bidder.

4.02.00 After setting up the weld joint for heat treatment operation, the Employer's signature shall be obtained on the strips chart of the recorder prior to starting of heat treatment cycle. The right hand corner of the strip chart at the starting point of the heat treatment cycle shall contain details like the weld number, material, diameter and thickness, method of heating adopted, prescribed ranges of heat treatment temperatures, date of heat treatment, reference to item number of the Field welding Schedule (as specified at clause no 7.00.00- of this chapter) etc.

4.03.00 Heat Treatment - weld number, material, diameter and thickness, method of heating adopted, prescribed ranges of heat treatment temperatures, date of heat treatment, reference to item number of the Field welding. Schedule shall be mentioned on data for identification.

5.00.00 **WELD EDGE PREPARATION**

Preparation at site of weld joint shall be in accordance with details acceptable to the Employer. Wherever possible, machining or automatic flame cutting shall be used for edge preparation. Hand flame cutting will be permitted only where edge preparation otherwise is impractical. All slag shall be removed from cuts and all the hand cuts shall be ground smooth to the satisfaction of the Employer. Flame cutting of alloy steel pipe shall be avoided. Wherever such cutting is done, a 200mm length at the cut face shall be removed by machining. Pneumatic hand tools such as edge preparation, tube cutting machine can be used.

6.00.00 **CLEANING AND SERVICING**

6.01.00 The inside of all tubes, pipes, valves and fittings shall be free from dirt, and loose scales before being erected. All the pipelines shall be thoroughly blown and/or flushed. Each steam and water tubes shall be blown with compressed air and shall be subjected to 'ball test' before erection to ensure that no obstructions exist. A system for recording of all such operations shall be developed and maintained in a manner to ensure that no obstructions are left inside the tubes and no tubes are left uncleaned and untested.

6.02.00 All valves and valve actuators, and dampers and damper actuators, if any, shall be thoroughly cleaned and serviced prior to pre-commissioning tests and/or Initial Operations of the plant. A system for recording of such servicing operation shall be developed and maintained in a manner acceptable to the Employer and to ensure that no valves or dampers including their actuators are left unserviced.

6.03.00 All interior surfaces of the turbine shall be thoroughly cleaned prior to boxing - up to remove all traces of oil preservations.

7.00.00 **FIELD WELDING SCHEDULE**

The Contractor shall submit to the Employer, a certified and complete field welding schedule for all the field welding activities to be carried out in respect of the pressure parts involved in the equipment furnished and erected by him, at least 90 days prior to the scheduled start of erection work at site. Such schedule will be strictly followed by the Contractor during the process of erection. The above field-welding schedule to be issued by the Contractor shall contain the following:

(a.) Drawing No (s)

(b.) Location of the weld

(c.) Size of the weld (outside diameter and thickness)

(d.) Type of joints

(e.) Material specifications

(f.) Size of fillet on backing ring, when the type of joint is with backing ring

(g.) Electrode/ filler metal specifications

(h.) Number of welds per unit

(i.) Quantity of filler metal per weld

(j.) Indication of required Non-destructive Examination (NDE) for each weld

(k.) Pre-heat temperatures for welding

(l.) Process of welding

(m.) Post-welding heat treatment temperature ranges, duration, under as specified at clause no 4.00.00 of this chapter entitled "Heat Treatment".

(n.) Qualification details of weld procedures to be adopted as specified at clause no 3.01.00 of this chapter entitled 'Qualification of Weld Procedures'.

8.00.00 SITE RUN MISCELLANEOUS PIPING

Sketches or diagrams of the proposed routings of all piping, not already indicated and routed on the shop drawings which were reviewed by the Employer, shall be submitted to the Employer for review, Employer's acceptance of such site routings shall be obtained before the piping is erected. All these site run piping shall be installed in such a manner as to present an orderly and neat installation. They shall be located as to avoid obstruction of access and passages. Valves, instruments or any other special items shall be located convenient for operation by the operating personnel. Pipe runs shall be plumb or level except where pitch for drainage is required. Pipe runs that are not parallel to the building structure, walls or column rows shall be avoided so that deflection of pipes between hangers does not exceed 6 mm. No miscellaneous pipe shall be routed and installed above or adjacent to electrical equipment.

9.00.00 THERMAL EXPANSIONS

All piping installation shall be such that no excessive or destructive expansion forces exist either in the cold condition or under condition of maximum temperature. All bends, expansion joints and any other special fittings, necessary to provide proper expansion, shall be incorporated. During installation of expansion joints and anchors, care must be taken to make sure that full design movement is available at all times for maximum to minimum temperature and vice-versa.

10.00.00 PIPING SUPPORTS

10.01.00 Hangers, supports and anchors shall be installed as required to obtain a safe, reliable and complete pipe installation. All supports shall be properly levelled and anchored when installed. The anchors shall be so placed that thermal expansion will be absorbed by bends without subjecting the valves or equipment to excessive strains.

10.02.00 The hanger assemblies shall not be used for the attachment of rigging to hoist the pipe into place. Other means shall be used to securely hold the pipe in place till the pipe support is completely assembled and attached to the pipe and building structures and spring support is set to accommodate the pipe way. All temporary rigging shall be removed in such a way that the pipe support is not subjected to any sudden load. All piping, having variable spring type supports, shall be held securely in place by temporary means during the hydraulic test of pipe system. Constant support type spring hangers used during hydraulic test shall be pinned or blocked solid during the test. After complete installation and insulation of the piping and filling of the piping with its normal operating medium, the pipe support springs shall be adjusted to the cold positions. If necessary, the spring support shall be re-adjusted to the hot positions after the line has been placed for service at its normal maximum operating temperature conditions. Electric arc welding only shall be used to weld all pipe supports to structural steel members that form part of the building supporting

structure. The structural beams shall not be heated more than necessary during welding of supports and such welds shall run parallel to the axis of the span. All lugs or any other attachments welded to the piping shall be of the same material as the pipe.

11.00.00 PRESSURE TESTING

11.01.00 On completion of erection of pressure parts, a hydraulic test in accordance with the requirements of the Indian Boiler Regulations shall be performed by the Contractor.

11.02.00 All the valves, high pressure pipes and inter-connected pipes connecting the pressure parts shall be tested along with pressure parts. All blank flanges or any removable plugs required for openings not closed by the valves, and piping provided, shall be furnished by the Contractor. The pressurization equipment including water piping from the supply, needed for the above test shall also be furnished by the Contractor. Any defects noticed during the testing are to be rectified and the unit re-tested. If any welding is done on the pressure parts after the Hydraulic test, the Hydraulic test for that portion of pressure parts shall be repeated.

11.03.00 Thy hydraulic test shall be considered successful only on certification to that effect

by the concerned inspecting Authority as per the provisions of the Indian Boiler Regulations and the Employer.

12.00.00 THERMOWELLS AND FLOW NOZZLES

12.01.00 All the thermowells and flow nozzles in the equipment furnished under the technical specifications shall be installed as a part of this work.

12.02.00 All thermowell connections incorporated in the steam service shall be plugged during the pressure testing and the blow out of steam piping systems. Upon completion of the blow out operation, all thermowells shall be installed and seam welded. Similarly, all flow nozzles in the steam lines shall also be installed only on completion of steam blowing operations unless otherwise agreed to by the Employer, depending upon the sequence of cleaning and purging operations to be adopted by the Contractor at the field.

13.00.00 INSULATION, LAGGING AND CLADDING

The provision of insulation, lagging and cladding of the various equipments and portion of the equipment covered under the Contract, shall be furnished by the Contractor as specified elsewhere or agree to separately in writing. Welds required for holding insulation on pressure parts shall be carried out by IBR qualified welder.

13.01.00 **Piping, Pipe Fittings & Valves**

All piping insulation and metal cladding furnished with the equipment to be erected shall be applied as specified herein.

13.01.01 **Piping**

The insulation on piping shall be applied using wire loops on 150mm centres. These wire loops shall be thoroughly embedded into the outer insulation surface and all cracks, voids and depressions shall be filled with insulating cement suitable for the piping temperature so as to form a smooth base for application of cladding. The wires used for piping insulation shall be of 16 SWG. The surface shall be smooth and uniform before applying the outer covering. All piping insulation ends shall be terminated at a sufficient distance from flanges to facilitate removal of bolts.

13.01.02 **Flanges**

Insulation on flanges shall be by means of blocks of insulating material securely bound to the flange by wire loops. Such blocks of insulation shall be long enough to overlap the adjacent pipe insulation by an amount equal to the thickness of adjacent pipe insulation. Smooth finish shall be obtained by the application of insulating cement. Alternatively, sectional pipe insulation of proper diameter may be used. Insulation on flanges shall not be done until the pipe and equipment have been in service during the initial operation and till all the flange bolts have been retightened.

13.01.03 **Bends and Elbows**

Insulation on bends and elbows shall be cut into sections sufficiently short to form a reasonable smooth external surface. After the application of insulation material in place, it shall be smoothly coated with insulating cement. Elbows may be insulated as above or alternatively by means of specially moulded insulation enclosures.

13.01.04 **Cladding**

Cladding shall be of aluminium sheet of thickness as per details given in detail Technical Specification or will be provided during detail engineering shall be machine rolled and formed to accurately fit insulation curvatures. Cladding shall be secured using self-tapping screws. Screws shall be adequate number and so located as to produce tight joints. The spacing of screws shall be as far as possible uniform and on centres not exceeding 150 mm. For outside diameters less than 230 mm, spacing of screws shall be on centres not exceeding 100 mm. adequate number of screws shall be provided for fixing the cladding and be so placed in such locations, as to produce a smooth cladding finish without bellying'. Insulated elbows having insulated diameters less than 330 mm shall be provided with preformed smooth aluminium elbow jackets. Wherever possible, all joints should be lapped a minimum of 50 mm with joints facing downwards and so placed that they are obscured from normal points of vision. All the joints in the cladding shall be made with suitable provisions for expansions. All butt joints such as those at piping tees shall be made using rolled seams. In addition, to prevent galvanic corrosion, suitable action, as specified at clause no 13.02.00 of this chapter, shall be taken.

13.01.05 **Valves and Fittings**

All valves and fittings (above valve size of 2 inches) installed in the pipelines shall also be applied with insulation and furnished with suitably shaped boxes so as to facilitate easy dismantling of the fittings. The insulation thickness for valves, valve fittings etc., shall be same as that used on the line on which they are installed. All voids shall be properly filled up with insulating material and as per the directions of the Employer.

13.02.00 **Protection of Equipment during Insulation Applications**

All equipment and structures shall be suitably protected from damage while applying insulation after completion of insulation. All equipment and structures shall be thoroughly cleaned and remove insulating materials which might have fallen on them.

14.00.00 CODE REQUIREMENTS

The erection requirements and procedures to be followed during the installation of the equipment shall be in accordance with the relevant Indian Electricity Rules & Codes, Indian Boiler Regulations, ASME codes and accepted good practices, the Employer's Drawings and other applicable Indian recognised codes and laws and regulations of the Government of India.

15.00.00 ELECTRICAL SAFETY REGULATIONS

15.01.00 In no circumstances will the Contractor interfere with fuses and electrical equipment belonging to the other Contractor or Employer.

15.02.00 Before the Contractor connects any electrical appliances to any plug or socket belonging to the other Contractor or Employer, he shall:

(a) Satisfy the Employer that the appliance is in good working condition.

(b) Inform the Employer of the maximum current rating,voltage and phase of the appliances.

(c) Obtain permission of the Employer detailing the socket to which the appliances may be connected.

The Employer will not grant permission to connect unitl he is satisfied that

(d) The appliance is in good condition and is fitted with suitable plug

(e) The appliance is fitted with a suitable cable having two earth conductors,one of which shall be an earthened metal sheath surrounding the cores.

15.03.00 No electric cable in use by the other Contractor/Employer will be disturbed without permission.No weight of any description willl be imposed on any such cable and ladder or similar equipment will rest against or to be attached with it.

15.04.00 No reapir work shall be carried out on any live equipment.The equipment must be declared safe by the Employer and a permit to work issued before any work is carried out.

15.05.00 The Contractor shall employ the necessary number of qualified,full time electricians to maintain his temporary electrical installation..

16.00.00 REMOVAL OF MATERIAL

No material brought to the Site shall be removed from the Site by the Contractor and/or his Sub-Contractors without the prior written approval of the Employer.

17.00.00 INSPECTION, TESTING AND INSPECTION CERTIFICATES

The provisions of the clause entitled Inspection, Testing and Inspection Certificates given in Part - C of the Technical Specification, shall also be applicable to the erection portion of the Works. The Employer shall have the right to re-inspect any equipment though previously inspected and approved by him at the Contractor's works, before and after the same are erected at Site. If by the above inspection, the Employer rejects any equipment, the Contractor shall make good for such rejections either by replacement or modification/ repairs as may be necessary to the satisfaction of the Employer. Such replacements will also include the replacements or re-execution of such of those works of other Contractors and/or agencies, which might have got damaged or affected by the replacements or re-work done to the Contractor's work.

18.00.00 ACCESS TO SITE AND WORKS ON SITE

18.01.00 Suitable access to site and permission to work at the Site shall be accorded to the Contractor by the Employer in reasonable time.

18.02.00 In the execution of the Works, no person other than the Contractor or his duly appointed representative, Sub-Contractor and workmen, shall be allowed to do work on the Site, except by the special permission, in writing by the Employer or his representative.

19.00.00 CONTRACTOR'S SITE OFFICE ESTABLISHMENT

The Contractor shall establish a Office at the Site and keep posted an authorised representative for the purpose of the Contract. Any written order or instruction of the Employer or his duly authorised representative, shall be communicated to the said authorised resident representative of the Contractor and the same shall be deemed to have been communicated to the Contractor at his legal address.

20.00.00 CO-OPERATION WITH OTHER CONTRACTORS

20.01.00 Contractor, who may be performing other works on behalf of the Employer and the workmen who may be employed by the Employer and doing work in the vicinity of the works under the Contract. The Contractor shall also arrange to perform his work as to minimise, to the maximum extent possible, interference with the work of other Contracts and their workmen. Any injury or damage that may be sustained by the employees of the other Contractors and the Employer, due to the Contractor's work shall promptly be made good at his own expense. The Employer shall determine the resolution of any difference or conflict that may arise between the Contractor and other Contractors or between the Contractor and the workmen of the Employer in regard to their work. If the work of the Contractor is delayed because of the any acts of omission of another Contractor, the Contractor shall have no claim against the Employer on that account other than an extension of time for completing his works.

Employer shall have full access to visit the contractor's site at any time for inspection and surveillance checks.

20.02.00 The Employer shall be notified promptly by the Contractor of any defects in the other Contractor's works that could affect the Contractor's Works. The Employer shall determine the corrective measures if any, required to rectify this situation after inspection of the works and such decisions by the Employer shall be binding on the Contractor.

21.00.00 DISCIPLINE OF WORKMEN

The Contractor shall adhere to the disciplinary procedure set by the Employer in respect of his employees and workmen at Site. The Employer shall be at liberty to object to the presence of any representative or employee of the Contractor at the Site, if in the opinion of the Employer such employee has mis-conducted himself or is incompetent, negligent or otherwise unde-sirable then the Contractor shall remove such a person objected to and provide in his place a competent replacement.

22.00.00	**CONTRACTOR'S FIELD OPERATION**
22.01.00	The Contractor shall keep the Employer informed in advance regarding his field activity plans and schedules for carrying out each part of the works. Any review of such plan or schedule or method of work by the Employer shall not relieve the Contractor of any of his responsibilities towards the field activities. Such reviews shall also not be considered as an assumption of any risk or liability by the Employer or any of his representatives and no claim of the Contractor will be entertained because of the failure or inefficiency of any such plan or schedule or method of work reviewed. The Contractor shall be solely responsible for the safety, adequacy and efficiency of plant and equipment and his erection methods.
22.02.00	The Contractor shall have the complete responsibility for the conditions of the Work-Site including the safety of all persons employed by him or his Sub-Contractor and all the properties under his custody during the performance of the work. This requirement shall apply continuously till the completion of the Contract and shall not be limited to normal working hours. The construction review by the Employer is not intended to include review of Contractor's safety measures in, on or near the Work-Site, and their adequacy or otherwise.
23.00.00	**PHOTOGRAPHS AND PROGRESS REPORT**
23.01.00	The Contractor shall furnish three (3) prints each to the Employer of progress photographs of the work done at Site. Photographs shall be taken as and when indicated by the Employer or his representative. Photographs shall be adequate in size and number to indicate various stages of erection. Each photograph shall contain the date, the name of the Contractor and the title of the photograph.
23.02.00	The above photographs shall accompany the monthly progress report detailing out the progress achieved on all erection activities as compared to the schedules. The report shall also indicate the reasons for the variance between the scheduled and actual progress and the action proposed for corrective measures, wherever necessary.
23.03.00	The Contractor shall submit the progress of work in video cassettes (2 copies) quarterly highlighting the progress and constraints at site.
24.00.00	**MAN-POWER REPORT**
24.01.00	The Contractor shall submit to the Employer, on the first day of every month, a man hour schedule for the month, detailing the man hours scheduled for the month, skill-wise and area-wise.
24.02.00	The Contractor shall also submit to the Employer on the first day of every month, a man power report of the previous month detailing the number of persons scheduled to have been employed and actually employed, skill- wise and the areas of employment of such labour.
25.00.00	**PROTECTION OF WORK**
	The Contractor shall have total responsibility for protecting his works till it is finally taken over by the Employer. No claim will be entertained by the Employer or the representative of the Employer for any damage or loss to the Contractor's works and the Contractor shall be responsible for complete restoration of the damaged works to original conditions to comply with the specification and drawings. Should any such damage to the Contractor's Works occur because of other party not being under his supervision or control, the Contractor shall make his claim directly with the party

concerned. If disagreement or conflict or dispute develops between the Contractor and the other party or parties concerned regarding the responsibility for damage to the Contractor's Works the same shall be resolved as per the provisions of the as specified at clause no 20.00.00- of this chapter entitled "Co-operation with other Contractors." The Contractor shall not cause any delay in the repair of such damaged Works because of any delay in the resolution of such disputes. The Contractor shall proceed to repair the Work immediately and no cause thereof will be assigned pending resolution of such disputes.

26.00.00 EMPLOYMENT OF LABOUR

26.01.00 In addition to all local laws and regulations pertaining to the employment of labour to be complied with by the Contractor pursuant to GCC, the Contractor will be expected to employ on the work only his regular skilled employees with experience of the particular work. No female labour shall be employed after darkness. No person below the age of eighteen years shall be employed.

26.02.00 All travelling expenses including provisions of all necessary transport to and from Site, lodging allow-ances and other payments to the Contractor's employees shall be the sole responsibility of the Contractor.

26.03.00 The hours of work on the Site shall be decided by the Employer and the Contractor shall adhere to it. Working hours will normally be eight (8) hours per day - Monday through Saturday.

26.04.00 Contractor's employees shall wear identification badges while on work at Site.

26.05.00 In case the Employer becomes liable to pay any wages or dues to the labour or any Government agency under any of the provisions of the Minimum Wages Act, Workmen Compensation Act, Contact Labour Regulation Abolition Act or any other law due to act of omission of the Contractor, the Employer may make such payments and shall recover the same from the Contractor's Bills.

27.00.00 FACILITIES TO BE PROVIDED BY THE EMPLOYER

27.01.00 **Communication**

The Employer will extend the telephone facilities, if available at Site, for purposes of Contract. The Contractor shall be charged at actuals for such facili-ties.

27.02.00 **Railway Siding**

Railway siding shall be provided by owner (up to plant entry point) for coal transportation to site. However the same may not be available to the bidder for material/supplies transport etc. Bidder has to plan its own arrangement for movement of ODC consignment to plant site.

Further, irrespective of readiness of railway siding, owner reserves the option of coal supply in stackyard before the synchronization of first unit for which bidder has to ensure readiness of coal supply system up to mill bunker.

28.00.00 FACILITIES TO BE PROVIDED BY THE CONTRACTOR

28.01.00 **Contractor's site office Establishment**

The Contractor shall establish a site office at the site and keep posted an authorized representative for the purpose of the contract, pursuant to GCC. The site office will include one conference meeting room (250-300 Sq Ft) for site meetings between the Contractor and the Employer. The contractor shall also provide four (4) furnished

	office rooms (150-250 SqFt) for use by the Employer to facilitate effective co-ordination during the tenancy of the contract.
28.02.00	**Tools, tackles and scaffoldings**
	The Contractor shall provide all the construction equipments, tools, tackles and scaffoldings required for pre-assembly, installation, testing, commissioning and conducting Guarantee tests of the equipments covered under the Contract. He shall submit a list of all such materials to the Employer before the commencement of pre-assembly at Site. These tools and tackles shall not be removed from the Site without the written permission of the Employer. The Contractor shall arrange Dozer, Hydra, Cranes, Trailer, etc. for the purpose of fabrication, erection and commissioning.
28.03.00	**Testing Equipment and Facilities:**
	The contractor shall provide the necessary testing, equipment and facilities.
28.04.00	**Site laboratory for civil works:**
	Contractor shall provide and maintain a site laboratory for the testing of construction material under the direction and general supervision of employer.
28.05.00	**First-aid**
28.05.01	The Contractor shall provide necessary first-aid facilities for all his employees, representatives and workmen working at the Site. Enough number of Contractor's personnel shall be trained in administering first-aid.
28.05.02	The Employer will provide the Contractor, in case of any emergency, the services of an ambulance for transportation to the nearest hospital.
28.06.00	**Cleanliness**
28.06.01	The Contractor shall be responsible for keeping the entire area allotted to him clean and free from rubbish, debris etc. during the period of Contract. The Contractor shall employ enough number of special personnel to thoroughly clean his work-area at least once in a day. All such rubbish and scrap material shall be stacked or disposed in a place to be identified by the Employer. Materials and stores shall be so arranged to permit easy cleaning of the area. In areas where equipment might drip oil and cause damage to the floor surface, a suitable protective cover of a flame resistant, oil proof sheet shall be provided to protect the floor from such damage.
28.06.02	Similarly the labour colony, the offices and the residential areas of the Contractor's employees and workmen shall be kept clean and neat to the entire satisfaction of the Employer. Proper sanitary arrangements shall be provided by the Contractor, in the work-areas, office and residential areas of the Contractor.
28.07.00	**Not used**
28.08.00	**Electricity**
	Refer to construction power, as envisaged at Clause 1.15.00 of Sub Section-II-B, Part A, Sec VI of Technical specification.

28.09.00 **Water**

Contractor shall make all arrangements himself for the supply of construction water as well as potable water for labour and other personnel at the worksite/colony. However, drawal of construction/potable water from bore-well shall be permitted if found suitable. Any statutory clearance required shall be obtained by the contractor. Assistance, if required shall be provided by the owner.

29.00.00 LINES AND GRADES

All the Works shall be performed to the lines, grades and elevations indicated on the drawings. The Contractor shall be responsible to locate and layout the Works. Basic horizontal and vertical control points will be established and marked by the Employer at Site at suitable points. These points shall be used as datum for the works under the Contract. The Contractor shall inform the Employer well in advance of the times and places at which he wishes to do work in the area allotted to him so that suitable datum points may be established and checked by the Employer to enable the Contractor to proceed with his works. Any work done without being properly located may be removed and/or dismantled by the Employer at Contractor's expense.

30.00.00 FIRE PROTECTION

30.01.00 The work procedures that are to be used during the erection shall be those which minimise fire hazards to the extent practicable. Combustible materials, combustible waste and rubbish shall be collected and removed from the Site at least once each day. Fuels, oils and volatile or flammable materials shall be stored away from the construction and equipment and materials storage areas in safe containers. Untreated canvas, paper, plastic or other flammable flexible materials shall not at all be used at Site for any other purpose unless otherwise specified. If any such materials are received with the equipment at the Site, the same shall be removed and replaced with acceptable material before moving into the construction or storage area.

30.02.00 Similarly corrugated paper fabricated cartons etc. will not be permitted in the construction area either for storage or for handling of materials. All such materials used shall be of water proof and flame resistant type. All the other materials such as working drawings, plans etc. which are combustible but are essential for the works to be executed shall be protected against combustion resulting from welding sparks, cutting flames and other similar fire sources.

30.03.00 All the Contractor's supervisory personnel and sufficient number of workers shall be trained for fire-fighting and shall be assigned specific fire protection duties. Enough of such trained personnel must be available at the Site during the entire period of the Contract.

30.04.00 The Contractor shall provide enough fire protection equipment of the types and number for the warehouses, office, temporary structures, labour colony area etc. Access to such fire protection equipment, shall be easy and kept open at all time.

31.00.00 SECURITY

The Contractor shall have total responsibility for all equipment and materials in his custody stores, loose, semi-assembled and/or erected by him at Site. The Contractor shall make suitable security arrangements including employment of security personnel to ensure the protection of all materials, equipment and works

from theft, fire, pilferage and any other damages and loss. All materials of the Contractor shall enter and leave the Employer Site only with the written permission of the Employer in the prescribed manner.

32.00.00 CONTRACTOR'S AREA LIMITS

The Employer will mark-out the boundary limits of access roads, parking spaces, storage and construction areas for the Contractor and the Contractor shall not trespass the areas not so marked out for him. The Contractor shall be responsible to ensure that none of his personnel move out of the areas marked out for his operations. In case of such a need for the Contactor's personnel to work out of the areas marked out for him the same shall be done only with the written permission of the Employer.

33.00.00 CONTRACTOR'S CO-OPERATION WITH THE EMPLOYER

In case where the performance of the erection work by the Contractor affects the operation of the system facilities of the Employer, such erection work of the Contractor shall be scheduled to be performed only in the manner stipulated by the Employer and the same shall be acceptable at all times to the Contractor. The Employer may impose such restrictions on the facilities provided to the Contractor such as electricity, etc. as he may think fit in the interest of the Employer and the Contractor shall strictly adhere to such restrictions and co-operate with the Employer. It will be the responsibility of the Contractor to provide all necessary temporary instrumentation and other measuring devices required during start-up and operation of the equipment systems which are erected by him. The Contractor shall also be responsible for flushing and initial filling of all the oil and lubricants required for the equipment furnished and installed by him, so as to make such equipment ready for operation. The Contractor shall be responsible for supplying such flushing oil and other lubricants unless otherwise specified elsewhere in documents and specifications.

34.00.00 PRE-COMMISSIONING AND COMMISSIONING ACTIVITIES

34.01.00 **GENERAL**

34.01.01 The Contractor upon completion of installation of equipments and systems, shall conduct pre-commissioning and commissioning activities, to make the equipment/systems ready for safe, reliable and efficient operation on sustained basis. All pre-commissioning/commissioning activities considered essential for such readiness of the equipment/systems including those mutually agreed and included in the Contractor's quality assurance programme as well as those indicated in clauses elsewhere in the technical specifications shall be performed by the contractor.

34.01.02 The pre-commissioning and commissioning activities including Guarantee/ demonstration/acceptability tests, checks and trial operations of the equipment/ systems furnished and installed by the contractor shall be the responsibility of the Contractor as detailed in relevant clauses in Technical Specification. The Contractor shall provide, in addition, test instruments, calibrating devices etc. and labour required for successful performance of these operations. If it is anticipated that the above test may prolong for a long time, the Contractor’s workmen required for the above test shall always be present at site during such operations.

34.01.03 The following activities shall be carried out by the contractor, 18 month prior to schedule date of commissioning of the equipment/systems installed by him.

(a.) The contractor shall furnish the organization chart of his operation and commissioning engineers for the acceptance of employer. Adequate number of operation and commissioning engineers shall be deployed by the contractor to effectively meet the requirement of round the clock operation in shifts also, till the plant is taken over by the employer.

(b.) The contractor shall submit the bio-data containing the details of experience of his operation and commissioning engineers for the acceptance of employer.

(c.) The contractor shall furnish the deployment schedule of his operation and commissioning engineers for the acceptance of the employer.

(d.) Apart from above, contractor shall ensure deployment of sufficient skilled/semi-skilled/unskilled manpower during pre-commissioning and commissioning activities.

34.01.04 It shall be the responsibility of the Contractor to provide all necessary temporary instrumentation and other measuring devices required during start-up and initial operation of the equipment/systems which are installed by him.

34.01.05 The Contractor shall also be responsible for flushing and initial filling of all oils and lubricants required for the equipment furnished and installed by him so as to make such equipment ready for operation. The Contractor shall be responsible for supplying such flushing oil and other lubricants unless otherwise specified elsewhere in these specifications and documents.

34.02.00 **COMMISSIONING DOCUMENTATION**

34.02.01 The contractor shall submit the commissioning documentation, comprising of Standard checklists, pre-commissioning procedures, testing schedules, commissioning schedules and commissioning networks for various equipment/ systems covered under the contract, for the approval of employer.

34.02.02 Standard checklist, as the name suggests, shall be a fairly general documents, containing the list of all checks required to be carried out for similar and repetitive type of equipment to ensure consistent and thorough checking. An indicative list of such equipment is enclosed as Annexure I.

34.02.03 The testing schedule is a document, designed for safe and systematic commissioning of individual equipment/sub-system (for example Boiler Feed Pump, condensate pump, compressor etc) Commissioning schedule is a document envisaged for commissioning of a system (for example feed system, Condensate system, Compressed Air system, Fire water system, Unit commissioning etc). The testing/Commissioning schedule shall have a standard format in order to maintain consistency of presentation, content and reporting. A brief write up on the contents of the Testing Schedule/Commissioning Schedule is enclosed as Annexure-II.

34.02.04 The contractor shall submit the list of commissioning documentation to be submitted by him, alongwith their submission schedule for various equipment/systems covered under the contract, with in 6(six) month from the date of award of contract, for the acceptance of employer.

34.02.05	The Contractor shall submit the commissioning documentation, for various equipment/covered under the contract, for the approval of employer, at least 18 months before the scheduled date of commissioning of the equipment/systems.
34.03.00	**COMMISSIONING ACTIVITIES**
34.03.01	Upon completion of pre-commissioning activities/tests, the contractor shall initiate commissioning of facilities. During commissioning the Contractor shall carry out system checking and reliability trials on various parts of the facilities.
34.03.02	Contractor shall carry out the checks/tests at site to prove to the Employer that each equipment of the supply complies with requirements stipulated and is installed in accordance with requirements specified.
34.03.03	Before the plant is put into initial operation the Contractor shall be required to conduct test to demonstrate to the Employer that each item of the plant is capable of correctly performing the functions for which it was specified and its performance, parameters etc. are as per the specified/approved values. These tests may be conducted concurrently with those required under commissioning sequence.
34.03.04	The Contractor shall also demonstrate the performance of all C&I equipment, the tests on main equipment of prior to that as the case may be.
34.03.05	Other tests shall be conducted, if required by the Employer, to establish that the plant equipment are in accordance with requirements of the specifications.
34.03.06	The Contractor shall conduct all the commissioning tests and undertake commissioning activities pertaining to all other auxiliaries and equipments including all electrical and C&I equipment/systems not specifically brought out above but are within the scope of work and facilities being supplied and installed by the Contractor and follow the guidelines indicated above or elsewhere in these technical specifications.
34.05.00	**Initial Operation**
	Upon completion of system checking/Tests as above and as a part of commissioning of facilities, complete plant/facilities shall be put on initial operation as stipulated in General Technical Requirements.
35.00.00	**MATERIALS HANDLING AND STORAGE**
35.01.00	All the equipments furnished under the Contract and arriving at Site shall be promptly received, unloaded and transported and stored in the storage spaces by the Contractor.
35.02.00	Contractor shall be responsible for examining all the shipment and notify the Employer immediately of any damage, shortage, discrepancy etc. for the purpose of Employer's information only. The Contractor shall submit to the Employer every week a report detailing all the receipts during the week. However, the Contractor shall be solely responsible for any shortages or damage in transit, handling and / or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.
35.03.00	The Contractor shall maintain an accurate and exhaus-tive record detailing out the list of all equipment received by him for the purpose of erection and keep such record open for the inspection of the Employer.

35.04.00	All equipment shall be handled very carefully to prevent any damage or loss. No bare wire ropes, slings, etc. shall be used for unloading and/or handling of the equipment without the specific written permission of the Employer. The equipment stored shall be properly protected to prevent damage either to the equipment or to the floor where they are stored. The equipment from the store shall be moved to the actual location at the appropriate time so as to avoid damage of such equip-ment at Site.
35.05.00	All electrical panels, controls gear, motors and such other devices shall be properly dried by heating before they are installed and energised. Motor bearings, slip rings, commutators and other exposed parts shall be protected against moisture ingress and corrosion during storage and periodically inspected. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion due to prolonged storage.
35.06.00	All the electrical equipment such as motors, genera-tors, etc. shall be tested for insulation resistance as per OEM Practice. Storage of EHV/Generator transformers under Nitrogen /Dry air shall not exceed the time duration as defined by OEM practice.
35.07.00	The Contractor shall ensure that all the packing materials and protection devices used for the various equipments during transit and storage are removed before the equipment are installed.
35.08.00	The consumables and other supplies likely to deteriorate due to storage must be thoroughly protected and stored in a suitable manner to prevent damage or dete-rioration in quality by storage.
35.09.00	All the materials stored in the open or dusty location must be covered with suitable weatherproof and flame-proof covering material wherever applicable.
35.10.00	If the materials belonging to the Contractor are stored in areas other than those earmarked for him, the Employer will have the right to get it moved to the area earmarked for the Contractor at the Contractor's cost.
35.11.00	The Contractor shall be responsible for making suitable indoor storage facilities to store all equipment which require indoor storage. Normally, all the electrical equipments such as motors, control gear, generators, exciters and consumables like electrodes, lubricants etc. shall be stored in the closed storage space. The Employer, in addition, may direct the Contractor to move certain other materials, which in his opinion will require indoor storage, to indoor storage areas which the Contractor shall strictly comply with.
35.12.00	Sound Storage Management system need to be followed for storage of material. First in First Out method (FIFO) to be adopted to avoid longtime storage. Storage duration of any material at site shall not be more than 3 months. Accordingly supply of material in sequence of erection at site to be ensured. To achieve the same, following is to be adopted: a. Dispatch clearance is to be given in order of sequence of erection. To achieve the goal, proper tags shall be maintained in ascending order. The tag shall be self-explanatory.

b. MDCC shall be issued by RIO based on clearance from Site FQA head, Main contractor, Erection head for dispatch and supply of material. Strict adherence to sequential supply of material as per supply schedule.

35.13.00 An automated storage and retrieval system consists of a variety of computer-controlled systems for automatically placing and retrieving of material may be adopted. Accordingly, each material shall be marked with unique identification code.

36.00.00 CONSTRUCTION MANAGEMENT

36.01.00 The field activities of the Contractors working at Site, will be coordinated by the Employer and the Employer decision shall be final in resolving any disputes or conflicts between the Contractor and other Contractors and tradesmen of the Employer regarding scheduling and co- ordination of work. Such decision by the Employer shall not be a cause for extra compensation or extension of time for the Contractor.

36.02.00 The Employer shall hold weekly meetings of all the Contractors working at Site, at a time and place to be designated by the Employer. The Contractor shall attend such meetings and take notes of discussions during the meeting and the decisions of the Employer and shall strictly adhere to those decisions in performing his Works. In addition to the above weekly meeting, the Employer may call for other meeting either with individual Contractors or with selected number of Contractors and in such a case the Contractor if called, will also attend such meetings.

36.03.00 Time is the essence of the Contract and the Contractor shall be responsible for performance of his works in accordance with the specified construction schedule. If at any time, the Contractor is falling behind the schedule, he shall take necessary action to make good for such delays by increasing his work force or by working overtime or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such actions in writing to the Employer, satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

36.04.00 The Employer shall however not be responsible for provision of additional labour and/or materials or supply or any other services to the Contractor except for the co-ordination work between various Contractors as set out earlier.

36.05.00 **Site management during construction phase till handing over of plant**

Bidder shall ensure that the plant site within the plant boundary is managed in a coordinated and professional way all through the construction phase till handing over of plant, ensuring safe, easy & unhindered working conditions and a healthy & hygienic working environment at site. He shall ensure the following measures at site while executing the project.

a) Unhindered motorable road access to all work areas and facilities both during the construction/erection and as they get completed progressively. Required temporary access roads other than the permanent roads shall also be provided. Bidder shall prioritize the construction of approach roads, roads around the main plant block, roads to office & storage areas and the offsite areas from the start of project itself. He shall finalize and submit the complete road layout plan along with priority and completion schedule immediately after the award for review by the Employer .He shall ensure that the roads are promptly repaired and maintained against any damages due to

movement of traffic/heavy trailers & cranes etc providing motorable access at all times. Adequate onsite stock of road materials shall be kept and maintained disturbed over the site for repairs especially before the monsoon period.

b) Proper drainage of rain water, ground water from excavations, water flows from batching plant / construction sites etc. He shall prioritize the construction of permanent drains from the start of the project itself. Till such time the permanent drainage network is done, he shall construct adequate temporary drains to ensure that there is no accumulation /stagnation of water in the plant site. Bidder may consider providing pre-cast RCC drains for temporary/ permanent drain construction for faster construction of drains. The drain construction shall be matched with progress of road construction for preventing damage to roads. Bidder shall provide and maintain adequate number of drainage pumps (both electrical and diesel operated) of suitable capacity for pumping out accumulated water especially during the monsoon periods. All drain diversions required shall be undertaken at the start of the project itself.

c) The plant site is fully secured against unauthorized access.

d) Proper housekeeping by systematic and proper disposal of earth from excavations(separately for usable & surplus earth), muck (from pile bores or otherwise), wastes (from dismantling of pile tops, concrete works etc), packing & insulation wastes, steel scrap, cable wastes etc generated during construction / erection works. Suitable disposal sites for each of above shall be identified in the layout and at site in the beginning of the project itself. It shall be ensured that all agencies engaged by the bidder follow the discipline to dispose off of earth spoils and wastes at the designated places. Preferably once in a week suitable time slot will be identified for housekeeping by all agencies and suitable instructions shall be issued in this regard. Bidder may engage a separate agency or identify a gang for collection of wastes and disposal to designated places. Suitable arrangement / tie-up will also be made for periodic disposal of wastes/ scrap from the designated places.

e) All fabrication areas shall be suitably hard crusted to provide a water free and proper working platforms. Suitable sheds preferably pre-engineered structures to be provided for paint shops, fabrication workshops etc for ensuring all weather work conditions for onsite structural works. For the main plant and auxiliary buildings, bidder should preferably plan the works in such a way that structural fabrication is done in suppliers' offsite works / workshops and onsite fabrication works are avoided / kept minimum.

f) Suitable onsite maintenance workshop for day to day breakdown maintenance heavy plant and equipment like batching plants, cranes, earth moving equipment, welding equipment etc. The workshop shall have stock of frequently needed spares and suitable repair facilities with experienced technicians/mechanics. A central test laboratory equipped with test equipment for routine tests like tests on soil, concrete, bricks, aggregates, welds etc with experienced staff shall be established at the start of the project itself.

g) All office and covered store buildings of the bidder and its agencies shall be of prefab/ pre-engineered / porta cabin construction. Shabby semi-finished constructions in brickwork/ GI / asbestos roof etc shall not be permitted.

h) First aid facilities and amenities like rest rooms, suitable pre-engineered toilets (separate for men and women), drinking water fountains/tanks, canteen, crèche for women workers shall be planned and established at the beginning of the project itself. These facilities shall be distributed over the plant area to enable easy access by the construction workers and staff and shall be marked on the plant layout. Suitable treatment for toilet discharge, like bio digesters etc shall be planned and conventional septic tanks / soak pits etc shall be avoided.

i) Proper lighting of all construction / erection areas. Bidder shall erect adequate number of high lighting masts in main plant, offsite, office and store areas for lighting during night. DG sets of adequate capacity shall be provided for emergency backup. The street lighting along the roads shall also be prioritized along with road construction. The construction power ring main shall be planned and erected immediately after the award.

j) Well planned and coordinated storage and movement of plant, equipment and construction materials. System wise / agency wise storage / laydown areas shall be planned and marked on the plant layout at the beginning itself. Bidder shall ensure that all its agencies comply to the areas allocated to them and follow the designated storage and movement plans. Adequate covered storage shall be constructed for storage of critical equipments like switchgears, MCCs, insulation etc.

k) Proper access control for construction workers, staff and visitors. Bidder shall ensure that suitable electronic based gate pass system is in place from start of project itself to keep record and track of all workers, staff and visitors entering/exiting the plant premises shift wise on daily basis.

l) Compliance to all safety requirements as specified in this document. Bidders shall establish a safety centre at the start of the project itself. It shall have a 24X7 manned safety control room in addition to a permanent safety equipment display room, separate training / lecture hall with AV facilities for safety training, store room with adequate stock of specified safety equipment, a first aid room and other amenities. Bidder shall install 25 Nos. CCTV cameras at all strategic locations in the plant area which shall be linked to the safety control room."

m) Compliance to all environment and other conditions stipulated by the concerned statutory authorities while according clearance / NOC (No objection certificate) to the project. Bidder shall ensure adequate sprinkling of water by deploying water tankers to prevent the fugitive dust nuisance during construction.

n) Development of suitable landscape & green belt areas and rainwater harvesting within the plant premises. Bidder shall plan to develop the landscape & green belt areas and rainwater harvesting from the start of the project itself. The landscape and rain water harvesting plan shall be finalized immediately after award of work and suitable work plan with priority and schedule shall also be finalized thereafter. Top soil before excavation shall

be suitably preserved and stacked for landscape and green belt development.

o) Provision of adequate shelters, water supply, sanitation and lighting in construction workers and staff camps. No camps for workers and staff shall be permitted within the plant premises and Bidder shall make separate arrangement outside the plant premises for locating and development of camps for construction workers and staff. The designated areas shall be suitably developed with infrastructure like roads, drains, water supply and sewerage and shall be free from water logging. Suitable low cost shelters will be provided for the workers. Complete area shall be secured by fencing and shall be provided adequate area lighting. Suitable waste disposal, shopping and recreation facilities will be developed in these camps.

Bidder shall ensure that due importance is given to site management as discussed above and a detailed work plan considering the above aspects is finalized immediately after the award. A senior level executive shall be identified who shall be responsible for implementation of the work plan. Suitable format for progress reporting on site management plan shall be developed and made part of the project progress report. The progress on implementation of above work plan shall be reviewed along with project progress in the monthly project review meetings with Employer. In case the progress on site management plan is unsatisfactory, Employer may withhold up to 1% of the monthly running bill (for civil and site erection works) till such time the required progress is demonstrated. In case in the opinion of Employer, bidder's actions on site management aspects is not adequate, Employer may get the relevant work executed through a separate agency and deduct the expenses incurred from Bidder's bill along with overheads @10 %.

36.06.00 **QUALITY CONTROL ROOM**

Bidder shall also establish Quality control room at the start of project .It shall have all the real time data of the PWHT , Smart storage area monitoring system data & CCTV cameras feed installed at strategic locations in the plant like SG ,TG area where erection work is in progress and digital records of NDT .

Two large size LED screens will be placed adjacent to the Head of FQA for monitoring the activities .Detailed specifications are mentioned in smart project management Chapter

36.07.00 Welder Training Center -Contractor shall setup a small welding training center 3 -4 welding booths equiped with GTAW & SMAW setup in a pota cabin/suitable enclosed space to train & hone skill of high pressure welders who are giving high rate of welding defect.

36.08.00 **Smart Storage area/yard monitoring**

All storage area including the open yards and covered sheds shall be equipped with smart storage monitoring system. All the boundaries of the storage areas shall be geofenced with fixed camera and entire inside area of storage (both open yards and covered sheds) should be covered with PTZ cameras such that there should not be any dark patch. Minimum 80 number of CCTV cameras is to be supplied. All camera should have analytics to identify storage condition, water logging, excess vegetation, any intrusion. In addition to this, each PTZ camera should have auto tracking

analytics to track any intruder. All hardware and software required to meet above intent shall be in the scope of bidder.

37.00.00 FIELD OFFICE RECORDS

The Contractor shall maintain at his Site Office up-to- date copies of all drawings, specifications and other Contract Documents and any other supplementary data complete with all the latest revisions thereto. The Contractor shall also maintain in addition the continuous record of all changes to the above Contract Documents, drawings, specifications, supplementary data, etc. effected at the field and on completion of his total assignment under the Contract shall incorporate all such changes on the drawings and other Engineering data to indicate as installed conditions of the equipment furnished and erected under the Contract. Such drawings and Engineering data shall be submitted to the Employer in required number of copies.

38.00.00 CONTRACTOR'S MATERIALS BROUGHT ON TO SITE

38.01.00 The Contractor shall bring to Site all equipment, components, parts, materials, including construction equipment, tools and tackles for the purpose of the Works under intimation to the Employer. All such goods shall, from the time of their being brought vest in the Employer, but may be used for the purpose of the Works only and shall not on any account be removed or taken away by the Contractor without the written permission of the Employer. The Contractor shall nevertheless be solely liable and responsible for any loss or destruction thereof and damage thereto.

38.02.00 The Employer shall have a lien on such goods for any sum or sums which may at any time be due or owing to him by the Contractor, under, in respect of or by reasons of the Contract. After giving a fifteen (15) days' notice in writing of his intention to do so, the Employer shall be at liberty to sell and dispose of any such goods, in such manner as he shall think fit including public auction or private treaty and to apply the proceeds in or towards the satisfaction of such sum or sums due as aforesaid.

38.03.00 After the completion of the Works, the Contractor shall remove from the Site under the direction of the Employer the materials such as construction equipment, erection tools and tackles, scaffolding etc. with the written permission of the Employer. If the Contractor fails to remove such materials, within fifteen (15) days of issue of a notice by the Employer to do so then the Employer shall have the liberty to dispose off such materials as detailed under as specified at clause no 38.02.00- of this chapter and credit the proceeds thereto to the account of the Contractor.

39.00.00 PROTECTION OF PROPERTY AND CONTRACTOR'S LIABILITY

39.01.00 The Contractor shall be responsible for any damage resulting from his operations. He shall also be re-sponsible for protection of all persons including members of public and employees of the Employer and the employees of other Contractors and Sub- Contractors and all public and private property including structures, building, other plants and equipments and utilities either above or below the ground.

39.02.00 The Contractor will ensure provision of necessary safety equipment such as barriers, sign - boards, warning lights and alarms, etc. to provide adequate protection to persons and property. The Contractor shall be responsible to give reasonable notice to the Employer and the Employers of public or private property and utili-ties when such property and utilities are likely to get damaged or injured during the performance of his Works and shall make all necessary arrangements with such

Employers, related to removal and/or replacement or protection of such property and utilities.

40.00.00 PAINTING

For painting refer Part-A, sub section-III, Section VI of Technical specification.

Painting for structures shall conform to the painting specification specified in Part-B under Civil.

Painting for piping shall conform to the painting specification given in Part-B of the respective chapter.

Painting for Electrical equipments/systems shall conform to the painting specification given in Electrical portion of Part-A and Part-B of technical specifications.

41.00.00 INSURANCE

41.01.00 In addition to the conditions covered under the Clause entitled "Insurance" in Section General Conditions of Contract (GCC), the following provisions will also apply to the portion of works to be done beyond the Contractor's own or his Sub-Contractor's manufacturing Works.

41.02.00 **Workmen's Compensation Insurance**

This insurance shall protect the Contractor against all claims applicable under the Workmen's Compensation Act, 1948 (Government of India). This policy shall also cover the Contractor against claims for injury, disability disease or death of his or his Sub-Contractor's employees, which for any reason are not covered under the Workmen's Compensation Act, 1948. The liabilities shall not be less than the following:

Workmen's Compensation	-	As per Statutory Provisions
Employee's Liability	-	As per Statutory Provisions

41.03.00 **Comprehensive Automobile Insurance**

This insurance shall be in such a form to protect the Contractor against all claims for injuries, disability, disease and death to members of public including the Employer's men and damage to the property of other arising from the use of motor vehicles during on or off the Site operations, irrespective of the Ownership of such vehicles. The liability covered shall be as herein indicated:

Fatal Injury	:	Rs.100, 000 each person
	:	Rs.200, 000 each occurrence
Property Damage	:	Rs.100, 000 each occurrence

41.04.00 **Comprehensive General Liability Insurance**

41.04.01 The insurance shall protect the Contractor against all claims arising from injuries, disabilities, disease or death of members of public or damage to property of others, due to any act or omission on the part of the Contractor, his agents, his employees, his representatives and Sub-Contractors or from riots, strikes and civil commotion. This insurance shall also cover all the liabilities of the Contractor arising out of the Clause entitled "Defence of Suits" in Section General Conditions of Contract (GCC).

41.04.02 The hazards to be covered will pertain to all the Works and areas where the Contractor, his Sub-Contractors, his agents and his employees have to perform work pursuant to the Contract.

41.05.00 The above are only illustrative list of insurance covers normally required and it will be the responsibility of the Contractor to maintain all necessary insurance coverage to the extent both in time and amount to take care of all his liabilities either direct or indirect, in pursuance of the Contract.

42.00.00 UNFAVOURABLE WORKING CONDITIONS

The Contractor shall confine all his field operations to those works which can be performed without subjecting the equipment and materials to adverse effects during inclement weather conditions, like monsoon, storms, etc. and during other unfavorable construction conditions. No field activities shall be performed by the Contractor under conditions which might adversely affect the quality and efficiency thereof, unless special precautions or measures are taken by the Contractor in a proper and satisfactory manner in the performance of such Works and with the concurrence of the Employer. Such unfavorable construction conditions will in no way relieve the Contractor of his responsibility to perform the Works as per the schedule.

43.00.00 PROTECTION OF MONUMENTS AND REFERENCE POINTS

The Contractor shall ensure that any finds such as relic, antiquity, coins, fossils, etc. which he may come across during the course of performance of his Works either during excavation or elsewhere, are properly protected and handed over to the Employer. Similarly the Contractor shall ensure that the bench marks, reference points, etc., which are marked either with the help of Employer or by the Employer shall not be disturbed in any way during the performance of his Works. If, any work is to be performed which disturb such reference, the same shall be done only after these are transferred to other suitable locations under the direction of the Employer. The Contractor shall provide all necessary materials and assistance for such relocation of reference points etc.

44.00.00 WORK & SAFETY REGULATIONS

44.01.00 General

i) The contractor shall comply with all the requirements of "The Building and Other Construction Workers (Regulation of Employment & Conditions of Service) Act," 1996 and its Central Rule 1998 / State Rules and any other statutory requirements as applicable.

ii) The Contractor shall follow NTPC Safety Rules as specified in SCC with respect to safety in construction & erection.

iii) The contractor shall have the approved Safety, Health and Environment (SHE) Policy in respect of Safety and health of Building Workers and it shall be circulated widely and displayed at conspicuous place in Hindi and local language understood by the majority of the workers. A copy of the safety policy should be submitted to Engineer in charge.

iv) The contractor shall submit the safety plan comprising of methods to implement the Safety Policy/ Rules, Risk assessment and ensuring Safety at work areas, Safety audits, inspections and its compliance, Supervision and responsibility to ensure Safety at various levels, Safety training to

employees, review of Safety and accident analysis, ensure Health and Safety Procedures to prevent accidents to Engineer I/c for approval as per the format of Safety plan as annexed at Annexure - III.

v) The Contractors shall ensure proper safety of all the workmen, materials, plant and equipment belonging to him or to the Employer or to others, working at the Site.

vi) All equipments used in construction and erection by the contractor shall meet BIS / International Standards and where such standards do not exist, the Contractor shall ensure these to be absolutely safe. All equipments shall be strictly operated and maintained by the contractor in accordance with manufacturer's operation manual. The contractor should also follow Guidelines / Rules of the Employer in this regard.

vii) The Contractors shall provide suitable latest Personal Protective Equipments of prescribed standard to all their employees and workmen according to the need. The Engineer I/c shall have the right to examine these safety equipments to determine their suitability, reliability, acceptability and adaptability. The contractor should also ensure these before their use at worksite.

viii) The Contractor shall provide safe working conditions to all workmen and employees at his workplace including safe means of access, railings, stairs, and ladders, scaffolding, work platforms, toe boards etc. The scaffoldings shall be erected under the control and supervision of an experienced and competent person. For erection of scaffolds, access, work platforms etc. shall be good and the contractor shall use standard quality of material.

ix) The Contractor shall follow and comply with all the Safety Rules, standards, code of practices of NTPC and relevant provisions of applicable laws pertaining to the safety of workmen, employees, plant and equipment as may be prescribed from time to time without any protest or contest or reservation. In case of any unconformity between statutory requirement and the Safety Rules of the Employer referred above, the latter shall be binding on the Contractor unless the statutory provisions are more stringent. As and when required he can refer / obtain copy of NTPC safety documents as stated above.

x) The contractor shall have his own arrangements with nearby hospitals for shifting and treatment of sick and injured.

The medical examination of the workers employed in hazardous areas shall be conducted as per Rule 223 0f The Building and Other Construction Worker (Regulation of Employment and Condition of Service) Central Rule 1998 Their health records shall be maintained accordingly and to be submitted to Engineer I/c when asked for. If any worker found suffering from occupational health hazard, the worker should be shifted to suitable place of working and properly treated under intimation to Engineer I/c. The medical fitness certificate to be submitted to Engineer (I/c).

xi) First Aid boxes equipped with requisite articles as specified in the Rule 231 of The Building and Other Construction Worker (Regulation of Employment and Condition of Service) Central Rule 1998 shall be provided at construction

sites for the use of workers. Training has to be provided on first aid to workmen & office bearers working at site.

44.01.01 **Emergency Action Plan**

The contractor shall prepare an emergency action plan approved by his competent authority to handle any emergency occurred during construction work. Regular mock drills shall be organized to practice this emergency plan. The Emergency Action Plan should be widely circulated to all the employees and suitable infrastructure shall be provided to handle the emergencies.

44.01.02 **Scaffolding**

The contractor shall take all precautions to prevent any accidental collapse of scaffolding or fall of persons from scaffolding. The contractor should ensure that scaffolding are designed by a competent person and it erection and repairs should be done under the expert supervision. The scaffolding shall meet the required strength and other requirements for the purpose for which the scaffold is erected. The material used for scaffold should conform to the BIS / International standards.

44.01.03 **Opening**

The contractor shall ensure that there is no opening in any working platform/any floor of the building, which may cause fall of workers or material. Whenever an opening on a platform/any floor of the building is unavoidable, the opening should be suitably fenced and necessary measures for protection against falling objects or building workers from such platform are taken by providing suitable safety nets, safety belts or other similar means.

44.01.04 **Explosives**

The contractor shall take all precautions while handling, using, storing or transporting of all explosives. Before usage of any explosive necessary warning / danger signals be erected at conspicuous places to warn the workers and general public. The contractor should strictly ensure that all measures and precautions required to be complied for use, handling, storing or transportation of explosives under the rules framed under the Explosives Act, 1884.

44.02.00 **Fencing of Machinery**

The contractor shall provide suitable fencing or guard to all dangerous and moving parts of machinery.

The contractor shall not allow any of the employees to clean, lubricate, repair, adjust or examine during machinery in motion, which may cause injury to the person.

44.03.00 **Carrying of Excessive Weight by a Worker**

The worker shall not be allowed to lift by hand or carry over his head, back or shoulder more than the maximum limit set by the prescribed rules for the construction Workers.

44.04.00 **Dangerous and Harmful Gases / Equipment**

The contractor shall ensure that the workers are not exposed to any harmful gases during any construction activity including excavation, tunneling, confined spaces etc.

The contractor should not allow any worker to go into the confined space unless it is certified by Engineer (I/c) to be safe and fit for the entry to such work place. Proper record and work permits should be followed to carry out such works.

44.05.00 **Overhead Protection**

The contractor shall ensure that any area exposed to risk of falling materials, articles or objects is roped off or cordoned off or otherwise suitably guarded from inadvertent entry of any person.

Wherever there is a possibility of falling of any material, equipment or construction workers while working at heights, a suitable and adequate safety net should be provided. The safety net should be in accordance with BIS Standards.

44.06.00 **Working at Heights**

All working platforms, ways and other places of construction work shall be free from accumulations of debris or any other material causing obstructions and tripping.

Wherever workers are exposed to the hazard of falling into water, the contractor shall provide adequate equipment for saving the employees from drowning and rescuing from such hazards. The contractor shall provide boat or launch equipped with sufficient number of life buoys, life jackets etc. manned with trained personnel at the site of such work.

Every opening at elevation from ground level through which a building worker, vehicle, material equipment etc. may fall at a construction work shall be covered and/or guarded suitably by the contractor to prevent such falls.

Wherever the workers are exposed to the hazards of falling from height, the contractor shall provide full harness safety belts fitted with fall arresting systems to all the employees working at higher elevations and life line of 8 mm diameter wire rope with turn buckles for anchoring the safety belts while working or moving at higher elevations. Safety nets shall also be provided for saving them from fall from heights and such equipment should be in accordance with BIS standards. Wherever there is a possibility of falling of any material, equipment or construction workers while working at heights, a suitable and adequate safety net should be provided. The safety net should be in accordance with BIS Standards.

The contractor shall provide standard prefabricated ladders on the columns where the workers are required to use them as an access for higher elevations till permanent staircase is provided. The workers shall be provided with safety belts fitted with suitable fall arresting system (fall arrestors) for climbing/getting down through ladders to prevent fall from height.

44.07.00 **Handling of Hazardous Chemicals**

The Contractor will notify well in advance to the Engineer I/c of his intention to bring to the Site any container filled with liquid or gaseous fuel or explosive or petroleum substance or such chemicals which may involve hazards. NTPC shall have the right to prescribe the conditions, under which such container is to be stored, handled and used during the performance of the works and the Contract shall strictly adhere to and comply with such instructions. The Engineer I/c shall have the right at his sole discretion to inspect any such container or such construction plant / equipment for which material in the container is required to be used and if in his opinion, its use is not safe, he may forbid its use. No claim due to such prohibition shall be entertained

by NTPC and NTPC shall not entertain any claim of the Contractor towards additional safety provisions / conditions to be provided for / constructed.

Further, any such decision of the Engineer I/c shall not, in any way, absolve the Contractor of his responsibilities and in case, use of such a container or entry thereof into the Site area is forbidden by NTPC, the Contractor shall use alternative methods with the approval of the NTPC without any cost implication to the NTPC or extension of work schedule.

Where it is necessary to provide and / or store petroleum products or petroleum mixtures and explosives, the Contractor shall be responsible for carrying-out such provision and / or storage in accordance with the rules and regulations laid down in Petroleum Act 1934, Explosives Act 1948, and Petroleum and Carbide of Calcium Manual published by the Chief Inspector of Explosives of India. All such storage shall have prior approval of the Engineer I/c. In case any approvals are necessary from the Chief Inspector (Explosives) or any statutory authorities, the Contractor shall be responsible for obtaining the same.

The Contractor shall be fully responsible for the safe storage of his and his Sub-contractor's radio-active sources in accordance with BARC/DAE (Bhabha Atomic Research Centre/ Department of Atomic Energy, Govt. of India) Rules and other applicable provisions. All precautionary measures stipulated by BARC/DAE in connection with use, the contractor would take storage and handling of such material.

The contractor shall provide suitable personal protective equipments to the workers who are handling the hazardous and corrosive substances including alkalis and acids.

As a precautionary measure the contractor should keep the bottles filled with distilled water in cupboard / Boxes near work place for emergency eye wash by worker exposed to such hazardous chemicals.

44.08.00 **Eye Protection**

The contractor shall provide suitable personal protective equipment to his workmen depending upon the nature of hazards and ensure their usage by the workers engaged in operations like welding, cutting, chipping, grinding or similar operations which may cause injuries to his eyes.

44.09.00 **Excavation**

The contractor shall take all necessary measures during excavation to prevent the hazards of falling or sliding material or article from any bank or side of such excavation which is more than one and a half meter above his footing by providing adequate piling, shoring, bracing etc. against such bank or sides.

Adequate and suitable warning signs shall be put up at conspicuous places at the excavation work to prevent any persons or vehicles falling into the excavation trench. No worker should be allowed to work where he may be stuck or endangered by excavation machinery or collapse of excavations or trenches.

44.10.00 **Electrical Hazards**

The contractor should ensure that all electrical installations at the construction work comply with the requirements of latest electricity acts / rules.

The contractor shall take all adequate measures to prevent any worker from coming into physical contact with any electrical equipment or apparatus, machines or live electrical circuits which may cause electrical hazards during the construction work. The contractor shall provide the sufficient ELCBs / RCCBs for all the portable equipments, electrical switchboards, distribution panels etc. to prevent electrical shocks.

The contractor should ensure use of single / double insulated hand tools or low voltage i.e., 110 volts hand tools.

The contractor should also ensure that all temporary electrical installations at the

construction works are provided with earth leakage circuit breakers.

44.11.00 **Vehicular Traffic**

The contractor should employ vehicle drivers who hold a valid driving license under the Motor Vehicles Act, 1988.

44.12.00 **Lifting Appliances, Tools & Tackles, Lifting Gear And Pressure Plant & Equipment etc.**

The contractor shall ensure all the lifting appliances, tools & tackles including cranes etc., lifting gear including fixed or movable and any plant or gear, hoists, Pressure Plant and equipment etc. are in good condition and shall be examined by competent person and only certified shall be used at sites. Periodical Examination and the tests for all lifting / hoisting equipment & tackles shall be carried out. A register of such examinations and tests shall be properly maintained by the Contractor and will be promptly produced as and when desired by the Engineer I/c or by the person authorized by him.

44.13.00 **Excessive Noise, Vibration**

The contractor shall take adequate measures to protect the workers against the harmful effect of excessive noise or vibration. The noise should not exceed the limits prescribed under the concerned rules, Noise Pollution (Regulation and Control) Rules, 2000. Generally for brownfield projects background noise is in the range of 58-60 DB, however it shall be responsibility of contractor to collect and measure the latest noise data at site.

44.14.00 **Electrical Installations**

44.14.01 The Contractor shall not interfere or disturb electric fuses, wiring and other electrical equipment belonging to the Employer or other contractors under any circumstances, whatsoever, unless expressly permitted in writing by the Engineer I/c to handle such fuses, wiring or electrical equipment.

Before the Contractor connects any electrical appliances to any plug or socket belonging to the other contractor or the NTPC, he shall

i) Satisfy the Engineer I/C that the appliance is in good working condition;

ii) Inform the Engineer I/C of the maximum current rating, voltage and phases of the appliances;

iii) Obtain permission of the Engineer I/C detailing the sockets to which the appliances may be connected.

The Engineer I/C will not grant permission to connect until he is satisfied that:

The appliance is in good condition and is fitted with suitable plug; having earth connection with the body.

Wherever armored / metallic sheathed multi core cable is used, the same armored / sheathed should be connected to earth.

iv) No repair work shall be carried out on any live equipment. The Engineer I/c must declare the equipment safe and a permit to work shall be issued by the NTPC / contractor as the case may be to carry out any repair / maintenance work. While working on electric lines / equipments whether live or dead, suitable type and sufficient quantity of tools will have to be provided by the contractor to electricians / workmen / Officers.

v) The contractor shall employ necessary number of qualified, full time Electricians / Electrical Supervisors to maintain his temporary electrica

installation.

he installations are provided with suitable ELCBs and RCCBs wherever required.

44.15.00 **Safety Organisation**

44.15.01 The contractor shall employ full time safety officer(s) as per requirement stipulated in NTPC Safety Rules, exclusively to supervise safety aspects of the equipments and workmen, who will coordinate with the NTPC Safety Officer. Further requirement of safety officers, if any, shall be guided by Rule 209 of The Building and Other Construction Worker (Regulation of Employment and Conditions of Service) Central Rule 1998. In case the work is being carried out through subcontractor, the employees / workmen of the sub-contractor shall also be considered as the contractor's employees/workmen for the above purpose.

44.15.02 The name and address of such Safety Officer of the Contractor will be promptly informed in writing to the EIC with a copy to the Project Safety Officer before he starts work or immediately after any change of the incumbent is made during currency of the Contract.

44.16.00 **Reporting of Accident and Investigation**

In case any accident occurs during the construction / erection or other associated activities undertaken by the Contractor thereby causing any near miss, minor or major or fatal injury to his employees due to any reason, whatsoever, it shall be the responsibility of the Contractor to promptly inform the same to the Engineer I/C, NTPC Safety Officer with a copy to NTPC Head of Project in the prescribed form and also to all the authorities envisaged under the applicable laws.

44.17.00 **Right to stop Work**

44.17.01 The Engineer I/C shall have the right at his sole discretion to stop the work, if in his opinion the work is being carried out in such a way that it may cause accidents and endanger the safety of the persons and / or property, and / or equipments. In such cases, the contractor shall be informed in writing about the nature of hazards and possible injury / accident and he shall comply to remove shortcomings promptly. The Contractor after stopping the specific work can, if felt necessary appeal against the order of stoppage of work to the Project Manager within 3 days of such stoppage of work and decision of the Project Manager in this respect shall be conclusive and binding on the Contractor.

44.17.02 The Contractor shall not be entitled for any damages / compensation for stoppage of work, {Sub-Clause XVIII (I)} due to safety reasons and the period of such stoppage of work shall not be taken as an extension of time for Completion of the Facilities and will not be the ground for waiver of levy of liquidated damages.

44.18.00 **Fire Protection**

The contractor shall provide sufficient fire extinguishers at place /s of work. The fire

extinguishers shall be properly maintained as per relevant BIS Standards. The employees shall be trained to operate the fire extinguishers / equipment.

44.19.00 **Penalties**

I If any contractor worker found working without using the safety equipment like safety helmet, safety shoes, safety belts, etc. or without anchoring the safety belts while working at height the Engineer I/c shall have the right to regulate the payment in accordance with provisions of SCC. Further such defaulting worker shall be sent out of the workplace immediately and shall not be allowed to work on that day. Engineer I/c / Safety Officer of NTPC will also issue a notice in this regard to the contractor.

II If two or more fatal accidents occur at same NTPC site under the control of contractor during the period of contract and he has

(1) not complied with keeping adequate PPEs in stock or

(2) defaulted in providing PPEs to his workmen

(3) not followed statutory requirements / NTPC safety rules

(4) been issued warning notice/s by NTPC head of the project on non observance of safety norms

(5) not provided safety training to all his workmen, the contractor can be debarred from getting tender documents in NTPC for two years from the date of last accident.

The safety performance will also be one of the overriding criteria for evaluation of overall performance of the contractors by NTPC. The contractor shall submit the accident data including fatal / non-fatal accidents for the last 3 years where he has undertaken the construction activities Projects-wise along with the tender documents. This will also be considered for evaluation of tender documents. If the information given by the contractor found incorrect, his contract will be liable to be terminated.

44.20.00 The Contractor will make available minimum quantity of all safety equipments and safety PPEs of required specifications as per suggestive list included bidding documents as a part of "List of minimum T & P". Further Contractor will ensure availabilitty of additional requirement for individual worker and safety equipment as per site requirement during execution of the contract till its completion.

44.21.00 The Contractor shall abide by the following during Construction and Erection activities:

I. Chain pulley block shall not be used for loads more than 2 (Two) tonne.

II. Hydra shall not be used for material transport.

III. Cage shall necessarily be provided to Monkey ladders of height more than 4 m.

IV. Fencing shall be provided to all Electrical Distribution boards and transformers etc.

44.22.00 Contractor shall ensure following regarding implementation of Safety:

a) Two Tier Safety Monitoring System:
Separate Safety Consultancy contract shall be awarded by NTPC for assisting and guiding overall Plant Safety during Construction. The safety consultant shall induct and engage manpower required as per specific requirements of project.
For Construction safety, Contractor shall engage certified safety team in consultation with NTPC Safety team /safety Consultant for each package/area.

b) Risk level of different area of plant shall be evaluated by NTPC Safety & Safety consultant. Based on the severity of risk level, total project area shall be categorized into different safety zones and each zone will be identified with different color coding.

c) Dedicated Project Safety Manager of Safety Consultant will be deployed. Contratcor to deploy area/ system wise safety representative for each system/ area of project e.g. SG area, TG Main Power House area and similarly in other BOP Systems.

d) The Safety Officer can stop work of any contractor if safety rules are violated.

e) There should also be safety clearance in Quarterly RA bills in addition to the clearances being presently taken from HR and Quality dept.

f) PPEs, scaffoldings, safety nets, testing tools etc. should be monitored by NTPC Safety Manager to control and maintain the uniformity of Quality for Safety equipment/ PPEs.

g) There should be 24/7 Safety Control room equipped with IP Camera, AI Input alarms and proper communication system for monitoring safety. All CCTV footage shall be available to control room. Drone based safety monitoring shall be done during day. The safety control room shall be operated & managed by NTPC through safety consultant.

h) Safety management plan for the Project must be submitted for approval before start of work.

i) In line with the Project Planning, Safety planning will be done jointly by Project Team and Consultants.

j) Availability of Fire Tender shall be ensured by contractor before start of construction work.

k) **Number of Safety Stewarts**: Each area (e.g. SG, TG, etc.) should have minimum 5 safety Stewarts from Main Agency and 5 from the sub agency.

l)	Contractor should provide scaffolding material, pipes, clamps, boards and scaffolding of standard quality.
m)	Uses of Safety net, Fire blankets and fall arrester shall be adequate.
n)	Construction Elevators shall be used during erection phase.
o)	Material transport through Hydra shall be avoided.
p)	Good Quality and new PPEs and tools and machinery shall be used.
q)	All Agency /Sub Agency will deploy Safety manpower after getting approval from Head of safety Consultant.
r)	Contractor Safety officer shall take approval of JSA /HIRA of each area from Safety consultant. Before Start of work in a particular area, concerned Safety consultant clearance is must.
s)	Inspect the site to ensure it is a hazard-free environment & promotes safe practices at the job site.
t)	Verifies that injury logs and reports are completed and submitted to NTPC.
u)	Receives reports from and responds to orders issued by NTPC and Labor inspectors.
v)	Serve as primary contact for project site incident and injury notification, investigation, and follow-up.
w)	Organize and maintain necessary project safety documentation.
x)	Training Setup to be created for giving basic education of Safety to workers.
y)	Safety Park and work simulation facility to be created at site.
z)	Health Check Up facility of workers.
aa)	Vendor Safety circle (with max 25 nos person) and monthly safety award to be created.
bb)	24/7 first aid center (common for all agency) and expenditure on contribution basis which is decided by NTPC safety department.
45.00.00	**FOREIGN PERSONNEL**
45.01.00	The Contractor shall submit to the Employer data on all personnel he proposes to bring into India from abroad for the performance of the Works under the Contract, at least sixty (60) days prior to their departure to India. Such data will include for each person the name, his present address, his assignment and responsibility in connection with the works, and a short resume of his qualification, experience etc. in relation to the work to be performed by him.
45.02.00	Any person unsuitable and unacceptable to the Employer shall not be brought to India. Any person brought to India, if found unsuitable or unacceptable by the Employer, the Contractor shall within a reasonable time make alternate arrangements for providing a suitable replacement and repatriation of such unsuitable personnel.
45.03.00	No person brought to India for the purposes of the works shall be repatriated without the consent of the Employer in writing, based on a written request from the Contractor for such repatriation giving reasons for such an action to the Employer. The Employer may give permission for such repatriation provided he is satisfied that the progress of work will not suffer due to such repatriation.

45.04.00	The cost of passports, visas and all other travel expenses to and from India, incurred by the Contractor shall be to his account. The Employer will not provide any residential accommodation and/or furniture for any of the Contractor's personnel including foreign personnel and Contractor shall make his own arrangements for such facilities in the area allotted at Site, to him by the Employer for that purpose.
45.05.00	The Contractor and his expatriate personnel shall respect all Indian Acts, Laws, rules and regulations and shall not in any way interfere with Indian political and religious affairs and shall conform to any other rules and regulations which the Government of India and the Employer may establish from time to time, on them. The Contractor's expatriate personnel shall work and live in close co-operation and coordination with their co-workers and the community and shall not engage themselves in any other employment neither part-time nor full-time nor shall they take part in any local politics.
45.06.00	The Employer shall assist the Contractor, to the extent possible, in obtaining necessary permits to travel to India and back, by issue of necessary certificates and other information needed by the Government agencies.
46.00.00	**FOUNDATION DRESSING & GROUTING FOR EQUIPMENT/ EQUIPMENT BASES**
46.01.00	The surfaces of foundations shall be dressed to bring the top surface of the foundations to the required level, prior to placement of equipment/equipment bases on the foundations.
46.02.00	All the equipment/ equipment bases, shall be grouted and finished by bidder as per these specifications unless otherwise recommended by the equipment manufacturer.
46.03.00	The concrete foundation surfaces shall be properly prepared by bidder by chipping, grinding as required to bring the top of such foundation to the required level, to provide the necessary roughness for bondage and to assure enough bearing strength.
46.04.00	**Grout**
	The grout for equipment foundation shall be high strength grout having a minimum characteristic compressive strength of 60 N/mm2 at 28 days. The grout shall be ready mix non-shrink, chloride - free, cement based, free flowing, non-metallic grout as recommended by equipment manufacturer. The ready mix grout shall be of reputed make as approved by the Employer.
	The Grout shall have good flowability even at very low water/ grout powder ratio.
	The Grout shall have characteristics of controlled expansion to be able to occupy its original volume to fill the voids and to compensate for shrinkage. Grout shall be of pre-mix variety so that only water needs to be added before use.
	The mixing of the Grout shall conform to the recommendations of the manufacturer of the Grout.
46.05.00	**Placing of Grout**
46.05.01	After the base has been prepared, its alignment and level has been checked and approved and before actually placing the grout, a low dam shall be set around the base at a distance that will permit pouring and manipu-lation of the grout. The height of such dam shall be at least 25mm above the bottom of the base. Suitable

size and number of chains shall be introduced under the base before placing the grout, so that such chains can be moved back & forth to push the grout into every part of the space under the base.

46.05.02 The grout shall be poured either through grout holes if provided or shall be poured at one side or at two adjacent sides to make the grout move in a solid mass under the base and out in the opposite side. Pouring shall be continued until the entire space below the base is thoroughly filled and the grout stands at least 25 mm higher all around than the bottom of the base. Enough care should be taken to avoid any air or water pockets beneath the bases.

46.05.03 In addition to the above, recommendations of Grout manufacturer shall also be followed.

46.06.00 **Finishing of the Edges of the Grout**

The poured grout should be allowed to stand undisturbed until it is well set. Immediately thereafter, the dam shall be removed and grout which extends beyond the edges of the structural or equipment base plates shall be cut off, flushed and removed. The edges of the grout shall then be pointed and finished with 1:2 cement mortar pressed firmly to bond with the body of the grout and smoothened with a tool to present a smooth vertical surface. The work shall be done in a clean and scientific manner and the adjacent floor spaces, exposed edges of the foundations, and structural steel and equipment base plates shall be thoroughly cleaned of any spillage of the grout.

46.07.00 **Checking of Equipment After Grouting**

After the grout is set and cured, the Contractor shall check and verify the alignment of equipments, alignment of shafts of rotating machinery, the slopes of all bearing pedestals, centering of rotors with respect to their sealing bores, couplings, etc. as applicable and the like items to ensure that no displacement had taken place during grouting. The values recorded prior to grouting shall be used during such post grouting check- up and verifications. Such pre and post grout records of alignment details shall be maintained by the Contractor in a manner acceptable to the Employer.

47.00.00 SHAFT ALIGNMENTS

All the shafts of rotating equipment shall be properly aligned to those of the matching equipments to as perfect an accuracy as practicable. The equipment shall be free from excessive vibration so as to avoid overheating of bearings or other conditions which may tend to shorten the life of the equipment. The vibration level of rotating equipments measured at bearing housing shall conform to Zone A of ISO 10816. All bearings, shafts and other rotating parts shall be thoroughly cleaned and suitably lubricated before starting.

48.00.00 DOWELLING

All the motors and other equipment shall be suitably doweled after alignment of shafts with tapered machined dowels as per the direction of the Employer.

49.00.00 CHECK OUT OF CONTROL SYSTEMS

After completion of wiring, cabling furnished under separate specification and laid and terminated by the Employer, the Contractor shall check out the operation of all

control systems for the equipment furnished and installed under these specifications and documents.

50.00.00 COMMISSIONING SPARES

50.01.00 It will be the responsibility of the Contractor to provide all commissioning spares including consumable spares required for initial operation till the Completion of Facilities. The Contractor shall furnish a list of all commissioning spares within 60 days from the date of Notification of Award and such list shall be reviewed by the Employer and mutually agreed to. However. such review and agreement will not absolve the Contractor of his responsibilities to supply all commissioning spares so that initial operation do not suffer for want of commissioning spares. All commissioning spares shall be deemed to be included in the scope of the Contract at no extra cost to the Employer.

50.02.00 These spare will be received and stored by the Contractor atleast 3 months prior to the schedule date of commencement of initial operation of the respective equipment and utilised as and when required. The unutilised spares and replaced parts, if any, at the end of successful completion of guarantee tests shall be the property of the Contractor and he will be allowed to take these parts back at his own cost with the permission of Employer.

51.00.00 CABLING

51.01.00 All cables shall be supported by conduits or cable tray run in air or in cable channels. These shall be installed in exposed runs parallel or perpendicular to dominant surfaces with right angle turn made of symmetrical bends or fittings. When cables are run on cable trays, they shall be clamped at a minimum intervals of 2000mm or otherwise as directed by the Employer.

51.02.00 Each cable, whether power or control, shall be provided with a metallic or plastic tag of an approved type, bearing a cable reference number indicated in the cable and conduit list (prepared by the Contractor), at every 5 meter run or part thereof and at both ends of the cable adjacent to the terminations. Cable routing is to be done in such a way that cables are accessible for any maintenance and for easy identification.

51.03.00 Sharp bending and kinking of cables shall be avoided. The minimum radii for PVC insulted cables 1100 V grade shall be 15 D where D is the overall diameter of the cable. Installation of other cables like high voltage, coaxial, screened, compensating, mineral insulated shall be in accordance with the cable manufacturer's recommendations. Wherever cables cross roads and water, oil, sewage or gaslines, special care should be taken for the protection of the cables in designing the cable channels.

51.04.00 In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints to be made, should the cable develop fault at a later date.

51.05.00 Control cable terminations shall be made in accordance with wiring diagrams, using identifying codes subject to the Employer's approval. Multicore control cable jackets shall be removed as required to train and terminate the conductors. The cable jacket shall be left on the cable, as far as possible, to the point of the first conductor branch. The insulated conductors from which the jacket is removed shall be neatly twined in bundles and terminated. The bundles shall be firmly but not tightly tied utilising plastic or nylon ties or specifically treated fungus protected cord made for this purpose. Control cable conductor insulation shall be securely and evenly cut.

51.06.00 The connectors for control cables shall be covered with a transparent insulating sleeve so as to prevent accidental contact with ground or adjacent terminals and shall preferably terminate in Elmex terminals and washers. The insulating sleeve shall be fire resistant and shall be long enough to over pass the conductor insulation. All control cables shall be fanned out and connection made to terminal blocks and test equipment for proper operation before cables are corded together.

52.00.00 EQUIPMENT DELIVERY AND ERECTION

52.01.00 General Requirements

(a.) This part covers Contractor's responsibilities for packing, shipping, ware-housing and the installation of all equipment and materials furnished and installed under this specification.

(b.) The Contractor shall submit for Employer's approval draft manual for Equipment Delivery and Erection (EDE Manual) covering detailed instructions, write up, technical data, drawings, check-lists, documentation formats for all activities after equipment manufacture upto installation of equipment. This manual shall cover general instructions for all equipment and specific instructions for individual equipment wherever required and shall include at least the following:

(1.) Instructions for packing, shipping, receiving handling, ware-housing and storage.

(2.) Instructions for location and installation of equipment furnished by this specification.

(3.) Installation drawings for field mounted equipment, panels, cubicles and other equipment covered under this specification.

(4.) Instruction relating installation of piping/ tubing, support and routing drawings of impulse pipes/signal tubes and tube/cable trays.

(5.) Check lists and quality assurance hold points.

(6.) Format for all related documentation.

(c.) The EDE Manual shall conform to the requirements of this specification, all applicable codes and standards, recommendations of equipment manufacturers and accepted good engineering practices and shall be subject to Employer approval during detailed engineering.

(d.) The Contractor shall ensure that all work under this part shall be performed as per the requirements of this specification, Employer approved EDE Manual and drawing/documents approved by the Employer during detailed engg.

52.02.00 Crating

(a.) All equipment and materials shall be suitably coated, wrapped, or covered and boxed or crated for moist humid tropical shipment and to prevent damage or deterioration during handling and storage at the site.

(b.) Equipment shall be packed with suitable desiccants, sealed in water proof vapour-proof wrapping and packed in lumber of plywood enclosures, suitably braced, tied and skidded. Lumber enclosures shall be solid, not slatted.

(c.) Desiccants shall be either silica gel or calcium sulphate, sufficiently ground to provide the required surface area and activated prior to placing in the packaging. Calcium sulphate desiccants shall be of a chemical nature to absorb moisture. In any case, the desiccant shall not be of a type that will absorb enough moisture to go into solution. Desiccants shall be packed in porous containers, strong enough to withstand handling encountered during normal shipment. Enough desiccant shall be used for the volumes enclosed in wrapping.

(d.) Review by the Employer of the Contractor's proposed packaging methods shall not relieve the Contractor of responsibility for damage or deterioration to the equipment and materials specified.

(e.) All accessory items shall be shipped with the equipment. ; Boxes and crates containing accessory items shall be marked so that they are identified with the main equipment. The contents of each box and crates shall be indicated by markings on the exterior.

(f.) All boxes, crates, cases bundles, loose pieces, etc. shall be marked consecutively from No.1 upward throughout all shipments from a given port to completion of the order without repeating the same number.

(g.) An itemized list of contents shall be enclosed inside each case and one other copy securely fastened to the outside of the case in a tin or light weight sheet metal envelope or pocket. The lists shall be plainly marked and placed in accessible locations to facilitate receipt and inspection. The packing list shall indicate whether shipment is partial or complete and shall incorporate the following information on each container, etc., according to its individual shipping number:

a) Export case markings
b) Case number
c) Gross weight and net weight in Kilograms
d) Dimensions in centimeters
e) Complete description of material

(h.) Packaging or shipping units shall be designed within the limitations of unloading facilities and the equipment which will be used for transport. Complications involved with ocean shipment and the limitations of ports, railways and roads shall be considered. It shall be the Contractor's responsibility to investigate these limitations and to provide suitable packaging to permit safe handling during transit and at the job site.

(i.) Electrical equipment, control and instrumentation shall be protected against moisture and water damage. All external gasket surfaces and flange faces, couplings, motor pump shafts, bearing and like items shall be thoroughly cleaned and coated with rust preventive compound as specified above and protected with suitable wood, metal or other substantial type covering to ensure their full protection.

(j.) Equipment having antifriction or sleeve bearings shall be protected by weather tight enclosures.

(k.) Coated surfaces shall be protected against impact, abrasion, discolouration and other damage. Surfaces which are damaged shall be repaired.

(l.) All exposed threaded parts shall be greased and protected with metallic or other substantial type protectors. All female threaded openings shall be closed with forged steel plugs. All pipings, tubing, and conduit equipment and other equipment openings shall be sealed with metallic or other rough usage covers and tapped to seal the interior of the equipment piping, tubing, or conduit.

(m.) Provisions shall be made to ensure that water does not enter any equipment during shipment or in storage at the plant site.

(n.) Returnable containers and special shipping devices shall be returned by the manufacturer's field representative at the Contractor's expense.

(o.) While packaging the material, care shall be taken for the limitation from the point of view of availability of railway wagon sizes in India.

52.03.00 **Factory Assembly**

(a.) Instrument enclosures shall be supplied and erected completely in the factory with instrument, air supply and blow down piping with necessary valves, fittings, etc. and also all electrical wiring between the instruments and the enclosure terminal blocks. Control panel and cubicles shall also be fully wired in the factory. Control panel mounted equipments are to be dismounted from the panels before shipment and individually packed for shipment. Electronic control modules of the plug-in type are to be removed from equipment racks after factory checkout are individually packed for shipment. Other equipment shall be fully assembled at the factory, except for necessary shipping splits in panels.

(b.) All separately packaged accessories items and parts shall be shipped with the equipment. Containers for separately packaged items shall be marked so that they are identified with the main equipment. An itemized packing slip, indicating what is in that carton only, shall be attached to the outside and inside of each container used for packing.

A master packing slip covering all accessories items for a given piece of equipment which are shipped in separate containers, shall be attached to one container.

52.04.00 **Equipment Installation**

(a.) **General Requirements**

(1.) The Contractor shall furnish all construction materials, tools and equipment and shall perform all work required for complete installation of all control and instrument equipment furnished under this specification.

(2.) Contractor shall prepare detailed installation drawings for each equipment furnished under this specification for Employer’s approval. Installation of all equipment/systems furnished by this specification shall be as per Employer's approval.

(3.) Erection procedures not specified herein shall be in accordance with the recommendations of the equipment manufacturers. The procedures shall be acceptable to the Employer.

(4.) The Contractor shall coordinate his work with other suppliers where their instruments and devices are to be installed under specifications.

(b.) **Installation Materials**

All materials required for installation, testing and commissioning of the equipment shall be furnished by the Contractor.

(c.) **Regulatory Requirements**

All installation procedures shall confirm with the accepted good engineering practice and with all applicable governmental laws, regulations and codes.

(d.) **Cleaning**

All equipment shall be cleaned of all sand, dirt and other foreign materials immediately after removal from storage and before the equipment is brought inside the power plant building or to other installation sites. All piping and tubes shall be air blown.

(e.) **Equipment Assembly**

Equipment installed under these specifications shall be assembled if shipped unassembled. The equipment shall be dismantled and reassembled as required to perform the installation and commissioning work described in these specifications.

(f.) **Equipment Setting**

Field mounted instruments and accessories shall be bracket or sub panel mounted on the nearest suitable firm steel work or masonry. The brackets, stands, supports and other miscellaneous hardware required for mounting instruments and accessories such as receiver gauge, air set, valve manifold, purge-meter etc. shall be furnished and installed. No field mounted instruments shall be installed such that it depends for support or rigidity on the impulse piping or on electrical connection to it.

Indicating type field mounted instruments shall be installed in such a way that centre of indicating dial shall be about 1600-1800mm from operating floor level. Non-indicating type field instruments shall be installed such that operating handle of manifold block / isolating cock comes within 1600 mm from operating floor level.

(g.) **Free-Standing Equipment**

Free-standing Cabinets shall be attached to the floor, concrete equipment bases or supporting steel as indicated on the manufacturer's drawings and the Employer's Plant Arrangement Drawings. The cabinets shall be shimmed for proper alignment before bolting them to the floor. Adjacent enclosures shall be shimmed to maintain mutually level appearance before they are attached to floor. Vibration dampening mounts shall be installed between supporting structures and panels when specified.

(h.) **Non-free Standing Equipment**

(1.) Non-free standing local enclosures and cabinets shall be mounted in

accessible locations on columns, walls, or stands in locations as indicated on the Employer's Plant Arrangement Drawings. Bracket and stands shall be fabricated as required to install the local enclosures and cabinets in a workman like manner.

(2.) Rough edges and welds on all fabricated supports shall be ground smooth. The supports shall be finished with two coats of primer and two coats of paint as specified in this part.

(i.) **Equipment Location**

(1.) All individual items of equipment not located in cabinets or on panels and racks are located approximately according to the floor elevation and the nearest building column designated by the Employer.

(2.) Solenoid valves not located in enclosures or mounted on valves shall

be mounted in easily accessible protected locations near the components with which they are associated.

(3.) All brackets, stands, supports and other miscellaneous hardware required for mounting devices shall be furnished and installed.

(4.) Thermometers shall be installed in the process lines and ducts as required and adjusted for ease in reading.

(5.) Permanent temperature wells on the main steam, hot reheat and cold reheat piping shall not be installed until steam blowing has been completed. Temporary temperature wells shall be installed in the main and reheat steam piping during steam blow and discarded after completion.

(6.) Any required adapting hardware such as pipe bushings, nipples, drilled caps and the like shall be provided for complete installation of control devices into process connections.

For location of C&I related equipment/devices, the requirement specified elsewhere in the technical specification may be referred.

(j.) **Installation of Field Mounted Instruments and Devices**

The Contractor shall submit installation drawings for all field mounted equipment furnished under this specification for Employer's approval. These drawings shall meet the requirements of this specification, installation drawings, applicable codes and standards and recommendations of manufacturers of instruments/devices. All installation work under this specification shall be strictly as per installation drawings approved by the Employer during detailed engineering stage.

In addition to above relevant Portion as specified elsewhere in technical specification may be referred.

(k.) **Piping Connections**

(1.) All equipment having piping connections shall be levelled, aligned and wedged in place but shall not be grouted or bolted prior to the initial fitting and alignment of connecting piping. All equipment shall, however, be grouted or bolted to its foundation prior to final bolting or welding of the connection piping.

(2.) All flanged joints shall be checked and retightened after approximately 10 days of operation at normal operating temperature.

(l.) **Equipment Checkout**

(1.) All equipment shall be cleaned after installation. Equipment subject to pressure differentials shall be checked for leakage.

(2.) After erection, all equipment having moving parts, having electrical apparatus, or subject to pressure differentials shall be trial-operated.

(m.) **Defects**

(1.) All defects in erection shall be corrected to the satisfaction of the Employer and the Project Manager. The dismantling and reassembly of Contractor furnished equipment to remove defective parts, replace parts, or make adjustments shall be included as a part of the work

under these specifications.

(2.) The removal of control and instrument equipment in order to allow bench calibration, if required, and the re-installation of the said equipment after calibration shall also be included as a part of the work under these specifications.

(n.) **Equipment Protection**

(1.) All equipment to be erected under these specifications shall be protected from damage of any kind from the time of contract award until commissioning of each unit.

(2.) The equipment shall be protected during storage as described herein.

(3.) Equipment shall be protected from weld spatter during construction.

(4.) Suitable guards shall be provided for protection of personnel on all exposed rotating or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy removal and maintenance.

(5.) Equipment having glass components such as gauges, or equipment having other easily breakable components, shall be protected during the construction period with plywood enclosures or other suitable means. Broken, stolen, or lost components shall be replaced by the Contractor.

(6.) Machine finished surfaces, polished surfaces, or other bare metal surfaces which are not to be painted, such as machinery shafts and couplings shall be provided temporary protection during storage and constructional periods by a coating of a suitable non- drying, oily type, rust preventive compound.

53.00.00 WELDING - SPECIAL REQUIREMENTS

If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipments to be performed under separate specifications, the requirements shall be submitted to the Project Manager in advance of commencement of erection work.

54.00.00 DEVIATIONS DISPOSITIONING:

Any deviation to the contract and employer approved documents shall be properly recorded in the format prescribed by NTPC. All the deviations shall be bought to the knowledge of employer's representative for suitable dispositioning.

55.00.00 NON-DESTRUCTIVE TESTING (NDT):

The contractor shall record results of NDTs carried out at site in the format acceptable to employer. All the radiographs & its report duly signed & correlated to the job shall be handed over to the employer. Sensitivity of all the test equipment shall be compatible to the job & acceptance norms agreed.

Computed RT shall be used as an advanced Engineering Practice .Main contractor to ensure minimum 10% computed radiography of total weld joint to be performed in construction phase .Main contractor to ensure the transfer & storage of these records in Server .

55.01.00 Sub contracting of NDT & PWHT / SR Agencies- NDT & PWHT / SR contract shall be directly awarded by the main contractor to their approved NDT & PWHT / SR agencies .

56.00.00 TESTING EQUIPMENT & FACILITIES:

Contractor shall provide the testing equipment and facilities necessary to carry out tests & inspections.

ANNEXURE-I

STANDARD CHECKLIST

COMMISSIONING/TESTING ESSENTIAL PRE-REQUISITE

1. MECHANICAL

(A.) **VALVES**

(1.) MANUALLY OPERATED VALVE

(2.) ELECTRICALLY OPERATED VALVE

(3.) PNEUMATICALLY ACTUATED VALVE

(4.) HYDRAULICALLY ACTUATED VALVE

(5.) SAFETY VALVE

(6.) ELECTROMATIC RELIEF VALVE

(7.) STEAM TRAP

(8.) BUTTERFLY VALVE (ELECTRICALLY OPERATED)

(9.) BUTTERFLY VALVE (MANUALLY OPERATED)

(10.) BUTTERFLY VALVE (FOUR WAY-ELECTRICAL)

(11.) NON-RETURN VALVE (INCLUDING HYDRAULIC/PNEUMATIC FCNRVS)

(12.) THREE WAY CONTROL VALVE

(13.) RELIEF VALVE

(14.) DIFFERENTIAL PRESSURE REGULATING VALVE

(15.) FLOAT OPERATED VALVES

(B.) TANKS AND PRESSURRE VESSELS

(1.) TANKS (METAL) UPTO 20 M2

(2.) TANKS (LARGE STORAGE)

(3.) PRESSURE VESSEL (BELOW 17 BARS)

(4.) AIR RECEIVER

(5.) PRESSURE VESSEL-ACCESS DOOR

(6.) TURBINE MAIN OIL TANK

(C.) PUMPS

(1.) PUMP LOW PRESSURE CENTRIFUGAL (MOTOR DRIVEN)

(2.) PUMP UP TO 350 HP (260 KW)

(3.) PUMP SUMP INSTALLATION

(4.) GEAR PUMP/SCREW PUMP

(D.) PIPE WORK SYSTEM

(1.) STEAM SERVICES
(2.) WATER SERVICES
(3.) OIL/FIRE RESISTANT FLUID SYSTEM
(4.) AIR SERVICES (COMPRESSOR)
(5.) HIGH PRESSURE SERVICES
(6.) CONSTANT LOAD SUPPORT
(7.) SPRING SUPPORTS
(8.) HANGERS AND OTHER SUPPORTS

(E.) STRAINER AND FILTER
(1.) STRAINER/FILTER BASKET TYPE
(2.) STRAINER ROTARY (LOW PRESSURE)
(3.) FILTER & STRAINERS CENTRIFUGAL SEPARATORS
(4.) FILTER & STRAINER Y-TYPE
(5.) FILTER & STRAINER (PLATE TYPE)
(6.) PURIFIER
(7.) FILTER-COMPRESSED AIR LINE

(F.) HEAT EXCHANGER
(1.) HEAT EXCHANGER (GENERAL)
(2.) HEAT EXCHANGER-OIL/WATER
(3.) ROTARY AIR HEATER

(G.) FANS AND COMPRESSORS
(1.) FANS-NON-PRESSURE LUBRICATED
(2.) FANS-AXIAL FLOW PRESSURE LUBRICATED
(3.) COMPRESSORS-GENERAL
(4,) DAMPERS & GATES

(H.) CRANES AND ELEVATORS
(1.) AUXILIARY OVERHEAD CRANE
(2.) TRAVEL SUPPORT STRUCTURE FOR CRANE
(3.) LONG TRAVEL & CROSS TRAVERSE MOTION OF CRANE
(4.) MAIN AUX. HOIST MOTION (CRANE)
(5.) ELECTRIC HOIST

(I.) POWER TRANMISSION
(1.) POWER TRANSMISSION GEAR BOX
(2.) BEARING
(3.) FLUID COUPLINGS

2. ELECTRICAL

(1.) SWITCHYARD

(2.) POWER TRANSFORMERS, LT INDOOR TRANSFORMERS, OUTDOOR TRANSFORMERS.

(3.) BATTERY CHARGERS, DC BATTERIES, DG SETS, STATION LIGHTING, OVERHEAD LINES.

(4.) MV BUS DUCTS

(5.) D.C. MOTOR

(6.) HV SQUIRREL CAGE INDUCTION MOTOR

(7.) 415 V SQUIRREL CAGE INDUCTION MOTOR

(8.) MOTOR OPERATED ACTUATORS

(9.) LT SWITCHGEARS/MCC

- (I.) STANDARD CHECLISTS FOR ALL TYPES OF RELAYS USED IN SWITCHGEARS PROTECTION SYSTEM
- (II.) PT CARRIAGE AND CUBICLES
- (III.) CABLE/BUS DUCT/BUS BARS
- (IV.) CONTRACTOR MODULE
- (V.) SWITCH FUSE MODULE
- (VI.) MASTER PANEL OF LUBE OIL PANEL
- (VII.) FEEDER PANEL OF LUBE OIL PANEL
- (VIII.) SPACE HEATER AND CABLE MODULE
- (IX.) CONTROL TRANSFORMER MODULE
- (X.) HT CIRCUIT BREAKER
- (XI.) 415 V CIRCUIT BREAKER

(10.) POWER CABLE

(11.) CONTROL CABLE

(12.) AUXILIARY CABLE

(13.) D.C. CABLE

(14.) EXPLOSION PROOF ELECTRICAL EQUIPMENT

(15.) JUNCTION BOX

(16.) CONTROL TRANSFORMER MODULE

(17.) BRUSH GEAR ASSEMBLY

(18.) AUX. CONTROL AND RELAY PANEL DESK

(19.) INDICATING INSTRUMENT

(20.) RECORDING INSTRUMENT

(21.) INTEGRATING INSTRUMENT

3. CONTROL & INSTRUMENTATION

(A.) CONDUCTIVITY ANALYSING EQUIPMENT INCLUDING TEST PROCEDURES

(B.) PH ANALYSER INCLUDING TEST PROCEDURE

(C.) SILICA ANALYSER

(D.) LEVEL SWITCH (FLOAT ACTUATED)

(E.) LEVEL SWITCH (ELECTRODE TYPE)

(F.) LEVEL SWITCH (DISPLACER ACTUATED)

(G.) TRANSMITTER (FLOAT OPERATED PNEUMATIC OUTPUT) INCLUDING TESTING PROCEDURE

(H.) LEVEL INDICATOR (FLOAT/PULLEY TYPE)

(I.) LOCAL TEMPERATURE INDICATORS INCLUDING TEST PROCEDURE

(J.) RESISTANCE THERMOMETER ELEMENT INCLUDING TEST PROCEDURE

(K.) THERMOCOUPLE ELEMENT AND CONNECTING CABLE

(L.) THERMOCOUPLE AND RESISTANCE THERMOMETER CONVERTOR/TRANSMITTER INCLUDING TEST PROCEDURES.

(M.) TEMPERATURE SWITCH/THERMOSTAT INCLUDING TEST PROCEDURES

(N.) COLD JUNCTION BOXES

(O.) ZENER BARRIER

(P.) O2 ANALYSER

(Q.) O2 IN HYDROGEN INCLUDING TEST PROCEDURES

(R.) PRESSURE AND VACUUM GAUGE

(S.) PRESSURE AND VACUUM SWITCH INCLUDING TEST PROCEDURE

(T.) DIFFERENTIAL PRESSURE TRANSMITTER INCLUDING TEST PROCEDURE

(U.) DIFFERENTIAL PRESSURE SWITCH INCLUDING TEST PROCEDURE.

(V.) FLOW INDICATOR (VARIABLE AREA)

(W.) ORIFICE PLATE

(X.) TURBINE FLOW TRANSMITTER

(I.) FLOW SWITCH

(II.) WEIR

(III.) NOZZLE

(IV.) FLOW INDICATOR (PNEUMATIC INPUT) INCLUDING TEST PROCEDURE

(V.) FLOW INTEGRATOR (PNEUMATIC INPUT) INCLUDING TESTPROCEDURE

(VI.) FLOW INDICATOR (FLOAT OPERATED) INCLUDING TEST PROCEDURE

(VII.) VENTURI (FLUID)

(VIII.) FLOW SWITCH (MAGNETIC TYPE)

(IX.) AVERAGING INLET

(X.) LIMIT SWITCHES

(Y.) TURBINE SUPERVISORY MEASURING SYSTEM

(Z.) POSITION MEASUREMENT AND INDICATION INCLUDING TEST PROCEDURES

(AA.) TACHOMETER

(BB.) VIBRATION MEASUREMENT

(CC.) DIGITAL INDICATOR

(DD.) MOVING COIL INDICATOR INCLUDING TEST PROCEDURE

(EE.) RECORDER INCLUDING TEST PROCEDURE

(FF.) FLAME SCANNER

(GG.) ELECTRICAL AUTO MANUAL CONTROL STATION

(HH.) PUSH BUTTON MODULE

(II.) ALARM ANNUNCIATOR EQUIPMENT INCLUDING TEST PRO

(JJ.) TEST PROCEDURE FOR ELECTRONIC MODULES OF DDCMIS

KK.) THERMO CONTROL VALVE

(LL.) TEST PROCEDURE FOR ADJUSTMENT OF MODULATING CONTROLLER - PID TERMS

(MM.) TEST PROCEDURE INDICATING CONTROLLER-ELECTRICAL INPUT AND PNEUMATIC OUTPUT

Note: The items which are not part of this specification may be considered as not applicable.

ANNEXURE-II

BRIEF WRITE UP ON THE CONTENTS OF TESTING SCHEDULE / COMMISSIONING SCHEDULE

Testing Schedules should be designed to ensure that the plant area, equipment or apparatus are tested and commissioned and will operate as per the employer's specifications and good engineering practices.

Testing Schedule/Commissioning Schedule is required to be of a standard format in order to maintain consistency of presentation, content and reporting.

Testing Schedule/Commissioning Schedule should contain the following sections to make the document a self-contained one:

1. Plant Details/Design data
2. Testing Objective/Proposals
3. State of the Plant
   a) Erection Status with respect to Mech. Elect and C&I
   b) Availability of the services required
   c) Safety requirements as per Manufacturer's
4. Test method including completion/acceptance criteria
5. Results
6. Appendix
   a) Testing Programme
   b) Mech/Elect/C&I -Plant item completing list
   c) List of Drawing/documents required for carrying out the testing.

ANNEXURE - III

SAFETY PLAN

01. Safety Policy of the Contractor to be enclosed:
02. When was the Safety Policy last reviewed:
03. Details of implementation procedure / methods to implement Safety Policy / Safety Rules:
04. Name, Qualification, experience of Safety Officer
05. Review of Accidents Analysis Method, Methods to ensure Safety and Health:
06. Unit executive responsible to ensure Safety at various levels in work area:
07. List of employees trained in safety employed before execution of the job. Give the details of training:
08. Safety Training Targets, Schedules, methods adopting to providing safety training to all employees:
09. Details of checklist for different jobs / work and responsible person to ensure compliance (copy of checklist to be enclosed):
10. Regular Safety Inspection Methods and Periodicity and list of members to be enclosed:
11. Risk Assessment, Safety Audit by Professional Agencies, Periodicity:
12. Implementation of Recommendations of Audit / Inspections. Procedures for implementation and follow up:
13. Provision for treatment of injured persons at work site:
14. Review of overall safety by top Management and Periodicity:
15. System for Implementation of Statutory legislations:
16. Issue of PPEs to employees, Periodicity / stock on hand etc:

Signature

Head of the Organisation with date & stamp

ANNEXURE-IV

Health Safety and Environment (HSE) Policy and HSE Management Manual

1. INTRODUCTION

1.1 Background

NTPC safety policy and various safety requirement has already been indicated in the site regulation and safety section of GCC. This document shall be supplementary to above document and shall be read in conjunction with site regulation and safety section of GCC. In case of any contradiction, the stringent of the two requirements (in the opinion of the employer) shall prevail.

NTPC being India's largest power utility and a responsible corporate entity, the statement of policy on health and safety at work sets out the commitment of NTPC to manage health and safety effectively, and what shall be achieved by NTPC, the Contractor and any appointed sub- contractor.

NTPC, the Contractor and any appointed sub-contractor is committed to provide and maintain a safe and healthy workplace for all staff, and to provide the information, training and supervision needed to achieve this.

All involved parties are committed to protect the fundamental rights of allappointed workers and feel obliged to create a sound worker-managementrelationship as a key ingredient in a sustainable and successful project execution.

All involved parties will have to assume the responsibility for H&S procedures, and need to be made aware of their responsibilities and to comply with NTPC's H&S Policy.

The following requirements are mandatory for each worker in maintaining a safe and healthy workplace through:

- Being involved in the workplace H&S System;
- Sticking to correct procedures and equipment;
- Wearing protective clothing and equipment whenever required;
- Reporting any pain or discomfort as soon as possible;
- Ensuring that all accidents and incidents are reported;
- Helping new workers, trainees and visitors to the workplace understandthe right safety procedures and why they exist;
- Telling the responsible managers immediately of any H&S concerns;
- Keeping the work place tidy to minimise the risk of any accidents.

The aim of all the stake holders is to achieve the following goals:

- Zero fatalities of workers, visitors or the public;
- Zero accidents and incidents of workers, visitors or the public;
- Zero harmful, hazardous or dangerous situations or occurrences;
- Zero environmental concerns or impacts;
- Continuous improvement of the health & safety performance at site under practical conditions.

1.2 Definition of Occupational Health & Safety

Since 1950, the International Labour Organization (ILO) and the World Health Organization (WHO) have shared a common definition of occupational health. It was adopted by the Joint ILO/WHO Committee on Occupational Health at its first session in 1950 and revised at its twelfth session in 1995 and is defined as follows:

Occupational health should aim at the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations; the prevention amongst workers of departures from health caused by their working conditions; the protection of workers in their employment from risks resulting from factors adverse to health; the placing and maintenance of the worker in an occupational environment adapted to his physiological and psychological capabilities; and, to summarize, the adaptation of work to man and of each man to his job.

"The main focus in occupational health is on three different objectives:

- the maintenance and promotion of workers' health and working capacity;
- the improvement of working environment and work to become conducive to safety and health and
- the development of work organizations and working cultures in a direction which supports health and safety at work and in doing so also promotes a positive social climate and smooth operation and may enhance productivity of the undertakings.

The concept of working culture is intended in this context to mean a reflection of the essential value systems adopted by the undertaking concerned. Such a culture is reflected in practice in the managerial systems, personnel policy, principles for participation, training policies and quality management of the undertaking."

Workers safety has to be understood as the practice of an employer using preventative measures to prevent hazards to the employees' personal safety. This practice includes creating plans and procedures for employees and managers in the workplace. In addition, workplace safety involves creating policies and keeping emergency materials available for employee and manager use while at a work site.

1.3 Purpose of the H&S Management Manual

The present H&E Management Manual shall delineate the Health and safety Requirements, incl. policies and guidelines, and outline the roles and responsibilities of the different parties involved in the implementation and oversight of Health, Safety and Environment Measures to ensure community, worker and public health and safety during construction.

The H&S Management Manual considers the applicable national occupational health, safety and welfare legislation as well as guidelines and standards established by the relevant Ministries and Authorities.

The H&S Management Manual other than Site Regulation and Safety provisions provided in Bidding Documents takes the following applicable IFC Performance Standards (PS) into account:

- PS 2: Labour and Working Conditions, dated January 1, 2012
- PS 3: Resource Efficiency and Pollution Prevention, dated January 1, 2012
- PS 4: Community, Health, Safety and Security, dated January 1, 2012.

The H&S Management Manual includes the Occupational Health & SafetyRequirements and arrangements that are mandatory for the Contractor for consideration and implementation.

In case the provisions in Site Regulation and Safety provisions provided in Bidding Documents are superior than the provisions indicated in this manual, the provisions provided in Site Regulation and Safety provisions provided in Bidding Documents shall prevail.

The defined H&S Standards are part of the contractual obligations, and no changes are possible without a prior written approval by NTPC.

1.4 Content of the H&S Management Manual

The H&S Management Manual contains an outline of the required H&S Organization at site and to be implemented by the Contractor.

It describes the overall H&S Management required for the organization of a safe and healthy working environment for the workers and to ensure that the public will not be affected by the construction activities. In addition to the organizational arrangements roles and responsibilities of the required H&S Staff of the Contractor are defined.

Attention is paid to the need for training to be implemented by the Contractor. It starts with the evaluation of training needs and defines the requirement of developing a training schedule as well as workers and visitorinduction.

Communication procedures are addressed and needed H&S Reporting is specified for the entire construction period.

As one of the most important subjects, the entire risk management process is comprehensively described, specifying the risk management process, the hierarchy of control and the safe system of work.

Reporting and monitoring procedures are developed for the fulfillment bythe Contractor and the standards for PPE are included.

The H&S Management Manual shall highlight the entire H&S Management System and also provide information on the H&S Standards to be followed by the Contractor.

2. HEALTH & SAFETY MANAGEMENT SYSTEM

An H&S Management System is implemented for the Project. The management system comprises of different components to be developed bythe Contractor.

That the Contractor must implement human resource policies and procedures that set out the approach to manage workers consistent with the requirements of IFC PS 2 as well as the applicable national laws and standards.

2.1 Health & Safety Management Manual

Contractor will implements this H&S Management Manual in order to delineate the Project's H&S Requirements, Policies and Guidelines as well as to outline the roles and responsibilities of the different parties involved in the implementation and oversight of measures to ensure community, worker and public health and safety during construction.

2.2 Contractor's H&S Plans

All Contractors shall establish an effective project specific H&S Plan. TheH&S Plan will be subject of NTPC's written approval. The H&S Plan shall be submitted by the Contractor not later than 4 weeks prior to any commencement of works at site.

Any work at site, incl. mobilization to the site will not be allowed to commence until NTPC deems the Contractor's H&S plan to be suitableand sufficient.

The H&S Plan shall describe how health and safety will be managed at site, incl. mobilization and transport to the site, and how the specified H&S Standards will be applied in practice. In addition the Contractor shall ensure adequate communication of these requirements throughout the supply chain,its supervision, and the workers themselves.

The H&S Plan shall specify the management arrangements for carrying outthe work including but not limited to:

- Overview of the project;
- Clearly identified risks associated with the scope of works;
- Program and milestones;
- Site management and organization;
- Key contractors and sub-contractors;
- Communication, Cooperation and Co-ordination;
- Site security;
- Traffic management;
- Welfare facilities and provision;
- Arrangements for supervision of contractors on site;
- Arrangements for information, instruction and training includinginduction;
- Management of hazards on site;
- Arrangements for identification of hazards, assessment of risk and production of Method Statements;
- Arrangements for hazardous undertakings e.g. confined space, work at height, hot work, excavations, cofferdams etc.;
- Permit to work system;
- Site rules;
- Arrangements for managing plant and equipment;
- Management or lifting operations;
- Management of temporary works;
- Arrangements for monitoring and auditing etc.;
- Requirements as defined by relevant statutory planning authorities e.g.traffic, noise, working hours etc.;
- Incident & accident investigation.

The H&S Plan shall also consider the site rules outlining the H&S Requirements for all workers. The site rules shall include but should not belimited to:

- Site access;
- Access to and transport on the site;
- Entering and leaving the site;
- Use of mobile phones;
- Smoking;
- PPE requirements;
- General behaviour;
- Transport to the site;
- Vehicle traffic within the site area;
- Access to the site and Working Areas;
- Restricted areas.

The H&S Plan shall consider related plans and the corresponding direct and indirect H&S Requirements. This refers especially to the following related plans and assessments:

- Hazardous materials and waste management plan;

A checklist for the review and approval of project specific H&S Plans shall be developed prior to the construction contract. The checklist shall define the minimum requirements to be met by the Contractor.

2.3 Contractor's H&S Procedures

The Contractor is requested to develop workplace specific H&S Procedures. In this matter, it should be noted that procedures are similar to method statements probably better known by Contractors. The required content of H&S Procedures is described below.

H&S Procedures are part of the Project framework for effective H&S Management. The H&S Policy states the intention to provide a safe and healthy workplace, and states the H&S goals of a workplace.

Specific health & safety workplace procedures shall address particular issues or hazards and the measures how to control those identified hazards. The procedures should be used together with other hazard control measures to eliminate or reduce the risks of accidents and incidents and illness and/or injuries at the working place.

H&S Procedures shall be developed for the following activities expected to apply during construction:

- Site access control and site security procedure;
- Health & safety protection at transmission line worksites;
- Isolation and lock-out;
- Use of hazardous chemicals;
- Simultaneous activities;
- Live line work;
- Shift work, shift rotation and fatigue;
- X-ray and NDT;
- Risk assessment;
- Job Safety Analysis;
- Working at height;
- Working in confined spaces;
- Use of personal protective equipment;
- Excavation works;
- Hot works;
- Welding;
- Emergency response procedure;
- Evacuation procedure (if applicable);
- First aid;
- Working in water (if applicable);
- Use of electrical equipment;
- Work on high voltage.

This checklist shall define the minimum requirements to be met by the Contractor.

2.4 **Contractor's Safe Work Instructions**

Safe work instructions shall be developed by the Contractor identifying the health and safety issues that may arise from use of the machinery and equipment. The safe work instruction must be based on the H&S Plan.

A safe work instruction should identify:

- the hazard associated with the use of a specific tool or equipment;
- the required control measures to be checked to ensure a safe use of aspecific tool or piece of equipment;
- the specific training and/or qualification required;
- the personal protective equipment to be worn.

Safe work instructions do not replace the requirement for a risk assessment,preparation of a workplace procedure, the need of a permit to work or the need for training.

A risk assessment of the equipment must be performed before developing safe work instruction procedures to identify the hazards and risk controls.

A checklist for the review and approval of project specific Safety Work Instructions will be developed by the PIC prior to the first construction contract. The checklist will define the minimum requirements to be met bythe Contractor.

2.5 **Contractor's H&S Forms**

The Contractor must develop forms like checklists for risk assessment etc. to support the support the use of workplace procedures, instructions, audits etc.

These forms must be attached to the respective documents, and must be read in closed conjunction with the corresponding document(s).

The checklists shall be subject of an update and revision in case improvements or needed changes were found suitable and required.

The checklists must be subject of project documentation, in the same wayand considering the same procedure that is applicable for the project documentation in general.

H&S Forms have to comprise the following subjects as a minimum:

- Contractor Audit Questionnaire
- Basic Risk Assessment
- Permit to Work
- Workplace Inspection Checklist
- Accident/Incident Report/Investigation
- Fire Risk Assessment
- Hazardous Substance Risk Assessment
- Ladder Inspection Checklist.

The forms to be used by the Contractor must include all pertinent information. Additional forms like inspection checklists, workplace inspection checklists might be necessary and should be prepared by the Contractor and are subject of approval by NTPC.

2.6 **Contractor's Grievance Management System**

2.6.1 **Workers Grievance Management System**

The Contractor must implement a grievance management system to enable the workers to raise complaints and to inform about non-compliances with the implemented H&S Management System. The grievance management system should provide the possibility to issues complaints in case of discrimination and/or the non-consideration of equal opportunities.

The grievance management system shall consider the possibility to contact directly a member of the H&S Staff. The contacted staff members must take a note of the reported complaint or non-compliance and must report it to thesite manager and the H&S Manager.

The H&S Management is requested to solve a complaint or non-compliancewithin 3 working days. In case the problem could not be solved an action procedure specifying the needed activities together with a final deadline until the problem is expected to be solved must be prepared and submitted to NTPC.

The Contractor is requested to provide the possibility for the workers to notify a complaint or non-compliance in a confidential way.

2.6.2 **Public Grievance Management System**

The grievance management system shall also be open for public complaints.

A respective procedure must be developed by the Contractor for review and approval. The grievance management system for the public must consider areporting procedure to the local authority to demonstrate to the administrative body that the complaint was identified, noted, managed and solved.

The responsible authorities at the community level must be identified by the Contractor 4 weeks prior to the start of the construction activities or 4 weeksprior to the mobilization to the site.

The reporting procedure should be discussed and agreed upon together with the administrative body and specific attention should be paid to any specific requirements to be announced by the authority. The contact with the authority should be established by having a face-to-face meeting. This meeting should be attended by an H&S Representative of the Contractor.

2.7 **H&S Committee**

It shall be governed by site regulation and safety requirement as stipulated in GCC

3. **ROLES, RESPONSIBILITIES AND ACCOUNTABILITY**

It shall be governed by site regulation and safety requirement as stipulated in GCC

3.2.1 **Child Labour**

The Contractor shall not employ children in any manner that is economically exploitative, or is likely to be hazardous or to interfere withthe child's education, or to be harmful to the child's health or physical, mental, spiritual, moral, or social development.

The Contractor must identify the presence of all persons under the age of 18 in his workforce. A respective record of all identified workers must be submitted to the H&S Coordinator for documentation purposes. The list must be subject to a continuous update. An updated list must be submitted to the H&S Coordinator of NTPC on a bi-weekly basis.

It is prohibited to employ children under the age of 18 for hazardous worksor works assessed to be of a medium or higher risk resulting from a particular risk assessment.

Independent from the fact that the minimum age for an employment of child labour is 14 years, all work of persons under the age of 18 must be subject to an appropriate risk assessment and regular monitoring of health, working conditions and hours of work.

3.2.2 **Pregnant Woman**

Pregnant employees have the following four major prerogatives:

- paid time off for antenatal care
- maternity leave
- maternity pay
- protection against unfair treatment, discrimination or dismissal.

In addition, the contractor must not change a pregnant employee's contract terms and conditions without agreement. If this will be done by a employer, it has to be handled as a breach of contract.

It's illegal for contractor to refuse to give pregnant employees time off for antenatal care or refuse to pay their normal rate for this time off.

The following rights shall be considered:

- Pregnancy-related illnesses
  If the employee is off work for a pregnancy-related illness in the 4 weeks before the expected date of birth of the child, maternity leave and statutory maternity pay by the employer has to start automatically.
- Compulsory maternity leave
  In case the employee does not take statutory maternity leave, they musttake 4 weeks off after the child is born.
- Telling the contractor about the pregnancy
  Employees are obliged to inform their contractor about the pregnancy at least 15 weeks before the beginning of the week of the expected date ofbirth or, in case of unawareness of the pregnancy during this timeframe,the contractor must be told as soon as possible.

  Employees must also tell the contractor when they want to start their statutory maternity leave and pay.
- Health and safety for pregnant employees
  After the receipt of information about the pregnancy of an employee, theemployer should assess the risks to the woman and her baby.

  Risks could be caused by:

  - heavy lifting or carrying
  - standing or sitting for long periods without adequate breaks
  - exposure to toxic substances
  - long working hours
  - vibration and mechanical shocks
  - extreme heat
  - noise
  - ionising radiation

- non-ionising (electromagnetic) radiation
- carbon monoxide
- lead
- polychlorinated Byphenyls
- organic solvents
- pesticides and herbicides
- tobacco smoke.

The MSDS to be provided together with each chemical substance to be in use or to be delivered at the construction site, storage area etc. should highlight the category.

Where there are risks, the contractor should take reasonable steps to remove the risks or by offering the employee different work or work places or by changing the working hours by the adaption of sufficient breaks.

In case the contractor can't remove any risks, the contractor must suspend the employee on full pay and without any reduction.

Pregnant contractor who think they're at risk but their employer disagrees should report to NTPC's H&S Manager during a site audit.

The contractor is obliged to inform every pregnant employee about their rights in writing and this information must be recorded.

4. TRAINING

It shall be governed by site regulation and safety requirement as stipulated in GCC

5. HEALTH & SAFETY REPORTING

5.1 Contractors Reporting Obligations

Independent from the general requirement and contractual obligations to implement a reporting scheme with respect to the progress, construction schedule and project reporting in general, the Contractor will be obliged to implement an H&S Reporting.

The H&S Reporting should provide an overview of the H&S Performance within a particular timeframe and with specific topics as mentioned below:

The H&S Reports should be submitted to NTPC Project Manager

5.1.1 Health & Safety Performance

5.1.1.1 Weekly Reports

The Contractor shall prepare weekly H&S reports. The weekly reports shall be submitted by close of business on the first working day after a completed working week, e.g. the reporting timeframe is from Monday to Saturday and the respective following working day is the upcoming Tuesday, if not a public holiday.

The weekly reports shall comprise of the following information with respect to the reporting timeframe:

- Originator
- Name of the project
- Activities performed
- Health occurrences

- Safety occurrences
- Resulting accidents, incidents or dangerous situations
- Undertaken measures.

5.1.1.2 **Monthly Reports**

The Contractor shall prepare monthly H&S reports. The monthly reports shall be submitted by close of business of the last working day of the first working week after the reporting timeframe, e.g. the reporting timeframe is from 1st of January until 31 of January and the due day of the submission ofthe report is the Friday of the first working week in February, if not a publicholiday.

The weekly reports shall comprise of the following information with respect to the reporting timeframe:

- Originator
- Name of the project
- Activities performed
- Health occurrences
- Safety occurrences
- Resulting accidents, incidents or dangerous situations
- Investigation results
- Undertaken measures
- Lessons learned
- Informed authorities and resulting obligations/conditions
- Results of workplace inspections.

5.1.2 **Hazards Reporting**

The H&S Staff of the contractor is requested to undertake workplace inspections. In case that hazards and risks are identified during workplace inspections, it is needed that the identified hazard or risk has to be solved immediately and without delay during the inspection.

In case that the problem could not be solved, a written report has to be prepared and issued to the H&S Manager or site manager highlighting:

- a description of the problem;
- the reason why it could not be solved during the inspection;
- the needed action;
- the responsible person;
- the associated hazards and risks;
- the deadline until the problem must be solved.

The occurrence must be reported in the monthly H&S Report.

Any other reporting requirements with respect to H&S, e.g. audit reports,weekly and monthly H&S Reports, remain unchanged.

6. HEALTH & SAFETY RISK MANAGEMENT

The risk management process with specifically requested forms requires a careful document administration and control. The Contractor should be aware that the documents resulting from the risk management process, in particular, the risk assessments, permits to work and job safety analysis, must be available during construction site audits and/or exemplary as part of a monthly report.

6.1 Risk Management Process

Risk management is the identification, assessment and prioritization of risks to avoid impacts on workers and the public.

The Contractor has to implement a suitable and appropriate risk management process to enable his site staff to prevent any non-compliances resulting in critical, harmful or dangerous situations followed by incidents, accidents or fatalities.

Alternatively suggested risk management processes shall be provided in theH&S Plan.

6.2 Hierarchy of Control

The first part of evaluating the risk stage, consideration must be given how likely each hazard could cause harm. When the potential for harm has been decided, the existing control measures should be identified. In this course, each step of the activity has to determine what control measures might already in place. When evaluating a risk it is imperative to check the applicable legislation and to ensure that everything required by law is in place or has to be done.

When considering current controls and further required control measures, the general principles of control should be applied:

Eliminate

- It has to be checked if the risk associated with the hazard could be eliminated.

Reduce

- It has to be assessed if the possible amount of the hazard or the exposure to the hazard could be reduced.

Isolate

- It must be evaluated if the hazard could be isolated. Isolating is the principle of preventing the contact with the hazard.

Control

- It must be assessed if a safe system of work, permit to work and/or procedures are in place to control the hazard to prevent that some bodybecomes injured.

Personal Protective Equipment

- As a final result of running through the hierarchy of control, the supply of personal protective equipment is the final result of controlling the hazard. The provision of PPE must not be the first and final stage of risk mitigation.

6.3 Safe System of Work

6.3.1 Risk Register

The Contractor is requested to develop and prepare a risk register. A risk register is a document that summarizes and defines the possible risks resulting from a particular activity, in the present case from particular construction or construction related activities. The concept of a risk register recognises that risk elements arising from proposed or actual activities fall into one of following three categories:

- Risks which are deemed to have a low risk and do not need to be managed;
- Risks that have a medium or high risk and will need to be managed;
- Risks which have an extreme risk and therefore the activity should probably not proceed.

The risk register records details all the risks identified for the construction phase and associates them in terms of likelihood of occurring and seriousness of impact.

The risk register to be prepared should identify:

- a description of each risk and its potential consequences;
- factors that may impact upon the likelihood and severity of the risk;
- an assessed risk ranking, such as
  - low,
  - medium
  - high or
  - very high;
- whether the risk ranking is acceptable or not;
- actions and controls that currently exist to mitigate risks

The definition of the risks from low to very high is explained in the following risk ranking table:

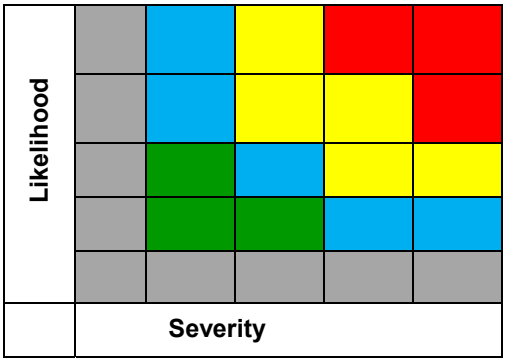


Table 6-1: Risk ranking table

It is recommended to develop the risk register at the beginning stage before start of a construction site by following the following steps:

- Identification of potential risks;
- Identification of the consequences;

- Identification of the likelihood and severity that the risk would result in adverse consequences;

Where risks have been ranked as medium, high or very high, mitigation measures must be addressed:

- **Medium (Risk ranking 3 to 4):** Mitigation actions to reduce the likelihood and severity should be identified and appropriate actions mustbe endorsed.

- **High (Risk ranking 6 to 9):** If uncontrolled, a risk event at this level may have a significant impact for the actions and tasks at a construction site as a whole. Mitigating actions need to be very reliable and should be approved and monitored by the Contractor. Even with mitigating actionsin place, the construction site staff potentially exposed to that risk shouldbe advised of identified or potential risks which have been graded at this level.

- **Very High (Risk ranking 12 to 16):** Activities and projects with unmitigated risks at this level should be avoided or terminated. Mitigation actions of these types of risks may outweigh the benefits of the execution method. This is because risk events graded at this level have the potential to have significant adverse effects with the potential to cause serious accidents and incidents resulting in fatalities.

It needs to be identified if any risk mitigation procedures are in place.

If it is found that there are none, procedures must be developed consideringthe following:

- Planned actions:
  Reduction the likelihood a negative risk will occur and/or reduce theseriousness should it occur (What should you do now?)

- Contingency actions:
  Planned actions to reduce the immediate seriousness of a negative riskwhen it does occur. (What should you do when?)

- Recovery actions:
  Planned actions taken once a negative risk has occurred to allow you to move on. (What should you do after?)

- Risk Transfer:
  e.g. through assignment of contractual responsibilities or insurance.

- Actions:
  Necessary to ensure the realisation of opportunities (positive risks).

A risk register for every single construction site must be developed by the responsible Contractor considering as well the tasks and activities to be undertaken and execute by sub-contractors. The risk register has to be prepared by a competent and experienced group of engineers and workers approx. 4 weeks before mobilization to the site and start of any works at site even if they deemed to be of general nature and without having a risk potential. The risk register has to consider as well every transportation activity to the construction site.

The risk register will be subject of review and approval by NTPC.

6.3.2 **Risk Assessment**

The Contractor is requested to undertake a risk assessment for all activitiesassessed to be of a medium, high or very high risk.

The risk assessment has to be carried out with the participation of the staffexperienced with the tasks and activities and the equipment:

- the responsible H&S Manager or a H&S Supervisor
- the foreman for the execution of the activity
- the worker(s) asked to undertake the activity.

The risk assessment has to be performed prior to the execution of the activity and it must be done in written. The written risk assessment must be documented and stored in the project file.

The risk assessment has to be undertaken in a simple and comprehensive way, understandable by each participant.

A specific risk assessment must be undertaken for tasks where children between the age of 14 and 18 will get appointed. This specific part of the risk assessment must be done independent from fact if the work will havethe potential of a very high, high, medium or less than medium risk.

6.3.3 **Permit to Work**

It shall be governed by site regulation and safety requirement as stipulated in GCC

Stage 1- Highlight Potential Hazards:

Worker(s) and the foreman guided by the H&S Advisor highlight potential hazards of a task and identify all necessary safety measures. The hazard identification must consider all required electrical and mechanical equipment. Stage 1 has to be carried out in writing.

Work is not permitted to commence until Stage 4.

Stage 2-Application of Permit:

The Foreman applies for permission to start work on a prescribed form and submit the application to the H&S Advisor only when all requirements and conditions described in the permit to work have been fulfilled. The Foreman has to indicate in the written permit to work that risk assessment was conducted. The risk assessment must be attached to the permit to work.

Stage 3-Evaluation of Permit:

The H&S Advisor will evaluate and verify that all safety conditions specified in the permit to work have been fulfilled and are adequate described. He may also recommend additional measures in the permit to work when necessary. He will need to inspect the location of work wherethe permit to work has been applied for, with the Foreman during this process.

Only when all safety requirements and conditions stated in the permit to work are fulfilled, the H&S Advisor will then endorse the permit to workform and forward to the Health & Safety Manager.

Stage 4-Approval of Permit:

The H&S Manager may approve and issue the permit to work only when heis satisfied that:

- Proper evaluation of risk and hazards for the work concerned has beenconducted;
- No incompatible work will be carried out in the same time and locationof the permit to work, which may pose a risk to the persons at work;
- All reasonably practicable safety measures have been taken and all persons involved in the work have been informed of the work hazardsunder the PTW;
- All electrical and mechanical equipment is demonstrable checked and in safe conditions.

A work permit is valid for one working day and for the specified working time. In case the tasks could not be finalised within the validity of the permitto work, the permit to work must be renewed before commencement of work on the day the work may continue.

The permit to work form must include at least the following information:

- Originator
- Date
- Description of task activity
- Duration of the task
- Needed equipment
- Security certificates of equipment
- Risk Assessment
- Already implemented mitigation measures
- Further mitigation measures
- Needed training or induction
- Approved by
- Date and time of approval.

6.3.4 Job Safety Analysis (JSA)

The Contractor has to undertake a JSA which is a procedure to integrate safety and health principles and practices into a particular job operation. In aJSA, each basic step of the job related hazards has to be identified and recommendations have to be provided to choose the safest way to do the job.

For conducting a JSA four main steps have to be considered:

- selecting the job to be analyzed
- breaking the job down into a sequence of steps
- identifying potential hazards
- determining preventive measures to overcome these hazards.

The Contractor must provide a specific methodology for conducting a JSA .

7. EMERGENCY RESPONSE

7.1 Emergency Response Procedures

An emergency is a serious, unexpected, often dangerous situation that requires immediate action. The emergency procedure is the strategy of actions to be outlined in the emergency response plan to response to anemergency event.

This could include, but not limited to rescue:

- from working at height;
- in confined spaces, shafts and tunnels;
- from fire & smoke, etc.

7.2 Emergency Response Plan (ERP)

The Contractor has to develop an ERP for review and approval by NTPC.

The ERP has to consider at least the following information and instruction for an adequate management of emergency situations:

- Result of a risk assessment to determine the most probably emergencysituation;
- Identification of suitable emergency response procedures, such as:
  - Determination of safe evacuation areas;
  - Determination of safe evacuation routes;
  - Determination of accurate and suitable fire fighting equipment;
  - Determination of fire brigade;
  - Training and induction of emergency response procedure.

Note: Specific attention should be paid to the investigation of the nearest hospital or first aid station. The contact numbers of the hospital or first aid station together with at least one contact of a medically examined staff team member of the hospital or first aid station must be included in the ERP in case of injuries at night-time hours or during weekends or during bank holidays.

7.3 First Aid at Site

It shall be governed by site regulation and safety requirement as stipulated in GCC

7.4 Fire Protection and Control

The Contractor shall undertake a suitable and adequate fire risk assessment for whatever is applicable under the scope of work of the respective construction contract.

The Contractor shall ensure that the necessary fire prevention, protection and control measures are installed and maintained. This shall commenceduring mobilisation and updated accordingly.

The Contractor shall nominate certain of his employees who shall be trained in fire fighting duties. Nominated fire fighting personnel shall be available at all times during ongoing works on site.

7.4.1 Fire Prevention, Protection & Control

The following requirements apply with respect to fire prevention, protection& control and must be considered wherever applicable:

- Adequate and suitable means for extinguishing fire shall be provided andmaintained.
- All stocks of inflammable substances shall be kept in a fire resisting storeor in a safe place outside any occupied building.

- Provided that no such store shall be so situated as to endanger the meansof escape from the workplace or from any part thereof in the event of a fire occurring in the store.
- Chemical fire-extinguishers shall be freshly charged at intervals not greater than those specified by the manufacturers, or otherwise once annually, and tested by the application of such hydraulic pressure thereto as shall be suited to the type of extinguisher tested, at intervals of not more than four years; and the dates of recharging the extinguisher and thelast hydraulic test shall be clearly marked on the body of the extinguisheror on a tab securely attached thereto.
- Install a temporary or permanent water supply with sufficient flowvolume and duration to supply the standpipes, hose stations, and sprinkler systems, before the construction of the facility to be protected. In permanent structures under contract in which standpipes are installed, connect the standpipe to the water supply, install the standpipe concurrently with construction of the structure, and maintain the standpipe in operable condition for fire protection use. Provide the standpipes with fire department connections on the outside of the structure, conspicuously marked, and located in an accessible location atstreet or road level.
- No fire, flame, open light or other agent likely to ignite volatile and inflammable substances shall be allowed or used in any part of a workplace in which volatile and inflammable substances are used.
- No person shall smoke in any part of a workplace where volatile and inflammable substances are used, and a notice prohibiting smoking shall be posted in a conspicuous place in every such part of the workplace.
- Inform workers of the fire hazards of the materials and processes to which they are exposed. Brief new workers on the parts of the plan that isessential for their protection and emergency evacuations.
- Provide additional training for personnel assigned tasks that require themto remain in a facility during a fire emergency.
- When working in potentially explosive atmospheres, safe non-electric tools and apparatus suitable for the use in such areas shall be employed.
- No plant, tank or vessel which contains or has contained any explosive orinflammable substance shall be subjected to any welding, brazing or soldering operation, or to any cutting operation which involves the application of heat, until all practicable steps have been taken to remove the explosive or inflammable substance and any fumes arising there from, or to render them non-explosive or non-inflammable; and if any plant, tank or vessel has been subjected to any such operation as aforesaid, no explosive or inflammable substance shall be allowed to enter the plant, tank or vessel until the metal has cooled sufficiently to prevent any risk of igniting the substance.

7.4.2 Means of Fire Escape

Every workplace shall have adequate means of escape in case of fire.and must be properly maintained and kept free from obstruction.

7.4.3 Fire Alerts

The Contractor has to set up a system to alert workers on site and the public in the neighbourhood. This should be a permanent installed fire alarm (which must be tested on a weekly basis), a klaxon, an air horn or a whistle,depending on the size and complexity of the site.

Any warning needs to be distinctive, audible above other noise andrecognizable by everyone in case of fire.

8. HEALTH, SAFETY MANAGEMENT & MEASUREMENT

8.1 Noise Management

The Contractor is requested to develop a working noise monitoring plan to identify those areas at site where noise levels are occurring in a harmful range.

Generally, a reasonable mitigation measure, of more importance than wearing hearing protection devices, is the reduction of noise levels to a level as low as reasonable possible. Avoidance has always the priority in comparison to passive reduction.

Noise levels must be kept below 80 dB (A) wherever possible. In case of exceeding this value, hearing protections must be provided to the workers and warning signs must be installed.

The noise monitoring must be repeated every week in case that the location of the construction site remains unchanged. In case of a change of the site, the noise monitoring has to be undertaken after implementation of site arrangements.

In case that a construction site could not be demarked in detail, the noisemonitoring has to be done for different activities.

The following table provides the standards, exposure times and need for personal protective equipment.

dB(A)	Exposure time[1)]		Need for PPE	Comment
	hours	minutes		
80	25	24	No	
85	8	0	No	
86	6	21	Yes	Suitable hearing protection must be provided. The hearing protection must be able to insulate the noise level to a value of 89 dB(A) or below.
87	5	2	Yes	
88	4	0	Yes	
89	3	10	Yes	
90	2	31	Yes	
95	0	47	Yes	
100	0	15	Yes	
105	0	4	Yes	
110	0	1	Yes	

Table 8-1: Noise standards, exposure times and need for PPE

1) Applicable to a 8h-working-shift

Source: US Department of Health and Human Services, Occupational Noise Exposure, page 18, dated June 1998

8.2 Air Quality Management

The air quality at site could be affected by different emissions resulting from combustion engines or resulting from the generation of dust during dryweather conditions.

Emissions from combustion engines are difficult to reduce. Some efforts not to affect the air quality are the switch-off of machines whenever possible and to limit the number of machines and equipment to a level as low as reasonable possible. The Contractor is requested to consider these recommendations during the construction phase.

Considering this requirement, the Contractor must undertake all necessary actions to reduce the generation of dust to the lowest possible levels. Project specific measures shall be included in the H&S Plan.

Mitigation measures to prevent increased dust generation include using

dust-suppressing water spray in areas of active earthmoving and on unpaved roads, using aggregate-covered access roads to minimize dust emissions and minimizing the areas of exposed soil or cleared of vegetation. Truck beds should be covered with a tarp or similar material to minimize dust during the transport.

Mitigation measures during project activities to prevent increased air emissions would include using requiring emission control devices on equipment, maintaining properly tuned engines, avoiding unnecessary idling, using electric motors instead of internal combustion engines, usinglow-sulfur diesel fuel where available, preparing asphalt away from populated areas.

8.3 Pre-employment Health Assessment

Pre-employment health checks for construction site workers shall be mandatory. These checks shall ensure that in no case the state of health ofemployed workers can be impaired by possible pre-existing diseases. The Contractor shall deploy a suitable experienced medic and appropriate materials and premises for these checks.

Workers shall be checked, and all the results shall be analysed, before his first workday, in order to mitigate any risk.

Therefore, the Contractor shall provide the abovementioned medical staff and material during the entire year. Usage of hospital capacities is an often used option to fulfil these requirements, where those capacities are available. Only personnel with appropriate health condition with respect totheir particular job shall be employed.

All workers who are subject to an exposure to occupational health riskssshall undergo periodic medical surveillance. This would be required forworkers:

- exposed to noise levels exceeding 85dB(A);
- exposed to hazardous materials, e.g. chemicals;
- carrying heavy loads.

It is recommended to offer such periodic examinations every 3 months.

In addition to the pre-employment health checks and periodic medical surveillance, the Contractor shall enable the site workers to pass an exit medical check after finishing their jobs on site. The exit medical check shallbe provided to all workers who worked more than 3 months constantly on the construction site.

All pre-employment, periodic or exit health checks must be documented foreach worker. The assessment records must be kept confidential and for the use by the project management only. The workers will have the right to askfor the results of the health checks.

The workers will have the right to decline any pre-employment, periodic or exit medical checks. In this case they will not have the possibility to apply for any compensation in case of health interferences resulting from their work activities in connection to existing diseases.

All pre-employment, periodic or exit health checks must be provided to the workers free of charge. The application for a health check must not result in a negative treatment of the respective worker.

The Contractor must ensure that any health checks requiring specific facilities, equipment or medical staff will be available at the constructionsite or in a reachable distance to travel.

8.4 Covid-19 Prevention

Contractor shall take all necessary measures related to Covid-19 prevention as per guidelines issued by Government authorities as well as NTPC guidelines (if any).

8.5 Health Surveillance

8.5.1 **Management of Alcohol and Drugs**

Smoking shall be prohibited at all times at the construction site, at worker's camp and at storage and fabrication areas. This includes the operating or use of all electrical or manual work equipment.

Smoking shall be restricted to clearly defined and highly visible areas, only.

The presence and consumption of non prescription drugs and alcohol isstrictly prohibited at all areas.

Drug and, especially, alcohol testing shall be arranged after weekends and especially for workers appointed for works consisting of potentially high-risk activities. The drug and alcohol test shall be undertaken in case of indications of a respective consumption.

Until the result of the test is public, the worker(s) must refrain from anywork at site.

In case of a positive test result, the worker has to be expelled from the sitewithout any undue delay until the completion of the project.

9. PERSONAL PROTECTIVE EQUIPMENT

It shall be governed by site regulation and safety requirement as stipulated in GCC

10. INCIDENT & ACCIDENT MANAGEMENT

It shall be governed by site regulation and safety requirement as stipulated in GCC

11. HEALTH & SAFETY REVIEWS

11.1 MCA H&S Audits and Reviews

Prior to commencement of the main construction phase, NTPC will conduct a pre-construction phase H&S Review to ensure that all the necessary arrangements are in place and suitable for the work being undertaken at that time. This will include compliance with this H&S Standards document, the project H&S Plan and country specific legislation.

NTPC will conduct site specific H&S Reviews on a regular basis and formal H&S Audits of the Contractor and its supply chain. Formal H&S Audits will be conducted at least, every 6 months. The duration of this audit will be a minimum of 1 day and will require the full co-operation of the Contractors project management team.

In addition to H&S Reviews to be undertaken by NTPC, it is possible thatfurther H&S Audits and Reviews will be carried out by relevant stakeholders i.e. Ministry of Labour or Ministry of Health etc.

The Contractor is obliged to provide any necessary support to the stakeholders to enable them to undertake their tasks and duties and to allowthe access to the sites for undertaking the audits and reviews.

NTPC will spend specific focus on construction sites and their conditions where children between the age of 14 and 18 are employed.

11.2 Contractors Health & Safety Review Programme

The Contractor shall implement an H&S Review Programme applicable for his construction site(s) that shall include a systematic evaluation of the implemented management system, compliance with this H&S Standards document, and the project H&S Plan and local legislative requirements.

11.2.1 Contractors H&S Audits

H&S Construction Site Audits must be undertaken on a monthly basis. Theaudits should be performed by the Site Manager, the H&S Manager and theH&S Advisor.

The audits should comprise the construction site itself, material andequipment storage areas, workshop areas and accommodation areas(Worker's camp area).

These audits shall be recorded and the results should be slipped into the monthly H&S Reports. A copy of the audit report must be attached to themonthly report.

11.2.2 Contractors H&S Inspections

H & S Inspections must be carried out on specific work areas and work places associated with the project on a weekly basis but independent thereofif they are assessed as medium or high risk areas or workplaces according to the risk register. The results of the inspections must be considered in the weekly H&S reports to be submitted to NTPC. A copy of the H&S Inspection report must be attached to the weekly report. The H&S

Inspections shall be executed by the H&S Manager together with the H&S Advisor.

11.2.3 Contractors Health & Safety Surveys

H & S Surveys shall be conducted by the Contractors' H&S Advisor on a daily basis. The date and time of the surveys must be documented but the results must not be recorded in a written report but significant findings mustbe communicated to the H&S Manager.

11.2.4 Contractors Management Surveys

Management surveys to be undertaken by the Contractors General Manager or his representatives shall be conducted at least every 3 months. The surveys must not be done by the responsible Site Manager, H&S Manager or H&S Advisor of the particular construction site. The results shall be recorded.

11.3 Reporting

The results of H&S Audits and H&S Inspections must be recorded and the reports must be submitted to NTPC within 3 working days after finalisation of the audit or inspection respectively. Forms to be used for theaudits and audit reports respectively, inspections and surveys will be provided by NTPC.

The reports must include all relevant subjects according to the purpose of the H&S Reviews, but at least the results and the needed corrective actions.

An reporting schedule for each particular construction site must be developed by the Contractor and should be submitted to NTPC for reviewand approval.

11.4 Corrective Actions

The H&S Review reports must include the need for corrective actions. The list corrective actions must include the following information:

- Identified risks and non-compliances;
- Needed corrective actions;
- Needed personal and material resources;
- Responsible person;
- Date for latest finalisation.

The effectiveness of the corrective actions will be subject of NTPC'sH&S Audits.

11.5 Compliance Reviews

One week after the implementation of the corrective actions, the H&S Manager is requested to undertake a compliance review. After observation of the full compliance of the corrective actions, the H&S Manager has to report the finalisation to NTPC.

12. SITE H&S REQUIREMENTS

It shall be governed by site regulation and safety requirement as stipulated in GCC.

13. STAYING & FOOD ARRANGEMENT FOR WORKERS

The contractor may consider providing hygienic food, beverages and refreshments during period of Project construction which may enhance the productivity level of the workers.

The contractor shall also arrange quarters in workers habitat area for accommodation of workers during period of stay at TALCHER TPP. The proper cleaning and hygiene shall be maintained in quarters. The random checks for hygiene and cleanliness shall be done by Employer and any violation on cleanliness shall not be acceptable. Employer may take action for the same as deemed fit.

SUB-SECTION-B – 17

SWITCHYARD ELECTRICAL

CHAPTER: SWITCHYARD ELECTRICAL

1.00.00 **SCOPE AND GENERAL INFORMATION**

1.01.00 In addition to the detailed scope and other requirements specified in Part-A, the intent of the specifications for various electrical equipments shall also cover the following scope:

1.01.01 Contractor shall be responsible for design and engineering of overall system/station, and all elements, systems, sub-systems, facilities, equipments, material, etc. The Contractor shall submit design calculations, drawings, codes, codes of practices, construction drawings, etc. for Employer's approval.

1.01.02 The basic design shall include, but not limited to, the following:

a) Development of general arrangement.
b) Development of detailed layout (plan & section/elevation) drawings.
c) Development of single line diagram with parameters of equipment and details of protection.
d) Protection and control philosophy and selection of protection, control and annunciation schemes.
e) Development of interlocking schemes.
f) Development of switchyard structure loading details.
g) Development of earthing system.
h) Development of direct stroke lightning protection system.
i) Insulation coordination of the EHV equipment.
j) Calculation of static and dynamic force load, and selection of spacer spans and equipment terminal loading.
k) Development of clearance diagrams.
l) Lighting design, Lux level calculation and conduit wiring diagram.
m) Development of power & control cable laying and termination schedules.
n) Relay setting calculations.
o) Development of erection key diagram with bill of material.
p) Foundation design and construction drawings.
q) Development of cable trench layout and sections and construction drawings.

1.01.03 Exposed live parts shall be placed high enough above ground to meet the requirements of Indian Electricity Rules and other statutory codes. All responsibilities regarding co-ordination with Electrical Inspection Agencies and obtaining clearance certificate from them rests with the Contractor. The necessary fees for such clearances shall be borne by the Owner.

1.01.04 All equipment shall be supplied with suitable terminal connectors. The spacing for quadruple and twin conductor shall be 450 mm.

1.01.05 The rigid busbars for equipment inter connections shall have rigid connections at one end and expansion /flexible at other end. The tubular Al. connections shall have not more than one joint per span. Corona Bell shall be provided at the end of the rigid busbars.

1.01.06 The line take off arrangement from GIS building up to line take off/intermediate gantry (as required) shall be through GIS ducts as indicated in Single line diagram. The line side insulators and hardware shall be provided by the line contractor, however the clamps and connectors for droppers to equipments are in the bidders scope. Location of line take off gantry and intermediate gantry (as required) for termination of Transmission line dead end tower to switchyard shall be finalized during detailed engineering based on the technical requirements. All the terminations shall be done as indicated in the Single line diagram. High speed earth switches(HES) shall be provided wherever required, HES shown in the SLD are the minimum requirements.

1.01.07 The minimum sizing criteria of the control room and GIS building shall be as given below:

	i)The GIS building shall be adequately designed so as have a passage of 2.0 m on either side and adequate overhead clearance for the movement of equipments without any obstruction, from the top of the GIS equipment to EOT Crane. The GIS Control Room Building shall have with provision of Switchgear room, Battery room, charger room, office, cable vault, SAS room, Lab room, CRP Panel room, conference room, Pantry, toilet etc. The GIS & control room building is to be designed keeping future provision for extension if any as shown in the Single line diagram. The GIS building shall have adequate provision (at least 4.0m) for maintenance bay shall be provided one side of GIS building considering the future provision for GIS extension. ii)Maintenance room (as a part of GIS building) shall be constructed for carrying out repair works / small part assembly, storage of material, test equipment and tools and tackles to be stored separately from GIS hall in this room. iii) GIS building shall have with provision of Toilet room etc..
1.01.08	The EOT crane to be provided inside the GIS building shall be of min. 6T capacity or as per the calculation of capacity required to move heaviest part for maintenance.
1.01.09	The sag tension, conductor spacing, short circuit forces, spacer location, conductor swing and clearances shall be carried out in accordance with IEC 60865 to achieve the specified clearances.
1.01.10	All overhead stringing shall be carried out by minimum double tension string insulator assembly.
1.01.11	Post insulators shall be provided at line entry and near transformers and other jumpers to avoid mechanical forces on the LA's and Bushings etc.
1.01. 12	Necessary fire wall shall be provided between single phases of reactors. The fire wall height shall be 500mm above reactor bushing.
1.01. 13	The pit size of reactors shall be designed for minimum 1000mm beyond the physical dimension of the reactor.
1.01. 14	The towers and gantries shall be suitable for a normal conductor tension of minimum 2T/conductor in case of twin moose and 1.5T/conductor in case of quad moose conductor. The foundations and structures etc. shall be designed accordingly. The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment structure, where it rests on the foundation pad shall be 2550 mm. All gantries and towers (including intermediate/required for turning etc.) as required for GT & ST O/H stringing & its anchoring on A-Row column of TG Building and line take off, are to be provided by the contractor. Minimum height of 400KV gantry for AIS shall be 16M+8.5MPeak however intermediate gantry height for O/H connection for GT shall be min. 22m+8.5m. Minimum height of 400KV AIS equipment level shall be 8.0M from the plinth level. The gantry width for 400kV AIS shall be min. 27m or as required to meet the specified clearances. Various minimum heights of the 400KV AIS switchyard shall be as given below from plinth level: Equipment level/1st level :8000mm 2nd level :16000mm
1.01.15	The switchyard shall be provided with peripheral roads and roads for maintenance/approach for GIS equipment, GIS Duct, major AIS equipment for maintenance purpose.
1.01.16	CVT JB shall have fuses for each core of the CVT. Further separate lockable CVT with TTBs for ABT metering cores (0.2S class) / owners supplied meters shall also be provided by the contractor.

1.01.17 The illumination level for AIS shall be 20 lux in general and minimum 50lux on equipment boxes. No lighting fixture shall be mounted on gantries, they shall be mounted on Lightning Masts/ High lighting masts only. Specification of lighting is provided elsewhere in the specification.

1.01.18 Contractor shall provide panel mounted automatic start / stop type centrifugal self-priming pump for sump pit to drain the water in approximately one (1) hour. The contractor shall also provide suitable pedestal/ foundation for this pump. The pump shall be complete with all necessary fittings such as NRV, inlet & outlet pipes of suitable length and dia.

1.01.19 All 'T' off connections at 'A' row of TG Building associated with transformers shall be provided with a bye pass utilizing two PG clamps for each T off. As far as possible the conductor shall pass without cut/joint unless otherwise necessary for planned shutdown/maintenance.

1.01.20 75mm thick base layer of M5 grade PCC shall be provided over the prepared sub grade in the entire area of the Switchyard inside the fence excluding foundations, roads, drains, cable trenches as per detailed engineering drawing. In switchyard area earth resistance measurement points shall be marked in the layout where the PCC shall not be provided. For easy drainage of water, adequate slope is to be provided from the ridge to the nearest drain. A final layer of minimum 75mm thickness of stone aggregate of 40mm nominal size shall be spread uniformly over PCC layer. In Switchyard before laying of PCC layer, the subgrade shall be properly compacted, and the top layer of the soil shall be treated for anti-weed considering the type of weeds found in the vicinity.

1.01.21 Adequate AC & Ventilation of Control room building and Ventilation of GIS Building, switchgear room etc. is to be provided by the contractor. Specification of AC & Ventilation is specified elsewhere in the specification (Part-B Mechanical)

1.02.00 **CLEARANCES :** The minimum clearances for 400kV AIS shall be as given below:

Phase to earth clearance :3500 mm
Phase to phase clearance :4000 mm
Section clearance : 6500 mm

The Contractor shall supply the structures suitable to meet the above clearances.

1.03.00 **SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING SUPPLIED**

The system shall be designed to limit the power frequency over voltage of 1.5 p.u. and the switching surge over voltage to 2.5 p.u. In 400 kV system the initial value of temporary over voltage could be 2.0 p.u. for 1-2 cycles. All the equipment/materials covered in this specification shall perform all its function satisfactorily without undue strain, restrike etc. under such over voltage conditions.

1.03.01 **SITE SUPERVISION OF EQUIPMENTS**

The contractor shall ensure that, erection, testing and commissioning of, GIS, Circuit Breaker, Isolator, Instrument Transformer, Surge Arrestor, Substation Automation System & protective relays is carried out, under the supervision of manufacturer of respective equipment.

1.04.00 **Insulation Co-Ordination and Selection of Surge Arrestor**

1.04.01 The contractor shall be fully responsible for complete insulation co-ordination of switchyard. Contractor shall ensure that adequate protective margin is available. If surge arrestors at some more locations other than those indicated in the tender drawings are required to be provided, the same shall be deemed to be included in the offer.

1.05.00 **SYSTEM PARAMETERS For GIS (400kV)** :

Sl.no	Description	
a	i)Highest System voltage	420kV rms
	ii)Rated / Nominal system voltage	400kV rms
b)	Lightning impulse voltage (ph to earth& between phases)	±1425kVp
	Across isolating distance	1425(+240) KVp

c)	Switching impulse voltage (ph to earth)	±1050kVp
	Across isolating distance	900(+345) KVp
d	Power frequency withstand (for I min. rms.) to earth & between phases	650kVrms
	Across isolating distances	815kVrms
e	Max.fault level(1sec)	63kA
d	Rated dynamic with stand current	157.5 kAP
f	PD Level for GIS	<5pico coulomb
g	Rated frequency	50Hz
h	Rated Ambient Temperature	50.deg.Cen
i	System earthing	Effectively earthed

1.05.01 **FOR AIS (400kV)** :

Sl.no	Description	
a	i)Highest System voltage	420kV rms
	ii)Rated / Nominal system voltage	400kV rms
b)	Lightning impulse voltage (ph to earth& between phases)	±1425kVp
	Across isolating distance	1425(+240) KVp
c)	Switching impulse voltage (ph to earth)	±1050kVp
	Across isolating distance	900(+345) KVp
d	Power frequency withstand (for I min. rms.) to earth & between phases	630kVrms
e	Max.fault level(1sec)	63kA
d	Rated dynamic with stand current	157.5 kAP
f	PD Level	<5pico coulomb
g	Rated frequency	50Hz
h	Rated Ambient Temperature	50.deg.Cen
i	System earthing	Effectively earthed
j	Min.creepage (31mm/kV)	13020mm
k	Seismic acceleration	0.3g
l	Max. radio interference for freq. between 0.5 MHz and 2.0 MHz at 266 kV rms	1000micro volt
m	Corona extinction voltage	Not less 320kV rms

Note: Bidder to consider above parameters for all the equipments of GIS & AIS. For other Parameters bidder to refer respective chapter.

1.06.00 **TYPE TEST REQUIREMENTS**

1.06.01 **TYPE TEST REQUIREMENTS FOR EQUIPMENTS OTHER THAN GIS & 400KV AIS CIRCUIT BREAKER :**

a) All equipments to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification. The validity period of reports shall be as per CEA Guidelines for the validity period of Type test(s) conducted on Major Electrical Equipment in power Transmission-May2020 & with latest amendments for the from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a Client.

b) However if contractor is not able to submit report of the type test(s) conducted as per CEA Guidelines for the validity period of Type test(s) conducted on Major Electrical equipment in power Transmission-May2020 & with latest amendments from the date of bid opening, or

in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/ owners representative and submit the reports for approval.

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

1.06.02 **TYPE TEST REQUIREMENTS FOR GIS & 400KV AIS CIRCUIT BREAKER:**

a) The Contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The Bidder shall indicate the charges for each of these type tests separately in the relevant schedule of BPS and the same shall be considered for the evaluation of bids. The type test charges shall be paid as per the charges quoted for each of these type tests separately in the relevant schedule of BPS (Bid Proposal Sheet) & no qty variation is allowed. only for the test(s) conducted successfully under the contract and upon certification by the Employer's engineer.

b) Bidder refer to Sub section -IIB -Electrical Systems / Equipments Clause No: 1.23.00.- Sl. No: 2.

c) In case the Contractor has conducted such specified type test(s) according to the relevant standard and / or specification as per CEA Guidelines for the validity period of Type test(s) conducted on Major Electrical equipment in power Transmission-May2020 & with latest amendments as on date of bid opening, submit the type test reports to the Employer for waiver of conductance of such type test(s). These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a Client. The Employer reserves the right to waive conducting of any or all the specified type tests(s) under this contract. In case the type tests are waived, the type test charges shall not be payable to the Contractor.

1.06.03 Common requirements (For GIS)

a) The Employer will have the right of getting any test of reasonable nature carried out on any component or completely assembled equipment at Contractor’s premises or at site or in any other place in addition to the aforesaid type and routine tests, to satisfy that the materials/equipment comply with the specification.

b) Failure of any equipment to meet the specified requirements of tests carried out at works or at site shall be sufficient cause for rejection of the equipment. Rejection of any equipment will not be held as a valid reason for delay in the completion of the works as per schedule. Contractor shall be responsible for removing all deficiencies and supplying the equipment that meet the requirement.

c) All equipments with their terminal connectors, control cabinets, main protective relays, energy meters etc. as well as insulators, insulator strings with hardware, clamps and connectors, marshalling boxes etc. shall be subjected to routine and acceptance tests in accordance with the requirements stipulated under respective equipment sections. Charges for the same shall be deemed to be included in the equipment price.
The following type tests (as applicable) are proposed to be conducted on a complete single pole assembly of one typical GIS switchgear bay module as per IEC 62271-203. The one Typical GIS switchgear bay module consists of equipment like Circuit breakers, Current transformers, Disconnectors / isolator, earth switches etc. of each type / rating.

i) Lightning impulse voltage dry tests.
ii) Switching impulse voltage dry tests.
iii) Power frequency voltage dry tests.
iv) Partial discharge tests.
v) Radio Interference Voltage test (as applicable)

vi) Test to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit.

vii) Test to prove the ability of the main circuit and earthing circuit to carry the rated peak and the rated short time withstand current.

viii) Test to verify the making and breaking capacity of the included switching devices.

ix) Test for satisfactory operation of the included switching devices.

x) Test to prove the strength of enclosures.

xi) Gas tightness test

xii) Electromagnetic capability test (if applicable)

xiii) Test on partitions

xiv) Internal arc tests.

xv) Mechanical operation tests.

xvi) Test to prove the satisfactory operation at limit temperature.

xvii) Verification of degree of protection of auxiliary and control circuits.

xviii) Test to prove performance under thermal cycling and gas tightness test on gas barrier insulators

xix) Capacitive Current switching test

xx) Shunt reactor current switching test

d) For surge arrestor and Bus VT following type tests are proposed to be conducted as per relevant IEC.

Surge Arrestor (As per IEC 60099-4)

a)Insulation with stand test on housing	b)Residual voltage test
c)Long duratrion current impulse with stand test	d)pressure relief test (if applicable)
e)operating duty test	f) Partial discharge test
g) leakage test	

BUS VT (As per IEC 60044-2)

a) Temparature rise test	b)Lightning impulse test
c) switching impulse test	d) Determination of errors
e) short circuit with stand capability	f)chopped lightning impulse test

1.07.00 **Type tests to be conducted on 400KV AIS Circuit Breaker**

a) Dieelctric tests	b)Radio interference voltage test
c) Temperature rise test	d) shor time withstand current, peak with stand test, short circuit test duties , short line fault test
e) Mechanical endurance	f)out of phase making & breaking test
g)Line charging current breaking test	h) Coronal test for 400kV
i) IP: 55test on each type of box	j)Seismic with stand test with structure for 400kV
k) Test for reactor switching duty for 400kV CB(for Bus reactor)	

1.08.00 **CORONA AND RIV TESTS AND SEISMIC WITHSTAND TEST (for 400kV AIS only):**

The corona and RIV tests shall confirm to the requirements as per **Annexure- A** to this chapter. The seismic withstand test shall conform to requirements as per **Annexure -B** to this section.

Annexure – A

CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST (For 400 kV AIS only)

1.0 **General**

Unless otherwise stipulated, all equipment together with its associated connectors where applicable shall be tested for external corona both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and measurement of radio interference voltage (RIV).

2.0 **Test Methods for RIV:**

2.1 RIV tests shall be made according to measuring circuit as per International Special – committee on Radio Interference (CISPR) Publication 16 -1 (1993) Part – I. The measuring circuit shall preferably be tuned to frequency with 10 % of 0.5 MHz but other frequencies in the range of 0.5 MHZ to 2 MHz may be used, the measuring frequency being recorded. The result shall be in microvolts. Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107 – 1964 except otherwise noted herein. In measurement of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

2.2 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, 115% and 130% for the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 420 KV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

3.0 **Test Methods for visible Corona :**

The purpose of this test is to determine the corona extinction voltage of the apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 130 % of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 130 %, the voltage level shall be raised till inception of corona or rated voltage whichever is lower. The voltage will then be decreased slowly until all visible corona disappears. The test procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which the visible corona (negative or positive polarity) disappears.

Annexure – B

SEISMIC WITHSTAND TEST (for 400 kV AIS only)

a.) The seismic withstand test on the complete equipment (except BPI) shall be carried out along with supporting structure.

b.) The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the terminal pad of the equipment and at any other point as agreed by the owner. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the purchaser.

2.00.00 REQUIREMENTS FOR GAS INSULATED SWITCHYARD

2.01.00 GENERAL

2.01.01 The GIS shall comply to IEC – 62271-203. The GIS shall be modular in structure and shall be housed indoor. The modules shall be single phase encapsulated and provided with hooks for handling by EOT cranes to be provided in the building. The modular design shall be capable of extension on either side without any major dismantling. The GIS equipments shall be housed in GIS building of overall height and width determined by the layout arrangement. The bus bars shall be rated for the duty specified and current rating shall be as per tender Single line Diagram (SLD). All the SF6 gas insulated circuit breakers, disconnectors, grounding switches and bus bars shall be of single-phase isolated type.

2.02.00 TECHNICAL REQUIREMENTS:

2.02.01 The VT's for GIS shall be installed within the GIS enclosure and shall be SF6 gas insulated or cast resin type. The secondary terminals shall be brought out in a dust proof enclosure suitably. The Surge arrestors for main buses shall be of GIS type only .

2.02.02 The earthing of the GIS shall be carried out considering the safety requirements as per relevant standards. The continuity of earthing shall be ensured considering electrical and thermal stresses caused by current they may have to carry. Each section & phase of

	the GIS enclosure shall be monitored for leakage of SF6 gas and suitable indication shall be provided in the control room.
2.02.03	Each breaker module of the GIS shall have a local control cabinet suitably located and shall be ground mounted meeting the requirements specified elsewhere for cabinets. Suitable interlocking arrangements shall be provided for the entire GIS.
2.03.00	**DESIGN AND SAFETY REQUIREMENT**
2.03.01	The compartments shall be such that maintenance on one feeder may be performed without de-energizing the adjacent feeders. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Stainless steel carbon impregnated or nickel plate rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions..
2.03.02	Gas barrier insulators shall be provided to divide the GIS into separate compartments. They shall be suitably located to minimize disturbance in case of leakage or dismantling. They shall be designed to withstand 1.5 times full rated pressure on one side while vacuum is exerted on the other side.
2.03.03	The material and thickness of the enclosures shall be such as to withstand an internal flash over without burn through for a period of 300ms till the backup relay protection clears the fault. Sufficient inspection windows/access openings shall be provided at the switchgear..
2.03.04	Each pressure filled enclosure shall be designed and fabricated to comply with the requirements of the applicable pressure vessel codes and based on the design temperature and design pressures as defined in IEC -62271-203.The contractor shall guarantee that the pressure loss within each individual gas-filled compartment shall not be more than half percent (0.5%) per year.
2.03.05	Each gas-filled compartment shall be equipped with static filters, density switches, filling valve and safety diaphragm. Each gas compartment shall be fitted with separate non-return valve connectors for evacuating & filling the gas and checking the gas pressure etc.
2.03.06	The thermal rating of all current carrying parts shall be minimum for one sec. for the rated symmetrical short-circuits current.
2.03.07	The arrangement of gas section or compartments shall be such as to facilitate extension of any make on either end without any drilling, cutting, or welding on existing equipments. The GIS shall be designed such that a future requirement as per single line diagram can be extended with-out any necessity to move or dislocate the existing switchgear bays. It shall be kept in view that very little shutdown time is needed for adding future requirement.
2.03.08	All the elements shall be accessible without removing support structures for routine inspections and possible repairs. The removal of individual enclosure part or entire breaker bays shall be possible without disturbing the enclosures of neighboring bays.
2.03.09	The actual position of circuit breakers, disconnectors and grounding switches must be positively displayed by mechanical indicators visible from the operating position.
2.03.10	The breaker enclosure shall have provision for easy withdrawal of the interrupter assemblies/complete CB pole.
2.03.11	The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electrodynamics stresses even under short circuit conditions.
2.03.12	The switchgear shall have provision for connection with ground mat risers. This provision shall consist of grounding pads to be connected to the ground mat riser in the vicinity of the equipment. The connection between the grounding pads of switchgear and ground mat risers shall be provided by the contractor. The contractor shall furnish the design details & drawings for ground mat for GIS.
2.03.13	The layout of Switchgear such that each equipment shall be easily accessible for monitoring, maintenance, and testing purpose. The fixed type walkways shall be provided for access to the equipment for maintenance and testing purpose. In addition to this hydraulic portable ladder shall also be provided by the contractor.
2.03.14	The heaters shall be rated for 240V AC supply and shall be complete with thermostat, control switches and fuses, connected as balanced 3-phase, 4-wire load.
2.03.15	Arrangement shall be provided to visually observe the contact position of disconnecting

switches and earth switches.

2.03.16 The enclosure & support structure shall be designed that a mechanic 1780mm in height and 80 Kg in weight shall be able to climb on the equipment.

2.03.17 The sealing provided between flanges of two modules / enclosures shall be such that long term tightness is achieved.

2.03.18 Alarm circuit shall not respond to faults for momentary conditions. The following indications in addition to those required elsewhere in the specifications shall be provided in the alarm & indication circuits in Bay Module Control Cabinets:

I) Gas Insulating System

a) Loss of gas density b) Loss of heater power (if required)

c) Low gas pressure d) Any other alarm necessary to indicate deterioration of the gas insulating system

II) Operating System

a) Low operating pressure .b) Loss of Heater Power. c) Loss of operating power.

d) Loss of control e) Pole-discordance . In addition, all the above alarms shall also be hooked up to the Substation Automation system.

2.03.19 The supplier shall submit guarantee that all offered SF6 GIS equipment has a Min.service life of 10,000 normal operations. The maintenance free period for any of its external components shall not be less than 5 years intervals. Internal components including refilling of gas shall not be less than 10 years. The supplier shall submit the O&M manuals of all GIS equipment, trouble shooting, recommended spares parts etc. The supplier shall propose the recommended period for schedule maintenance.

2.03.20 Online Partial Discharge Monitoring system for GAS insulated switchgear and Busduct shall be provided to monitor the entire GIS installation as per the Specification mentioned at **Annexure-C:**

Annexure-C: ONLINE PD MONITORING SYSTEM FOR GAS INSULATED SWITCHGEAR: GIS equipment shall be designed to minimize partial discharge or other electrical discharge. A state-of-the art Partial Discharge Monitoring system shall be provided to monitor the entire GIS installation.

i)An on-line continuous Partial Discharge Monitoring (PDM) system shall be designed to provide an automatic facility for the simultaneous collection of PD data at multiple points on the GIS & its associated GIB ducts and Voltage Transformers adopting UHF technique.

ii)On-line continuous Partial Discharge Monitoring (PDM) system shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 100 MHz–2GHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principle of operation shall be based on UHF principle of detection.

iii)The scope shall cover Engineering, supply, installation, testing and commissioning of partial discharge continuous monitoring system, with all necessary auxiliaries and accessories to make a complete system as per technical specification, including site demonstration of successful operation. The PDM system shall be provided with all its hardware and software, with readily interfacing to the UHF PD couplers installed in the GIS of present bays and future bays as shown in SLD plus 20% additional as extra. Details of this shall be submitted during engineering stage for approval.

The number of UHF PD coupler for future bays shall be decided based on GIS layout finalized under present scope (considering present GIS equipment with future provision).

iv)The PD Monitoring PC Work Station shall be in the control room of the GIS substation. Workstation PCs shall be pre-loaded with all necessary Hardware & Software. The PCs shall have each Combo drive & Retrievable disk drive (1 TB), Ethernet port 100Mbps, colour printer. The workstation PC shall be powered by suitable dedicated UPS. PDM system shall have built in self-checking facility.

Design of on-line PDM System:

1. The sensitivity of the offered system shall be in accordance with CIGRE Document No. 654 that will be verified as part of site sensitivity tests.
2. UHF attenuation data of GIS shall be submitted for the switching devices, spacers, bends etc.
3. The signal attenuation level of co-axial cable per meter length and justification for the length of cable connection between the couplers and detector units shall be furnished.
4. The overall sensitivity of PD detection system shall consider the spacing between couplers and the associated cabling, filters, amplifiers, etc.
5. The PD sensors shall be identified / coordinated with the corresponding detector unit etc. with proper identification labelling and indicated in the substation PDM SLD.
6 Supply requirement (AC & DC) to be specified for the complete monitoring system.
7. Power supply to PDM PC shall have protection against surges, overload and short circuit. A dedicated on-line UPS system shall also be provided as a backup during supply interruption, to ensure trouble-free & reliable running of the PDM System for a minimum of 15 minutes duration.
8. PDM System shall be provided with a user security for accessing the system with a log-on and password entry procedure. The user levels shall be defined as a Master User and other users for the modification of system, update, and entry of parameters or manual operation. System shall be able to generate 3D point on wave pattern whenever any PD activity detected by the system. System shall be able to give online 3D point on wave pattern, online PRPD (phase resolved PD) and online short time trend etc. System shall be able to generate the all the logs related to system fault, system access, PD event, and any changes in system setting etc.
9. The selected mode of propagation of PD signal (electromagnetic wave) inside GIS for the design of sensors shall be furnished.

T he applicable standards to meet IEC & IEEE requirements for electromagnetic compatibility shall be specified. The offered system should have been tested for the same for working in a 400kV & above substation environment. The necessary documentation must be submitted in this regard.

Calibration: The UHF Couplers must be first calibrated as per CIGRE procedure TF 15/330305 as part of factory acceptance tests to guarantee detection sensitivity of 5pC or better. The GIS of same design shall be used as test specimen during the coupler calibration. The pulse injection level determined through above factory calibration tests shall only be used as reference for site sensitivity checks during commissioning of PDM system. The data sheet/frequency response characteristics shall be submitted for reference.

The system shall generate alarms if suspected partial discharge activity is noticed or the system itself is in failure, thereby eliminating the necessity of periodic system access by the user and one such alarm shall be connected to Substation automation system (SAS). The alarms shall be configured coupler wise.

Filtering Facility: The filtering facility must be provided to distinguish real PD from internal/external noise such as switching operations, self-test signal, radio, communication signal etc.

Diagnostic Software: To interpret various types of PD defects, intelligent diagnostics software (expert system) shall be built- in as part of the PDM software capability. This is mainly to reduce the dependence on PD specialist. The bidder shall also make available typical point-on-wave patterns as library pictures to train the user.
Special tools and critical spare parts for trouble free operation of the system are also to be supplied along with the PDM system. Pulse generator for UHF sensor sensitivity test shall also be supplied as a standard accessory.

2.03.21 Adequate number of gas leak detectors shall be installed at various locations at the base

of the GIS structure to detect presence of gas which may be harmful for human. The detector shall send alarm signal locally as well as at remote stations.

2.04.00 MANDATORY MAINTENANCE EQUIPMENTS

The maintenance equipment necessary for the operation and maintenance of GIS shall be supplied. In addition to this maintenance equipment specified at **Annexure-D** of this section shall also be supplied and covered in the contractor's scope.

2.05.00 MANDATORY MONITORING EQUIPMENTS

THE MONITORING EQUIPMENT NECESSARY FOR THE OPERATION AND MAINTENANCE OF GIS SHALL BE SUPPLIED. A LIST OF SUCH EQUIPMENTS IS ENCLOSED AT **ANNEXURE-E** OF THIS SECTION.

2.06.00 BELLOWS OR COMPENSATING UNITS:

Adequate provision shall be made to allow for the thermal expansion of the conductors and of differential thermal expansion between the conductors and the enclosures. The metallic bellows (preferably of stainless steel) of following types or other suitable arrangement shall be provided wherever necessary:

2.07.00 INDICATION AND VERIFICATION OF SWITCH POSITIONS

Local Indicators shall be provided on all circuit breakers, For Disconnectors and earth switches local indicators (3ph / 1ph - preferably local indicators for all phases of disconnectors and earth switches) shall be provided, which shall clearly show whether the switches are open or closed. The indicators shall be mechanically coupled directly to the main contact operating drive rod or linkage and shall be mounted in a position where they are clearly visible through glass windows.

2.08.00 PRESSURE RELIEF :

Pressure relief devices shall be provided in the gas sections to protect the main gas enclosures from damage or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electrical fault arcs (preferably) in downward direction). Pressure relief devices shall be achieved either by means of diaphragms or plugs venting directly into the atmosphere in a controlled direction.

2.09.00 PRESSURE VESSEL REQUIREMENTS

The enclosure shall be designed for the mechanical and thermal loads to which it is subjected in service. The enclosure shall be manufactured and tested according to the pressure vessel code (ASME/CENELEC code for pressure Vessel.) The bursting strength of Aluminum casting must be at least 5 times the design pressure. A bursting pressure test shall be carried out at 5 times the design pressure as a type test on each type of enclosure. Each enclosure must be tested as a routine test at 1.5 times the design pressure for one minute.

2.10.00 BUSBARS

2.10.01 The conductors of the bus bars shall be fabricated from aluminum/copper tubular sections of cross- sectional area suitable to meet the current rating requirements. The bus bars shall be housed in single phase enclosure. The tubular bus section shall be housed in corrosion resistant aluminum enclosures, filled with pressurized SF6 gas. The conductors shall be supported from the enclosures by insulators shaped to ensure uniform electrical field distribution and zero corona at rated voltage. The bus end connections shall be made with multi-contact connectors to allow for axial thermal expansion of the bus. The enclosure connections shall be flanged and shall be fitted with gaskets or O-ring seals to provide an effective gastight joint between sections.

2.10.02 Main bus bars shall be designed to have future extension bay if any as indicated in the single line diagram. The bus conductor end connectors and enclosure flanges shall be designed accordingly.

2.10.03 Each gas compartment barrier shall be easily identifiable from the outside of the switchgear. The means of identification used shall be a black band, approx. 10mm wide,

permanently affixed to the barrier insulator on the outer surface of the enclosure at the location of the barrier insulator. In case of leakage of the gas from any compartment, indication of respective compartments should be provided on the annunciator.

2.11.00 BAY MODULE CONTROL CABINETS

2.11.01 Each switchgear bay module shall be suitable for local control and remote control. The contractor shall supply the main control cabinet of the floor standing type along with GIS equipments. The cabinet shall have double, full height, hinged, gasketed, lockable doors. One door shall have a safety glass window through which the various switchgear controls can be viewed without opening the doors.

2.11.02 The following equipments shall be mounted on the cabinet door:

- Remote/local control transfer switch for the circuit breakers and disconnector switches.
- Normal operation/maintenance control transfer switch for disconnector of remote electrical controls.
- Mimic diagram of the switchgear bay complete with semaphore indicators for the switchgear component position indication and local control switches for open / close or close-trip control of the circuit breaker, isolators and grounding switches.

2.11.03 The annunciator system shall have sufficient modules and illuminated windows for providing annunciation for low / high gas pressure / density, alarms & trips for circuit breaker operating mechanism and all other abnormal conditions.

2.11.04 Each annunciator panel shall be complete with an audible warning horn, acknowledge/reset for horn silence and lamp test push buttons. Apart from annunciator system in LCC, alarm contacts for remote alarm indication shall have to be wired separately in LCC terminal block. The control cabinets shall be suitable for bottom entry of cables.

2.12.00 SUPPORTING STRUCTURES

2.12.01 The Contractor shall design, fabricate and supply the equipment supporting framework including all rails, transverse & longitudinal beams and supporting members with all necessary hardware & embedded parts. General structural designs and structural details shall be subject to the approval of the Employer.

2.12.02 Non-corrosive metal or cadmium plated steel shall be used for bolts and nuts throughout the work when either or both are subjected to frequent adjustment or removal.All steel structure members shall be hot dip galvanised.

2.13.00 MONITORING

2.13.01 The gas density in each gas compartment shall be monitored by electrically isolated & independently adjustable temperature compensated density switches. The factory set density switches shall also be acceptable. Two level density switches shall be provided for each GIS bus compartment to initiate remote devices of level-I alarm and level-II tripping. The setting of level-I alarm and level – II tripping shall be such that the dielectric strengths of SF6 gas are maintained. The necessary indication shall be provided at the circuit breaker control cabinet identifying the gas compartment from which a level-I alarm is initiated. Two level density switches shall be provided for each circuit breaker compartment to initiate the following:

i) Level-I- Remote alarm and prevent closing of the breaker in case it is open.

ii) Level-II- Initiation of Zone trip, Contact shall be in accordance with the requirement.

2.13.02 Gas pressure monitoring devices shall be fitted with test valves such that field testing of the monitoring device can be performed without draining the main gas system. Each gas section shall be fitted with a suitable valve for routine gas sampling.

2.14.00 HIGH VOLTAGE TRANSIENTS

High voltage transients from switching operations and internal faults are coupled to the external enclosure of the GIS. .

2.15.00 HEATERS: All the heaters shall be suitable for connection to a 240V AC, single phase, 50

Hz supply. The heater in the mechanism housing shall be connected inside the housing to this supply and shall be thermostatically controlled. The leads to the tank heaters shall be enclosed in a conduit.

2.16.00 SERVICE LIFE

SF6 circuit breakers, disconnecting switches and grounding switches will be subjected to frequent and occasionally repetitive, no load / full load operations and switching off short circuit currents, capacitive and inductive currents within their ratings. The Contractor shall propose the recommended period for scheduled maintenance.

2.17.00 Shop test

2.17.01 Each transport section of switchgear shall be shop tested. The routine tests of GIS equipments which have been covered under other relevant IEC standards)

a) Routine tests (on transport section):
   - i) Dry Power frequency voltage withstand tests on the main circuit.
   - ii) Dielectric tests on auxiliary and control circuit.
   - iii) Tests to verify the resistance of the main circuit
   - iv) Partial discharge tests
   - v) Pressure test on enclosures
   - vi) Gas tightness test.
   - vii) Mechanical operation tests.
   - viii) Tests of auxiliary, electrical, and hydraulic devices.
   - ix) Check of wiring.x) Power frequency voltage dry tests

   xi) Voltage tests on auxiliary and control circuits xii) Fluid leakage tests (where applicable).The applicable standards for the above tests shall be IEC 62271-203, IEC 62271-100, and IEC 62271-1.In addition, corrosion protection tests at random on all equipment shall be performed.

2.18.00 Type Tests

For Type Test requirement, please refer clause No.1.06.02 & 1.06.03.

2.19.00 Performance Tests

The performance tests shall comprise of:

a) Field stage tests, to be carried out during erection, to demonstrate that the equipment or any component or subassembly has been properly erected and functions correctly.

b) Commissioning tests, precedent to the acceptance of work, in respect of the equipment or any section of the equipment, to demonstrate proper operation.

2.20.00 Field Stage Tests:

From time to time at various stages of erection, tests of sub-assemblies of the equipment shall be carried out as instructed by the Employer. The contractor shall make records of all measurements and shall make corrections or adjustments as required. A record of all stage tests shall be embodied in a report.

2.21.00 Commissioning Tests

On completion of the erection and installation, following commissioning tests shall be performed as per IEC 62271-203, CIGRE working Group 23.03, 1975-Electra No.42, 7-29:

(a) One minute power frequency withstand tests for the main circuits. As per IEC 62271-203 high voltage tests at site with lightning impulse and switching impulse voltages are also acceptable as alternative. The Contractor may carry out either of the above tests but relative merits of particular type of test over the other tests to be carried out by the contractor should be indicated in the offer.
(b) Partial discharge measurement tests.
(c) Voltage tests for the main circuits
(d) Voltage tests for the auxiliary and control circuits.
(e) Tests to verify the resistance of the main circuits.
(f) Operation tests for various components.
(g) Gas leakage tests.
(h) Calibration/checking of SF6 gas pressure/density switches.

Measurement of moisture.

After erection, a test shall be made to prove the absence of the dangerous voltages in the enclosure and other metal parts such as pipes and framework. If the tests prove the existence of any fault or faults in the equipment, or any failure to meet the requirements of the specifications the Employer may direct Contractor to rectify the defects or repair, reconstruct or replace faulty work and Contractor shall without delay, carry out the instructions of the Employer in this respect.

Commissioning tests shall be as per the IEC standard and shall not be restricted to the tests stated above. The Contractor shall also recommend any additional commissioning tests.

2.22.00 Final Acceptance Tests

After commissioning tests have been satisfactorily completed, the contractor shall carry out tests as per relevant standards.

2.23.00 Test Reports

The contractor shall record all the relevant facts and the quantities on the basis of which a final test report shall be prepared. Such reports will be prepared in a form approved by the Employer and reproduced at the expense of the contractor in six copies for submission to the Employer.

TRAINING: BIDDER SHALL PROVIDE TRAINING TO THE EMPLOYER'S PERSONNEL AS PER THE DETAILS GIVEN BELOW:

Sl No.	Description of Training	Training Duration (Days)	Place of Training	Number of Trainees from Employer	Boarding & Lodging
1	GIS				
a)	GIS equipments including system description, Basic Design and engineering, Quality Assurance concepts, Erection and operational aspects for the offered equipments.	5 days	Manufacturers works	8	To be provided by Bidder
b)	Operation, Maintenance, Site Testing and Trouble shooting for GIS.	5 days	Site	6	-

Annexure-D -SPECIFICATION OF MANDATORY MAINTENANCE EQUIPMENT

1.0 SF6 Gas Handling Plant:-

a) SF6 gas filling and evacuating equipment (Portable**), Qty : 1no**

The capacity of this plant shall be such that it shall not take appreciable time for filling or evacuating of a GIS bay including all equipments compartment. The required vacuum for complete evacuation shall be attained with the help of this plant.

b) SF6 gas filtering, drying, storage and recycling plant- **Qty : 1no** This shall include all the necessary devices for measurement of purity, moisture content, decomposition products etc. of SF6 gas mixing with air/oil/moisture during above process should be proved to be Nil during testing.The capacity of the plant shall be such as to handle and store min 300 litres of SF6 gas or Sf 6 Gas quantity of largest compartment.

2.0 **SF6 Gas leak detector - Qty: 1no**

The sensing probe shall be such that it can reach all the points on the GIS where leakage is to be sensed. The accuracy of the equipment shall be at least 10 ppm.

3.0 **Operational analyser with DCRM kit- Qty:1no**

a) It shall have facility to record the breaker contact movement during opening, closing, auto reclosing and make-break operation, the speed of contacts at various stages of operation, travel of contacts, opening time, closing time and make break time etc.The analyser shall have provisions for recording at least 12 different functions of the circuit breaker. All necessary transducers (i.e., three nos. for complete 3 phase speed and travel record of breaker), cables, pickups, attachments required for the breaker shall be supplied with the analyser. The cables supplied shall be sufficient for recordings at site on a completely assembled and erected breaker.

b) All the necessary catalogues write up for operation and maintenance of the analyser shall be furnished along with each analyser and peripheral system. The necessary equipments for monitoring various parameters of circuit breaker termed as signature analysing shall be supplied along with all software, laptop computer, devices etc. with the breaker. The same shall be demonstrated at site on a fully assembled breaker.

4.0) Self-powered hydraulic aerial working platform with articulated and fly boom for General purpose maintenance in switchyard and Transformer yard. (Suitable for 24m working height)- **Qty : 1no**

All above maintenance equipments shall be demonstrated at site during handover.

Annexure-E

MANDATORY MONITORING EQUIPMENTS

1.0 Dew Point Meter, Qty : 1no

i) The meter shall be capable of measuring the dew point of SF6 Gas of the Circuit Breaker/GIS equipment It should be portable and adequately protected for outdoor use. The meter shall be provided with due point hygrometer with digital indication to display the dew point temperature in degree C. or PPM. It should be capable of measuring the corresponding pressure at which due point is being measured. The measurement direct without the use of any other material/chemical like dry ice/acetone etc. It should be battery operated with rechargeable batteries.

The equipment should have the following parameters :a)Measuring range: Up to -100 degree C Dew Point (b) Accuracy: + 2-degree C. (c) Display: 4-digit LCD, inch. High

2.0 PORTABLE PD MONITORING SYSTEM FOR GAS INSULATED SWITCHGEAR , Qty: 1no

i) GENERAL: The equipment shall be used for detecting different types of defects in Gas Insulated Stations (GIS) such as Particles, Loose shields and Partial Discharges as well as for detection of Partial discharges in other types of equipment such as Cable Joints, CTs and PTs.

ii) It shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 10 KHz – 500 KHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principal of operation and the method of measurement shall be non-intrusive. The instrument is able to detect partial discharges in cable joints, terminations, CTs and VTs etc., with the hot sticks.

iii) Detection and measurement of PD and bouncing particles shall be displayed on built in large LCD display and the measurement shall be stored in the instrument and further downloadable to a PC for further analysis to locate actual source of PD such as free conducting particles, floating components, voids in spacers, particle on spacer surfaces etc.

iv) The equipments should have the following parameters:

a) Measurement shall be possible in noisy environment.
b) The equipment shall be battery operated with built-in battery charger. It shall also be suitable for 230V AVC/50 Hz input.
c) Measurement shall be possible in the charged switchyard in the presence of EMI/EMC. Supplier should have supplied similar detector for GIS application to other utilities. Performance certificate and the list of users shall be supplied along with the offer.
d) Instrument shall be supplied with standard accessories i.e. connecting cables (duly screened) to sensors, Lap-top PC, diagnostic software, carrying case, rechargeable battery pack with charger suitable for 230V AC, 50 Hz supply connecting cables (duly screened) to view in storage. Contractor shall provide adequate number of sensors in the offered GIS for detection of Partial discharge, the number and location of these sensor shall be subject to approval of the employer.
e) The function of software shall cover the following :
- Data recording, storage and retrieval in computer
- Data base analysis
- Template analysis for easy location of fault inside the GIS
- Evaluation of PD measurement i.e., Amplitude, Phase Synchronisation etc.
- Evaluation of bouncing/loose particles with flight time and estimation on size of particle.
- Report generation

f) To prove the suitability of working in charged switchyard condition, practical demonstration shall be conducted before acceptance.
g) Supplier shall have “Adequate after sales service” facility in India.
k) Necessary training may be accorded to personnel to make use of the kit for locating PD sources inside the GIS. Instrument shall be robust and conform to relevant standard

3.0) SF6 gas analyzing equipment and instruments should have capacity for performing the following functions: **Qty: 1no**

a) The moisture content measurement or alternatively dew point measurement.
b) The SF6 gas content measurement.
c) Sensitivity should not be affected by dust, humidity, heat & wind etc.
d) Acidic product detection

4.0) **Portable Leakage current analyzer (for Gapless Surge Arrester), Qty: 1no**

3.00.00 CIRCUIT BREAKER

3.01.00 **GENERAL :**

Circuit Breakers shall be metal enclosed SF6 gas insulated, single phase encapsulated for GIS, both comprising three identical single pole units, complete in all respects with all fittings and wiring. The controlled switching device for circuit breakers (as indicated in single line diagram) shall meet the requirements as specified in **Annexure-I.**

3.02.00 **DUTY REQUIREMENTS**

3.02.01 The circuit breaker shall meet the requirements of Capacitive Class: C2, Mechanical Endurance: M2, Electrical Endurance class: E2 type of duty as per IEC for 400kV.

3.03.00 **CONSTRUCTIONAL FEATURES**

3.03.01 All the three poles of the breaker shall be linked together either electrically/pneumatically or electro hydraulically, In case of 400kV.

3.03.02 Circuit breakers shall be provided with two (2) independent trip coils, suitable for trip circuit supervision. The trip circuit supervision relay would also be provided. Necessary terminals shall be provided in the central control cabinet of the circuit breaker.

3.04.00 **SULPHUR HEXAFLOURIDE (SF6) GAS CIRCUIT BREAKER**

Circuit breakers shall be single pressure type.Each pole shall form an enclosure filled with SF6 gas independent of two other poles. Common monitoring of SF6 gas can be provided for the three poles of circuit breaker having a common drive. The interconnecting pipes in this case shall be such that the SF6 gas from one pole could be removed for maintenance purposes. Sufficient SF6 gas shall be supplied to fill all the circuit breakers installed plus an additional 20% of the quantity as spare.

3.05.00 **OPERATING MECHANISM**

3.05.01 Circuit breaker shall be operated by pneumatic mechanism or electrically spring charged mechanism or electro-hydraulic mechanism or a combination of these. It shall be gang operated in case of 3-phase reclosing operation as applicable.

3.05.02 The pneumatically operated mechanism shall offer unit compressor with each circuit breaker with the breaker local air receivers having a capacity for two 'CO' operations of the breaker at the lowest pressure for reclose duty without refilling.

3.05.03 The Spring-operated mechanism shall be complete with motor, opening spring & closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit. If power is available to the motor, a continuous sequence of closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty. After failure of power supply to the motor, one close-open operation shall be possible with the energy contained in the operating mechanism. Motor ratings shall be such that it requires not more than 30 seconds for fully charging the closing spring.

3.05.04 The hydraulic mechanism shall be suitable for at least two close open operations after failure of ac supply to the motor starting at pressure equal to lowest pressure of auto-reclose duty. All hydraulic joints shall have no oil leakage under the site conditions and joints shall be tested at factory against oil leakage at a minimum of 1.5 times maximum working pressure.

3.06.00 **FITTINGS AND ACCESSORIES**

3.06.01 **UNIT COMPRESSED AIR SYSTEM**

a) The unit compressed air system for each breaker shall be provided with compressed air piping, piping accessories, control and non-return valves, filters, coolers of adequate capacity, pressure reducing valves (if any), isolating valves, drain ports, etc. The air compressor shall be driven by automatically controlled motor. It shall be of air-cooled type complete with preferably oil-less cylinder lubrication. The compressors or pumps shall be mounted within the operating mechanism housing or a separate weather-proof and dust-proof housing. Each compressor shall be equipped with a time totaliser.

b) The compressor size shall be such that it can perform following operations satisfactorily:
i) Total running time of compressor not exceeding 45 minutes per day, considering 2% leakage and 2 CO-operations.
ii) Air charging time not exceeding 20 minutes after one CO operation of thebreaker.

c) Air Receivers**:**
i) The capacity of receivers shall be sufficient for two (2) CO operations of the breaker.
ii) Air receiver shall be designed in accordance with the latest edition of the ASME Code for Pressure Vessel - Section VIII of BS:5179. A corrosion allowance of 3.0 mm shall be provided for shell and dished ends. Receivers shall be hot dip galvanized.

d) Controls and Control Equipment**:**
i) The compressor control shall be of automatic start stop type initiated by pressure switches on the receiver. Supplementary manual control shall also be provided.
ii) All control equipment shall be housed in a totally enclosed cabinet. Pressure gauges and other indicating devices, control switches shall be mounted on the control cabinet.

iii) Facility to annunciate failure of power supply to the compressor control shall also be provided.

e) Compressed Air Piping, Valves and Fittings:

i) The flow capacity of all valves shall be at least 20% greater than the compressor capacity.

ii) The high-pressure system shall be such that after one 0 - 0.3 Sec - CO operation, the breaker shall be capable of performing one CO operation within 3 minutes.

iii) All compressed air piping shall be bright annealed, seamless phosphorous Deoxidized Non-Arsenical Copper alloy or stainless-steel pipe (C-106 of BS: 2871).

3.07.00 **TESTS : Type test**

a) 400KV GIS circuit breaker shall be type tested in accordance with the requirement stipulated under clause no 1.06.02 & 1.06.03.

b) 400KV AIS circuit breaker shall confirm to type tests as per IEC in accordance with the requirement stipulated under clause no. 1.06.02.

3.07.02 **Routine Tests**

Routine tests as per IEC on the complete breaker/ pole along with its own operating mechanism and pole column shall be performed on all circuit breakers.

3.07.03 **SITE TESTS**

All routine tests except power frequency voltage dry withstand test on breaker shall be repeated on the completely assembled breaker at site.

3.08.00 **PARAMETERS :GENERAL**

Sl.no	Description	
a)	Type of Circuit breaker	SF6 insulated
b)	No. of poles	Three(3poles)
c)	Rated operating duty cycle	O - 0.3 sec. - CO - 3min. – CO
d)	Total closing time	Not > than 150ms
e)	Reclosing	1ph & 3ph high speed auto reclosing
f)	Trip and closing coil voltage	220V DC
g)	Auxiliary contacts	As required plus10NO & 10NC contacts per breaker as spare.

3.08.02 **400kV Class Circuit Breakers (GIS)**

Sl.no	Description	
a)	Rated line charging breaking current(voltage factor of 1.4)	600A at 90deg.cen
b)	First pole to clear factor	1.3
c)	Rated break time	As per IEC

ANNEXURE-I

Requirement of Controlled Switching Device for 400KV Circuit Breaker

The circuit breaker with controlled switching as indicated in single line diagram shall meet the following requirement:

1. The Switching controlled Device shall be used to reduce increased over voltages, re ignition between circuit breaker contacts that may be caused by normal switching of high voltage circuit breakers and hence optimize the stresses on circuit breaker while switching the circuit. The switching-controlled device will be called device henceforth.
2. Circuit breaker should be able to be switched while switching controlled device is not in operation e.g., during maintenance work or power supply is not connected, a bypass shall be provided to the device. In these cases, the switching commands will then be forwarded

directly to the circuit breaker via this Bypass. The switching time will not be controlled with these switching operations.

3. The controller shall get command to operate the breakers manually or through auto re-close relay at random. The controller shall be able to analyze the current and voltage waves available through the signals from secondaries of CTs & CVTs for the purpose of calculation of optimum moment of the switching the circuit breaker and issue command to circuit breaker to operate.
4. The device should have display facility at the front for the settings and measured values, alternatively a laptop shall be supplied with each CSD to facilitate display at the front for the setting and measured values.
5. The device shall have self-monitoring facility.During the switching operations, current and voltage waveforms and other parameters shall be recorded and saved together with calculated values. The control switching device provided shall be networked to an Engineering workstation (EWS) located in the switchyard control room. It shall be possible to extract the switching oscillographic records and to do CSD parameterization from this EWS. All necessary software & hardware shall be in bidder's scope. .
6. It shall have self-monitoring facilities. Faults which impair the functioning of the device or peripheral components, failure of trip voltage or sensors shall be displayed visually and shall give alarm.
7. The device shall be designed to operate correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency as specified elsewhere in the specification.
8. The device shall have time setting resolution of 0.1 ms or better.
9. Test reports for the following type tests shall be submitted:
    a. Dielectric withstand test as per IEC 60255-27.
    b. High voltage Impulse test as per IEC 60255-27.
    c. Slow damped oscillatory wave test as per IEC60255-26
    d. Fast transient test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-4)
    e. Electrostatic Discharge test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-2)
    f. Surge Immunity test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-5)
    g. Power frequency magnetic field test as per IEC 60255-26 (class 5 installation as per base standard IEC 61000-4-8)
    h. Radiated radio frequency electromagnetic field test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-3)
    i. Conducted disturbance induced by radio frequency field as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-6)

j. Power frequency immunity test on binary input as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-16)

4.00.00 DISCONNECTOR : GENERAL

4.01.01 The isolators and accessories shall conform in general to relevant IEC 62271-102 (or equivalent Indian Standard) except to the extent explicitly modified in specification. Earth switches shall be provided on isolators as marked on SLD.

4.01.03 The isolators and earth switches shall be A. C / D.C. motor operated.

4.02.00 **DUTY REQUIREMENTS**

4.02.01 The earth switches wherever provided shall be constructional interlocked so that the earth switches can be operated only when the isolator is open and vice-versa. Mechanical Endurance : M2 type of duty as per IEC for 400kV.

4.02.02 In addition to the constructional interlock, isolator and earth switches shall have provision to prevent their electrical and manual operation unless the associated and other interlocking conditions are met. All these interlocks shall be of failsafe type.

4.02.03 The earthing switches shall be capable of discharging trapped charges of the associated lines. Isolator and earth switches shall be able to bear on the terminals the total forces including wind loading and electrodynamic forces on the attached conductor without impairing reliability or current carrying capacity.

4.03.00 **CONSTRUCTIONAL FEATURES (For GIS)**

a) The three pole/ Single pole group operated disconnectors shall be operated by electric motor suitable for use on 220 V DC ungrounded system/415V AC system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current & short circuit.

b) Disconnectors shall be designed as per relevant IEC. These shall be suitable to make and break the capacitive charging currents during their opening and closing. They shall also be able to make & break loop current which appears during transfer between bus bars. The contact shielding shall also be designed to prevent restrikes and high local stresses caused by the transient recovery voltages when these currents are interrupted.

c) The disconnecting switches shall be arranged in such a way that all the three phases operate simultaneously. All the parts of the operating mechanism shall be able to withstand starting torque of the motor mechanism without damage until the motor overload protection operates.

d) It shall be possible to operate the disconnecting switches manually by cranks or hand wheels. The contacts shall be both mechanically and electrically disconnected during the manual operation.

e) The operating mechanisms shall be complete with all necessary linkages, clamps, couplings, operating rods, support brackets and grounding devices. All the bearings shall be permanently lubricated or shall be of such a type that no lubrication or maintenance is required.

f) The opening and closing of the disconnectors shall be achieved by either local or remote control. The local operation shall be by means of a two-position control switch located in the bay module control cabinet.

g) Remote control of the disconnectors from the BCU in Relay room & switchyard control room shall be made through remote / local transfer switch.

h) The disconnector operations shall be interlocked electrically with the associated circuit breakers in such a way that the disconnector control is inoperative if the circuit breaker is closed.

i) Each disconnector shall be supplied with auxiliary switch having eight normally open and eight normally closed contacts for use by others over and above those required for disconnector operation purposes. The auxiliary switch contacts are to be continuously

adjustable such that, when required, they can be adjusted to make contact before the main switch contacts. Additionally, MBB contact as required shall also be provided.

j) The signaling of the closed position of the disconnector shall not take place unless it is certain that the movable contacts will reach a position in which the rated normal current, peak withstand current and short time withstand current can be carried safely.

k) The signaling of the open position of the disconnector shall not take place unless the movable contacts have reached such a position that the clearance between the contacts is at least 80 percent of the rated isolating distance.

l) All auxiliary switches and auxiliary circuits shall be capable of carrying a current of at least 10 A DC continuously.

m) The auxiliary switches shall be capable of breaking at least 2 A in a 220-V DC circuit with a time constant of not less than 20 milliseconds.

n) The disconnectors and safety grounding switches shall have a mechanical key (padlocking key) and electrical interlocks to prevent closing of the grounding switches when disconnector switches are in the closed position and to prevent closing of the disconnectors when the grounding switch is in the closed position.

o) The local control of the disconnector and high-speed grounding switches from the bay module control panel should be achieved from the individual control switches with the remote/local transfer switch set to local.

p) All electrical sequence interlocks will apply in both remote and local control modes.

q) Each disconnector shall have a clearly identifiable local, positively driven mechanical position indicator, together with position indicator on the bay module control cabinet and provisions for taking the signals to the power house control room. The details of the inscriptions & colouring for the indicator are given as under:

Sign	Background	Colour
Open position	Open	Green
Closed position	Closed	Red

r) All the disconnector and earth switches shall be provided with inspection window so that the travel of the switch contacts in both open and close positions can be verified by visual inspection.

s) The disconnecting switches shall be provided with rating plates and shall be accessible for inspection.

t) The disconnecting switches shall be capable of being padlocked in both the open and closed positions with the operating motor automatically disengaged. The padlocking device shall be suitable for a standard size lock with a 10mm shank. The padlock must be visible and directly lock the final output shaft of the operating mechanism. Integrally mounted lock when provided shall be equipped with a unique key for such three-phase group. Master key is not permitted.

4.04.00 SAFETY GROUNDING SWITCHES & HIGH SPEED GROUNDING SWITCHES:

a) Three-pole/ Single pole, group operated, safety grounding switches shall be operated by electric motor for use on 220V DC ungrounded system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current and short circuit.

b) In order to provide test facilities for CTs, transformers, cables etc., certain ground switches may require to be electrically insulated from the enclosures and have easily removable ground connections.

c) Each safety grounding switch shall be electrically interlocked with its associated disconnector and circuit breaker such that it can only be closed if both the circuit breaker and disconnector are in open position. Safety grounding switch shall however be mechanically key interlocked with its associated disconnector.

d) Each safety grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the bay module control cabinet and provision for taking the signal to Powerhouse Control Room.

e) The details of the inscription and colouring for the indicator are given as under:

Sign	Background	Colour

Open position	Open	Green
Closed position	Closed	Red

f) Each ground switch shall be fitted with auxiliary switches having six normally open and six normally closed contacts for use by others over and above those required for local interlocking and position indication purposes.

g) Provision shall be made for padlocking the ground switches in either the open or closed position.

h) The safety grounding switches shall conform to the requirements of IEC 62271-102

l) Mechanical position indication shall be provided locally at each switch along with remote indication at each bay module control cabinet & in the power house control room.

j) The short circuit making current rating of each ground switch shall be at least equal to its peak withstand current rating of 125KA. The switches shall have inductive / capacitive current switching capability as per IEC-62271-102.

m) The high speed grounding switches shall conform to the requirements of IEC-62271-102. The electrical duty class : E1 & Mechanical duty class : M1 as per IEC shall be provided .

n) 400KV GIS disconnector, Earth, Grounding/ safety / high speed earth switches shall be type tested in accordance with the requirement stipulated under clause no 1.06.02 & 1.06.03.

4.11.00 **PARAMETERS: General**

Sl.no	Description	
a)	Type of isolator	Metal enclosed,SF6 insulated
b)	No. of poles	Three(3poles)
c)	Rated operating time	Not > than 12sec
d)	Control voltage	220VDC
e)	Auxiliary contacts on isolator	Min.8NO & 8NC contacts per pole/isolator .
f	Auxiliary contacts on earth/ safety/grounding/high speed switch	Min.6NO & 6NC contacts per pole/isolator .
g)	Operating mechanism of isolator and earth switch	AC/DC/universal motr

5.00.00 INSTRUMENT TRANSFORMER : CODES AND STANDARDS

Current transformers	IEC 61869-2, BS: 3938, IS: 2705
Voltage transformers	IEC 60044-2&5, IEC 60358, IS: 3156
Insulating oil	IS: 335

5.01.00 GENERAL REQUIREMENTS (FOR GIS)

a) The instrument transformers i.e., current and voltage transformers shall be single phase transformer units. Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.

b) The contractor is required to submit the VA burden calculations and obtain approval from the Employer before proceeding with design of the cores. The other characteristics of CTs shall be as given below:

5.02.00 PARAMETERS AND CONSTRUCTION DETAILS (GIS)

5.02.01 GENERAL FOR CURRENT TRANSFORMER (GIS)

(a) One minute power frequency Withstand voltage between Secondary terminal and Earth is :5kV

(b)	Partial discharge level	10 pico Coulombs max.
(c)	Type of insulation	Class A
(d)	Number of cores	Details are given **in Table-I** below
(e)	Number of terminals in	All terminals of control circuits wired

	box	marshalling up to marshalling box plus 20 terminals spare.
(f)	Rated extended primary current	120% of rated primary current

5.02.02 Construction Details

a) The current transformers incorporated into the GIS will be used for protective relaying and metering. The secondary windings shall be air/gas insulated. All the current transformers shall have effective electromagnetic shields to protect against high frequency transients.

b) Each current transformer shall be equipped with a marshalling box with terminals for the secondary circuits, which are connected to the local control cubicle. The star / delta configuration and the inter connection to the line protection panels will be done at the CT terminal block located in the local control cubicle.

c) The rated extended current rating voltage and rated thermal current shall also be marked on the name plate. The diagram plate shall show the terminal markings and relative physical arrangement of the current transformer cores with respect to the primary terminals(P1 & P2)

d) The position of each primary terminal in the current transformer SF_6 gas section shall be clearly marked by two plates fixed to the enclosure at each end of the current transformer.

e) Current transformers guaranteed burdens and accuracy class are to be intended as simultaneous for all cores. The current transformers shall be suitable for high-speed auto reclosing.

f) Electromagnetic shields to be provided against high frequency transients typically 1-30 MHz.

g) Provision shall be made for primary current injection testing of current transformers.

5.03.00 BUS VOLTAGE TRANSFORMERS (GIS)

5.03.01 General

a) The voltage transformers and accessories shall conform to IEC and other relevant standards except to the extent explicitly mentioned in the specification. Voltage transformers shall be of the electromagnetic type with SF_6 gas insulation. The earth end of high voltage winding and the ends of secondary winding shall be brought out in the terminal box.The rating and diagram plate shall be provided complying with the requirement of IEC specification incorporating the year of manufacture and including turn's ratio, voltage ratio, burden, connection diagram etc.

b) The beginning and end of each secondary winding shall be wired to suitable terminals accommodated in a terminal box mounted directly on the voltage transformer section of SF6 switchgear.

c) All terminals shall be stamped or otherwise marked to correspond with the marking on the diagram plate. Provision shall be made for earthing of the secondary windings inside the terminal box.

d) The transformer shall be able to sustain full line voltage without saturation of transformer. Core details are given in **Table-II.**

5.03.02 Constructional Details

a) The voltage transformers shall be located in a separate bay module on the bus and will be connected phase-to ground and shall be used for protection, metering and synchronizing. The voltage transformers shall be of induction type, nonresistant and shall be contained in their own- SF6 compartment, separated from other parts of installation.

5.04.00 GENERAL REQUIREMENTS (For AIS)

5.04.01 The instrument Transformers i.e voltage transformers / CVT shall be single phase transformer units and shall be supplied with a common marshaling box for a set of three single phase units. All exposed mild steel shall be hot dip galvanised or painted with Grey color of shade RAL 9002.The instrument transformers shall be hermetically sealed units. The instrument transformers shall be provided with filling and drain plugs. Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.

5.04.02 The Instrument transformer shall be with Polymer Insulator. For CVT cantilever strength shall not be less than 250kg.No oil shall come into direct contact with Zinc galvanized surface.

5.05.00 VOLTAGE TRANSFORMERS (CVTs) (AIS):

5.05.01 Voltage transformers shall be of capacitor voltage divider type with electromagnetic unit.2The CVTs shall be thermally and dielectrically safe when the secondary terminals are loaded with guaranteed thermal burdens. The electro-magnetic unit (EMU) shall comprise of compensating reactor, intermediate transformer, and protective and damping devices. The oil level indicator of EMU with danger level marking shall be clearly visible to maintenance personnel standing on ground.

5.05.02 The secondaries shall be protected by HRC cartridge type fuses for all windings In addition fuses shall also be provided for protection and metering windings for connection to fuse monitoring scheme. The secondary terminals shall be terminated on stud type non-disconnecting terminal blocks via the fuse inside the terminal box of degree of protection IP: 55. The access to secondary terminals shall be without the danger of access to high voltage circuit. The protection cores shall not saturate at about 1.5 times the rated voltage for a min. duration of 30 secs.

5.06.00 MARSHALLING BOX : Marshaling box shall conform to all requirements as given in part auxiliary. The wiring diagram for the interconnection of three phase instrument transformer shall be pasted inside the box. Terminal blocks in the marshaling box shall have facility for star/delta formation, short circuiting and grounding of secondary terminals. The box shall have enough terminals to wire all control circuits plus 20 spare terminals

5.07.00 **PARAMETERS FOR VOLTAGE TRANSFORMERS (For AIS): General Parameters**

Sl.no	Description	
a)	Standard reference range of frequencies	96% to 102% for protection. 99% to 101% for measurement
b)	High frequency .capacitance	With in 80% to 150%
c)	Equivalent resistance over entire carrier frequency range	<40 ohms
d)	One min.power frequency with stand voltage (B/W LV(HF) terminal	10KV rms & earth for exposed terminals or 4kV rms for terminals enclosed in weather proof box
e)	No of terminals in cabinet mFor secondary winding	Required , plus 10nos spare.
f	Rated thermal burden	750VA.
g)	Partial discharge	Max.10 pico coulombs
h)	Rated voltage factor	1.2continuous, 1.5 for 30sec
i)	No of cores	As per details given I Table-II below
j	CVT HF capacitance	4400/8800pf (as required)

5.0.04 **TESTS**

a) 400KV GIS Instrument transformer shall be type tested in accordance with the requirement stipulated under clause no 1.06.02 & 1.06.03.

b) The voltage transformers (For AIS) shall confirm to type tests and subjected to routine tests in accordance with the relevant IEC/IS and shall also conform to the following additional type tests as applicable:

i) Radio Interference and Corona test
ii) Seismic withstand test along with structure (for 400kV only)

iii) Thermal co-efficient test i.e. measurement of Tan-Delta as function of temperature (at ambient and between 80 deg. C and 90 deg. C) and voltage (at 0.3, 0.7, 1.0 and 1.1 Um).(for CT only)

iv) Multiple chopped impulse test on Primary winding.

TABLE-I

CORE DETAILS OF 400kV CTs-Protection (GIS) CT-A

Following details shall be applicable for all protection class CT cores.
The rated extended primary current of the CTs shall be 120% continuous of 3000A.

CT No.	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	3000/ 2000/ 1000/1	-----	PS	6000/4000/ 2000	15/ 10/ 5 Ohm	20/ 30/ 60
2	3000/ 2000/ 1000/ 500/1 , BCU & Synchronising.	20/0/20/20/20	0.2S		-----	-----

Physical arrangement of CTs shall be as per Protection SLD.

CORE DETAILS OF 400kV CTs-Protection (GIS) CT-B

Following details shall be applicable for all protection class CT cores.
The rated extended primary current of the CTs shall be 120% continuous of 3000A.

CT No.	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	3000/ 2000/ 1000/1	-----	PS	6000/4000/ 2000	15/ 10/ 5 Ohm	20/ 30/ 60

Physical arrangement of CTs shall be as per Protection SLD.

CORE DETAILS OF 400kV CTs-Protection (GIS) CT-C(ST / GT/ Busreactor)

Following details shall be applicable for all protection class CT cores.
The rated extended primary current of the CTs shall be 120% continuous of 3000A.

CT No.	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	3000/ 2000/ 1000/ 500/1 , (EM)	20/0/20/20/20	0.2S			

Physical arrangement of CTs shall be as per Protection SLD.

CORE DETAILS OF 400kV CTs-Protection (GIS) CT-C (Line Side)

Following details shall be applicable for all protection class CT cores.
The rated extended primary current of the CTs shall be 120% continuous of 3000A.

CT No.	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	3000/ 2000/ 1000/1 (Main#1)	-----	PS	6000/4000/ 2000	15/ 10/ 5 Ohm	20/ 30/ 60
2	3000/ 2000/ 1000/1 (Main#1)	-----	PS	6000/4000/ 2000	15/ 10/ 5 Ohm	20/ 30/ 60
3	3000/ 2000/ 1000/ 500/1 ABT Metering (EM), PMU	20/0/20/20/20	0.2S		-----	-----
4	3000/ 2000/ 1000/ 500/1 ABT Metering (EM-Main, Check)	20/0/20/20/20	0.2S		-----	-----

Physical arrangement of CTs shall be as per Protection SLD.

CORE DETAILS OF 400kV VT(GIS) & 400KV CVT — **TABLE – II**

Secondary Core	Application	Rated Secondary Voltage (V)	Accuracy	Output Burden – Minimum
I	Protection	110/v3	3P	75 VA
II	Protection	110/v3	3P	75 VA
III	Metering	110/v3	0.2	75 VA
IV	Metering	110/v3	0.2	75VA (Additional core#IV for AIS CVT only)

The accuracy of 0.2 on secondary III should be maintained through the entire burden range up to total simultaneous burden 150 VA on all the three windings without any adjustments during operation.

* This is minimum burden specified, however bidder to consider VA burden to suit the requirement of the offered system. The supporting calculation to be furnished during detail engineering.

6.00.00 SURGE ARRESTOR

6.01.00 **GENERAL : T**he surge arrestors shall conform in general to IEC-60099-4 and IS:3070 / IS:15086(part-4) except to the extent modified in the specification.

6.01.01 Arrestors shall be hermetically sealed single phase units, self-supporting construction, suitable for mounting on lattice/tubular type support structures.

6.02.00 **DUTY REQUIREMENTS**

6.02.01 The Surge Arresters (SAs) shall be capable of discharging over-voltages occurring due to switching of unloaded transformers, reactors and long lines. The reference current of SAs shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage. The SAs shall be capable of withstanding meteorological and short circuit forces under site conditions.

6.03.00 **CONSTRUCTIONAL FEATURES (FOR AIS)**

6.03.01 The non linear blocks shall be sintered metal oxide material. The SA construction shall be robust with excellent mechanical and electrical properties. SAs shall have pressure relief devices suitable for preventing violent failure of insulator housing and providing path for flow of rated fault currents in the event of arrester failure.

6.03.02 Outer insulator of Surge arrestor shall be of Polymer type. The SA shall not fail due to polymer contamination. Polymer housing shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage up to maximum design value for SA. The cantilever strength of the surge arrestor shall be minimum 500kg for 400kV and above voltage class system.

6.03.03 The end fittings shall be made of corrosion proof material and preferably be non-magnetic. The sealing arrangement of the Surge Arrester stacks shall be done incorporating grooved flanges with O-rings/elliptical cross section gasket of Neoprene or Butyl rubber.

6.04.00 **CONSTRUCTIONAL FEATURES FOR GAS INSULATED SURGE ARRESTOR**

a) It will be SF6 gas insulated, metal enclosed surge arrestor of the gapless nonlinear zinc oxide, heavy duty, station type. The arrestor enclosure shall be vertically or horizontally mounted to suit the layout of the switchgear and shall be fitted with a discharge counter located in an easily accessible position.

b) The main grounding connection from the surge arrestor to the earth shall be provided by the Contractor. The size of the connecting conductor shall be such that all the energy is dissipated to the ground without getting overheated.

6.05.00 **FITTINGS AND ACCESSORIES FOR AIS**

6.05.01 Each SA shall be complete with insulating base for mounting on structure. SAs shall be provided with grading and/or corona rings as required.

6.05.02 i)Self-contained discharge counters, suitably enclosed for outdoor use (with Min.IP:56 degree of protection) and requiring no auxiliary or battery supply shall be fitted with each SA along with necessary connections to SA and earth. Suitable leakage current meters shall also be supplied in the same enclosure. The reading of milliammeter and counter shall be visible through an inspection glass panel to a man standing on ground. A pressure relief vent/suitable provision shall be made to prevent pressure build up.

ii)The surge counter shall be provided with a potential free contact which shall close whenever a surge is recorded by the surge monitor. Necessary arrangement shall be provided for extending the contact information to substation Automation system.

iii) Insulated copper conductor of adequate size and length shall be used for connecting discharge counter terminal and lightning arrester earth terminal. Insulation level of the conductor shall not be less than 5 kV.

Suitably sized bypass copper shunts shall be provided for bypassing the discharge counter for removal / maintenance of the counter.

iv) (Note: Optional) : Surge monitor comprising a digital type counter, leakage current detector shall be provided for each arrester and the same shall be mounted at eye level height to facilitate easy reading of the counter and leakage current detectors. Necessary arrangement shall be provided for extending the reading of surge counter, leakage current indication in the SAS.

6.06.00 **PARAMETERS: General (400kV)**

Sl.no	Description	
a)	Nominal discharge current	20kA of 8/20 microsec.wave

b)	Long duration discharge class	3 or 4
c)	Current for pressure relief test	63kA rms
d)	Prospective symmetrical fault current	63kA rms
e)	Low current duration test value	As per IEC.
f	Partial discharge at 1.05MCOV	Not >than 50pc

(The arrestor voltage / rating shall be as per the study of insulation co-ordination)

The surge arrestors are provided to protect the following equipment whose insulation levels are indicated in the **Table** I given below. The contractor shall carry out the insulation coordination studies for deciding the location of the surge arrestors.

TABLE-1

Sl.no	Equipment to be Protected	Lightning impulse(kVp)	Switching impulse(kVp)
a)	Power Transformer	± 1425	± 1050
b)	Instrument Transformer	± 1425	± 1050
c)	Reactor	± 1300	± 1050
d)	CB/isolator (Ph to ground)	± 1425	± 1050
	Across open contacts	± 1425(± 240)	± 900(± 340)

Surge arrestors shall be capable of discharge on severe re-energisation switching surges on a 400 kV line upto 450 km. length with surge impedance of 300 ohms and capacitance of 11.986 nF/km amd over voltage factor of 2.3 p.u. Surge arrestor shall be capable of discharging energy equivalent to class 3 or 4 of IEC for a 420 kV system on two successive operations followed immediately by 50 Hz energization.

6.07.00 **TESTS**

6.07.01 Surge arrestor (GIS) shall be type tested in accordance with clause no. 1.06.02 & 1.06.03. Surge arrestors (AIS) shall confirm to all type tests (as applicable) as per IEC 60099-4 and shall be subjected to routine and acceptance tests in accordance with IEC-60099-4. The resistive current drawn by the arrestor for at rated voltage shall be indicated in the routine test report.

7.00.00 POST INSULATOR

7.01.00 **GENERAL :**The post insulators shall conform in general to latest IS: 2544 and IEC – 60815, 60168.

7.02.00 **CONSTRUCTIONAL FEATURES**

7.02.01 Post type insulators shall consist of a porcelain / Polymer part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators shall be accepted. Height of post insulator shall be preferably as given under parameters of this part. The other requirements of insulator as given under auxiliary requirements shall also be applicable.

7.03.00 **TESTS**

7.03.01 In accordance with the stipulations elsewhere the post insulators shall conform to type tests and acceptance, sample and routine tests as per IS: 2544, IEC-60168 shall be carried out.

7.03.02 In addition to acceptance/sample/routine tests as per IS: 2544, IEC-60168, the following tests shall also be carried out.

a) Ultrasonic tests on all cut shells as routine check.
b) Visual examination and magna flux test on all flanges prior to fixing.

c) Check for uniformity of thickness and weight of zinc coating as a sample test from each lot of flanges prior to fixing.
d) Bending load test shall be carried out at 50% minimum failing load in four directions as a routine test.
e) Bending load in four directions at 100% minimum bending load guaranteed on samples as per clause-2.3 of IEC. Subsequently this post insulator shall not be used.
f) Tests for deflection measurement at 20, 50, 70% of specified minimum failing load on sample.

7.04.00 **PARAMETERS**

7.04.01 400 kV class Post Insulators

Sl.no	Description	
a)	Type	Solid core
b)	Dry and wet one min.power frequency voltage	680kV rms
c)	Dry impulse withstand positive and negative(kVp)	1550rms
d)	Wet switching surge withstand (kVp)	1175 rms
e)	Total min.cantilever strength(kg)	800
f	Min. torsional moment(kg- m)	600
g	Total height of insulator(mm)	3650

Note: If corona extinction voltage is to be achieved with the help of corona ring or any other similar device, the same shall be deemed to be included in the scope of the bidder without any price implication.

8.00.00 WAVE TRAP : GENERAL:

The Wave Trap covered under the package shall conform to IEC 353 or IS:8792, IS:8793 and relevant IEC/IS Specifications except to the extent modified by the specification.

8.01.00 **LOCATION OF EQUIPMENT :**

8.01.01 Wave Traps as specified under this section shall be installed at the respective transmission line bays as indicated in single line diagram.

8.02.00 **TECHNICAL REQUIREMENTS**

8.02.01 Wave Trap shall be inserted into high voltage transmission line to prevent undue loss of carrier signal for all power system conditions. Its impedance shall be negligible at power frequency (50 Hz) so as not to disturb power transmission but shall be relatively high over the frequency band appropriate to carrier transmission.

8.02.02 Wave trap shall consist of a main coil designed to carry continuously the rated current without exceeding the limit of temperature rise. It shall be supplemented with a protective device and tuning device. Wave trap shall be Broad Band tuned for its entire carrier frequency range. Resistive component of impedance of the Wave trap within its carrier frequency blocking range shall not be less than 570 ohms.

8.02.03 Wave trap shall be provided with a protective device in the form of lightning arrestor which shall be designed and arranged such that neither significant alternation in its protective function nor physical damage shall result from either temperature rise or the magnetic field of the main coil at continuous rated current or rated short time current The protective device shall be shunt connected to the main coil and tuning device. The lightning arrestor provided shall have a rated discharge current of 10 kA. Coordination, however, shall be done by taking 20 kA discharge current into account.

8.02.04 The lightning arrestor provided with the Wave trap of each rating shall fully comply with the requirements of IS-3070-Part-I (1974)/IEC-60099. It shall conform to type tests as applicable and type test certificate for the same shall be submitted by the Bidder.

8.02.05 The lightning arrester provided with the Wave trap shall be subject to routine and acceptance tests as per IEC – 60099. The Wave trap on 400 kV lines shall show no visual corona at extinction voltage of 320 kV rms. Suitable corona rings shall be incorporated in the line trap for 400 kV. Wave trap shall be equipped with bird barriers.

8.02.06 Wave trap shall preferably be spray painted with light admiralty Grey paint (shade 697 of IS-5) or may have its natural epoxy colour.

8.02.07 Wave trap shall conform to IEC - 60353 fulfilling the following technical particulars.

Sl.no	Description	
a)	Nominal discharge current of protective device	10kA
b)	Type of tunning	Broad band
c)	Rated Blocking band width	90-500KHZ
d)	inductance	1.0 mH / 0.5 mH
e)	Radio intergerence voltage level at 266kVTotal min.cantilever strength(kg)	Not > than500micro volts

8.02.08 In accordance with the requirements stipulated elsewhere, the Wave Trap shall confirm to following type tests and shall be subjected to routine and acceptance tests as per IEC-60353.

a) Measurement of inductance of the main coil
b) Measurement of temperature rise
c) Insulation tests
d) Short time current tests
e) Corona Extinction Voltage Measurement
f) Radio Interference Voltage measurement

8.03.00 **WAVE TRAP MOUNTING**

8.03.01 The Wave Trap for 400kV shall be suitable for outdoor pedestal mounting and shall be mechanically strong enough to withstand the stresses due to maximum wind pressure of 195 kg/square meter. For pedestal mounting, each Wave trap shall be mounted on a lattice structure formed by three solid core type insulators.

9.00.00 REQUIREMENT OF AUXILIARY ITEMS

9.01.00 **ALUMINIUM TUBULAR CONDUCTOR**

9.01.01 The aluminium tube shall be grade 63401 WP (range2) as per IS 5082.There shall be no negative tolerance on OD and thickness of the tube. Other tolerances shall be as per IS:2678 and 2673.

9.01.02 Tests: In accordance with stipulations of specification routine tests shall be conducted on tubular conductor as per IS:5082. Also, the wall thickness and ovality shall be measured by ultrasonic method. In addition, 0.2% proof tests on both parent material and aluminium tube after welding shall be conducted.

a)	size	4”IPS(EH Type)
b)	Outer diameter	114.20mm with no negative tolerance
c)	Thickness of tube	8.51 mm with no negative tolerance
d)	Cross-sectional area	2825.61 sq. mm.
e)	weight	7.7kg/m

9.02.00 **ACSR CONDUCTOR**

a)	Code and standard & Name	IS:398, MOOSE ACSR
b)	Overall diameter	31.77mm

c)	Strands and wire diameter of	
	a) Aluminium	54/3.53mm
	b)steel	7/3.53mm

9.03.00 **CLAMPS AND CONNECTORS**

9.03.01 The material of clamps and connectors shall be Aluminium alloy casting conforming to designation A6 of IS:617 for connecting to equipment terminals and conductors of aluminium. In case equipment terminals are of copper, the same clamps/connectors shall be used with 2mm thick bimetal.

9.03.02 The material of clamps and connectors shall be Galvanised mild steel for connecting to G.S. shield wire.

9.04.00 **INSULATOR STRING HARDWARE**

9.04.01 The insulator hardware shall be of bolted type and shall be of forged steel except for insulator cap, which can be of malleable cast iron. It shall also generally meet the requirements of clamps and connectors as specified above. In one span, Tension string assembly at one end shall be supplied with suitable turn buckle.

9.04.02 Disc Insulator for porcelain type insulator

The disc insulator shall meet the following parameters:

a)	Type	Antifog type insulator
b)	Size of insulator	255X145
c)	Electro mechanical strength	120KN
d)	Leakage distance(mm)	Min.430 or as required to meet the total creepage
e)	Power frequency voltage- dry & wet	80kV, 50kV

9.04.03 Insulator string (400KV) **: Porcelain type / composite long rod type)**

a)	Creepage distance size	Min.13020mm
b)	One Minute Power frequency voltage	680KV
c)	Lightning impulse	+/- 1550 KV
d)	Switching impulse	+/- 1050 KV
e)	No of disc.insulator (for porcelain)	25nos
f)	Eelctromechanical strength	120KN (porcelain)

9.05.00 **SPACERS :** Spacers shall conform to IS:10162. They shall be of non-magnetic material except nuts and bolts, which shall be of hot dip galvanised mild steel.

9.05.01 Spacers shall generally meet the requirements of clamps and connectors as specified above. Its design shall take care of fixing and removing during installation and maintenance.

9.05.02 In addition to the type tests as per IS:10162, clamp slip test should have been conducted. In this test the sample shall be installed on test span of twin/quad bundle string at a tension of 44.2 kN (4500 kg). One of the clamps when subjected to a longitudinal pull of 2.5 kN (250 kg) parallel to the axis of conductor shall not slip, i.e. permanent displacement between conductor and clamp after the test shall not exceed 1.0 mm. This test should have been performed on all other clamps of the sample.

9.06.00 **EARTHING CONDUCTOR**

a) The main conductor buried in earth shall be 40mm dia rod for main and auxiliary mat. The earthing conductors over the ground shall be of 75x12 mm GS flat. The earthing leads for columns and auxiliary structures, cable trenches shall be of 75x12 mm GS flat. The earthing of the lighting fixtures shall be carried out by 16 SWG wire.

b) All earthing conductors above the ground level shall be galvanised steel only.

9.07.00 **Earthwire for Lightning Protection**

a) Number of strands 7 of steel

	b) Strand diameter	3.66 mm
	c) Overall diameter	10.98 mm
	d) Weight	583 kg/km approx.
	e) Ultimate tensile strength	68.4 kN minimum
	f) Total cross-sectional area	73.65 sq.mm.
	g) Calculated d.c. resistance	2.5 ohms/km at 20 deg.C.
	h) Direction of lay of outer layer	Right hand

9.08.00 **BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS, AND DISC INSULATORS**

9.08.01 Bushings shall be manufactured and tested in accordance with IS:2099 & IEC:60137 while hollow column insulators shall be manufactured and tested in accordance with IEC 62155/IS 5284. The support insulators shall be manufactured and tested as per IS:2544 / IEC 60168/IEC 60273. The insulators shall also conform to IEC 60815 as applicable having alternate long and short sheds.

Support insulators/ bushings/ hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

9.09.00 **CABINETS, BOXES, KIOSKS, PANELS, ETC.**

9.09.01 All types of control cabinets, junction boxes, marshaling boxes, lighting panels, terminal boxes, operating mechanism boxes, Kiosks etc. shall generally conform to IS:5039, IS:8623 and IEC: 60439 as applicable. They shall meet all other requirements specified elsewhere in the specification.

9.10.00 **BAY MARSHALLING BOX**

9.10.01 Bay Marshaling Box located at a convenient location to receive and distribute cables shall be provided as required. It shall meet all the requirements as specified for cabinets/boxes.

9.10.02 It shall have three separate distinct compartments for following purposes:

- To receive two incoming 415V, three phase, AC supplies controlled by 100A four pole MCBs with auto changeover provision, and to distribute five (5) three phase ac supplies controlled by 32A four pole MCBs. It shall also be provided with 63A, 3 phase 4 pin industrial grade receptacle with rotary switch.
- To receive three phase incoming from first compartment and to distribute ten (10) single phase ac supplies controlled by 16A two pole MCBs.
- 150 nos. terminal blocks in vertical formation for interlocking facility.

9.11.00 **Type tests**

All equipment with their terminal connectors, control cabinets, main protective relays, etc. as well as insulators, insulator strings with hardwares, clamps and connectors, marshalling boxes, etc., shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with the requirements stipulated under respective equipment sections.

10.00.00 INSTALLATION

10.01.00 **EARTHING:** The earthing shall be done in accordance with requirements given in **Annexure-II** of this section and drawing enclosed with the specifications. Earthing of panels shall be done in line with the requirements given in respective equipment section of this specification.

10.02.00 **CIVIL WORKS :**The civil works shall be done in accordance with requirements stipulated elsewhere in the specification.

10.03.00 **STRUCTURAL STEEL WORKS :**The structural steel works shall be done in accordance with requirements stipulated elsewhere in the specification.

10.04.00 **LIGHTNING PROTECTION**

10.05.01 Direct stroke lightning protection (DSLP) shall be provided in the switchyard by lightning masts (at least 50 m high) and shield wires.

10.05.02 Lightning protection System down conductors shall not be connected to other conductors above ground level. Also no intermediate earthing connection shall be made to Surge arrester, Voltage Transformer, earthing leads for which shall be directly connected to rod electrode.Every down conductor shall be provided with a test joint at about 150mm above ground level. The test joint shall be directly connected to the earthing system. The lightning protection system shall not be in direct contact with underground metallic service ducts and cables.

10.06.00 **EQUIPMENT ERECTION NOTES**

a) All support insulators, circuit breaker interrupters and other fragile equipment shall be handled with cranes with suitable booms and handling capacity. The contractor shall strictly follow manufacturer's recommendations for handling and erection of equipment.

b) The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc. Handling equipment, sling ropes etc. should be tested before erection and periodically thereafter for strength.

c) Bending of piping should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced. The pipes shall be thoroughly cleaned before installation.

10.07.00 **CABLING**

10.07.01 Cabling shall be on cable racks, in trenches, vertical shafts, excavated trenches for direct burial, pulled through pipes and conduits run clamped on steel structures etc. in accordance with the requirements specified elsewhere in the specification.

10.07.02 Cables inside the switchyard shall be laid on bolted GI angle supports at 600mm spacing with separate tiers for control and power cables. The GI angles shall be bolted / welded to galvanized insert plates inside RCC trenches.

10.07.03 Cabling in the control room shall be done on ladder type cable trays with supports at an interval of 2000mm.All interpole cables (both power & control circuit) for equipments shall be laid in cable trenches/G.I. Conduit Pipe of NB 50/100mm which shall be buried in the ground at a depth of 300mm.

ANNEXURE-II

a) EARTHING NOTES FOR SWITCHYARD
GENERAL

i) Earthing of operating boxes, cubicles shall be done by 50 X 6 mm GS flat while cable trenches and structure by 75 X 12 mm GS flat. Neutral points of systems of different voltages, metallic enclosures and frame works associated with all current carrying equipments and extraneous metal works associated with electric system shall be connected to a single earthing system unless stipulated otherwise.i. Earthing system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, relevant Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.

b) EARTHING OF GIS

i) The grounding system shall be designed and provided as per IEEE-80-2000 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-mechanical interferences.

ii.) The GIS contractor shall define clearly what constitutes the main grounding bus of the GIS. The GIS contractor must supply, commission the entire grounding work of GIS viz conductor, clamps, joints, bimetallic strips (for connection between different type of earthing materials), operating and safety platforms etc.

iii.) The enclosure of the GIS shall be grounded at several points so that there shall be grounded cage around all the live parts. A minimum of two nos. of grounding connections should be provided for each of circuit breaker, transformer terminals, cable terminals, surge arrestors, earth switches and at each end of the bus bars. The grounding continuity between each enclosure shall be effectively interconnected with links or straps to bridge the flanges. Subassembly-to-subassembly bonding shall be provided to provide gap & safe voltage gradients between all intentionally grounded parts of the GIS assembly & between those parts and the main grounding bus of the GIS.

iv) The enclosure grounding system shall be designed to minimize circulating currents and to ensure that the potential rise is kept to an acceptable level. Each marshalling box, local control panel, power and control cable sheaths and other non-current carrying metallic structures shall be connected to the grounding system of GIS via connections that are separated from GIS enclosures.

v) The contractor shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents caused by lightning strikes, operation of surge arrester, phase/earth fault and discharges between contracts during switching operation. The grounding system shall ensure safe touch & step voltages in all the enclosures. The contractor shall provide suitable barrier of non-liner resistor/counter discontinued SF6/Transformer and SF6/ HV cable bushing etc. to mitigate transient enclosure voltage.

c) DETAILS OF EARTHING SYSTEM

Item	Size	Material
Main Earthing conductor	40mm dia rod	Mild steel
Conductor above ground & earthing leads (for equipment)	75 x 12 G.S. Flat 50 x 6	Galvanized steel Galvanised steel
Rod Electrode	:40mm dia, 3000mm	Mild steel
G.I. Earth wire	:7/8 SWG	GI
Copper Flat (if required)	as per requirement	

d) For Step and Touch Potential the following parameters shall be considered
i) Current distribution factor – 1 (one)
ii) Duration of fault current – 0.5 sec
iii) Human body weight – 50kg

e) Grid resistance shall be less than 1(one) ohm.

f) **EARTHING CONDUCTOR LAYOUT**

i. Earthing conductors in outdoor areas shall be buried at least 600mm below finished grade level unless stated otherwise.

ii. Minimum 6000mm or higher spacing between rod electrodes shall be provided based on the earth mat design calculations.

iii. Wherever earthing conductors cross cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid at least 300mm below them and shall be re-routed in case it fouls with equipment/structure foundations.

iv. Earthing conductor along their run-on cable trench ladder columns, beams, walls, etc. shall be supported by suitable welding/cleating at intervals of 750mm. Wherever it passes through walls, floors etc. galvanized iron sleeves shall be provided for the passage of the conductor. Both ends of the sleeves shall be sealed to prevent the passage of water through the sleeves.

v. Earthing conductor around the building shall be buried in earth at a minimum distance of 1500mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500mm away from such location.

vi. In outdoor areas, tap connections shall be brought 300mm above ground level for making connections in future in case equipment is not available at the time of grid installations.

vii. Earthing conductors crossing the road shall be either installed in Hume pipes or laid at greater depth to suit the site conditions.

viii. Earthing conductors embedded in the concrete fibre shall have approximately 50mm concrete cover.

ix. Contractor shall also provide interconnection (two interconnection per Unit) of Switchyard Earth mat with the Plant earth mat.

g) **EQUIPMENT AND STRUCTURE EARTHING**

i. The connection between earthing pads and the earthing grid shall be made by short and direct earthing leads free from kinks and splices.

ii. Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval

iii. Metallic conduits shall not be used as earth continuity conductor.

iv. A separate earthing conductor shall be provided for earthing lighting fixtures, lighting poles, receptacles, switches, junction boxes, lighting conduits, etc.

v. Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam, conduits, etc. and steel reinforcement in concrete it shall be bonded to the same.

vi. Cable and cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running along with the supply cable which, in turn, shall be connected to earthing grid conductor at minimum two points, whether specifically shown or not.

vii. Railway tracks within switchyard area shall be bonded across fish plates and connected to earthing grid at several locations.

viii. Earthing conductor shall be buried 2000mm outside the switchyard fence. Every post of the fence and gates shall be connected to earthing loop by one lead.

ix. Flexible earthing connectors shall be provided where flexible conduits are connected to rigid conduits to ensure continuity.

h) **JOINTING: shall be as per enclosed drawing equipment earthing standard drawing details shown in this specification.**

i) **POWER CABLE EARTHING**

Metallic sheaths and armour of all multi core power cables shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only.

j) **SPECIFIC REQUIREMENT FOR EARTHING SYSTEMS**

i. Earthing terminal of each surge arrester, capacitor voltage transformer and lightning down conductors shall be directly connected to rod electrode which in turn, shall be connected to station earthing grid.

ii. Auxilliary earthing mat of 1500mm X 1500mm size comprising of closely spaced conductors at (300mm x 300mm) spacing and at 300mm below ground shall be provided below the operating handles of the isolators. Operating handle shall be directly connected to earthing mat.

k) **SPECIFIC REQUIREMENTS FOR LIGHTNING PROTECTION SYSTEM**

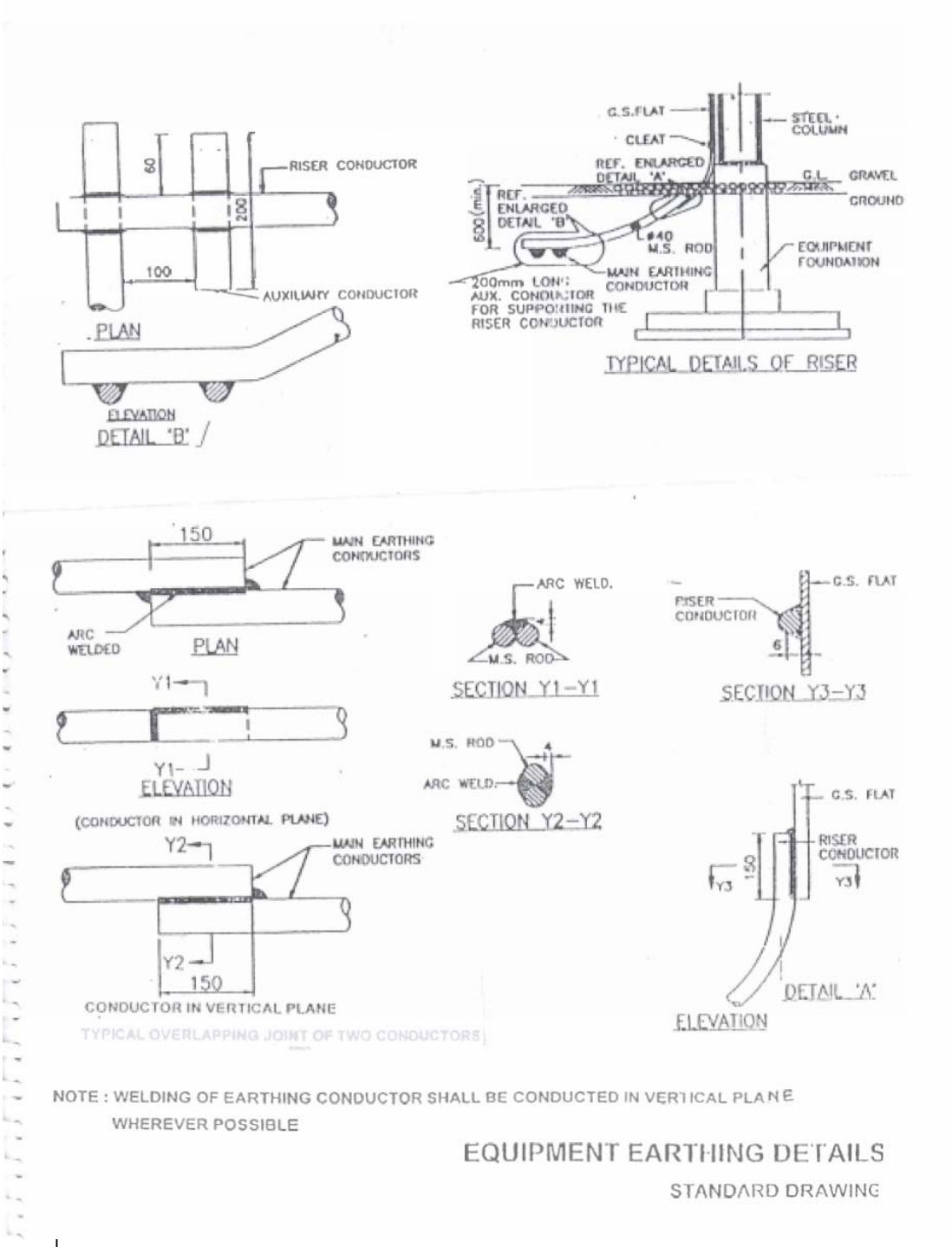
i. Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.

ii. Down conductors shall be cleated on the structures at 2000mm interval.

iii. Connection between each down conductor and rod electrodes shall be made via test joint located approximately 150mm above ground level.

iv. Lightning conductors shall not pass through or run inside G.I. conduits.

v. Lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.



11.00.00 SITE TESTING AND COMMISSIONING

11.01.00 **INTRODUCTION**

An indicative list of tests for AIS and GIS as applicable is given below. Contractor shall perform any additional test based on specialties of the items as per the field QP/ instructions of the equipment supplier or Employer without any extra cost to the Employer.

The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall get the list of instruments approved from the Employer.

11.02.00 **GENERAL CHECKS**

a) Check for physical damage.
b) Visual examination of zinc coating/ plating
c) Check from name plate that all items are as per older/ specification.
d) check tightness of all bolts, clamps and connecting terminals using toque wrenches.
e) For oil filled equipment check for oil leakage, if any. Also check oil level and top up.
f) Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanized surfaces.
g) Check cleanliness of insulator and bushings.
h) All checks and tests specified by the manufactures in their drawings and manuals as well as all tests specified in the relevant code of erection.
i) Check for surface finish of grading rings (corona control ring.)
j) Pressure test on all pneumatic lines at 1.5 times the rated pressure shall be conducted.

11.03.00 **CIRCUIT BREAKERS**

a) Insulation resistance of each pole.
b) Check adjustments, if any, suggested by manufacturer.
c) Breaker closing and tripping time.
d) Slow and power closing operation and opening
e) Trip free and anti-pumping operation.
f) Minimum pick-up volts of coils
g) Contact resistance
h) Functional checking of compressed air plant and all accessories
i) Functional checking of control circuits, interlocks, tripping through protective relays and auto-reclose operation.
j) Insulation resistance of control circuits, motor etc.
k) Resistance of closing and tripping coils.

11.04.00 **ISOLATORS**

a) Insulation resistance of each pole
b) Manual and electrical operation on interlocks
c) Insulation resistance of control circuits and motors.
d) Ground connections
e) Contact resistance
f) Proper alignment to minimise the vibration to the extreme possible during operation.
g) Measurement of operating torque for isolator and Earth switch
h) Resistance of operating and interlocking coils.

11.05.00 **CURRENT TRANSFORMERS**

a) Insulation Resistance Test
b) Polarity test.
c)Ratio identification test-checking of all ratios on all cores by primary injection of current.
d) Dielectric test of oil (wherever applicable).
e) Magnetizing characteristics test.
f) Capacitance and tan delta measurement at minimum 10kV.

11.06.00 **VOLTAGE TRANSFORMERS/CAPACITOR VOLTAGE TRANSFOREMER**

a) Insulation resistance test.
b) Polarity test.
c) Ratio test.
d) Dielectric test of oil (if applicable).
e) Capacitance and tan delta measurement at minimum 10kV.

11.07.00 **SURGE ARRESTER**

a) Grading leakage current.
b) Resistance of ground connection.
c) Resistive current drawn at rated voltage after energisation.

11.08.00 **PHASING OUT**

The phasing out of all supplies in the station system shall be carried out.

11.09.00 **STATION EARTHING**

a) Check soil resistivity
b) Check continuity of grid wires
c) Check earth resistance of the entire grid as well as various sections of the same.
d) Check for weld joint and application of zinc rich paint on galvanised surface.
e) Dip test on earth conductor prior to use.

11.10.00 **CONDUCTOR STRINGING AND POWER CONNECTORS**

a) Physical check for finish
b) Electrical clearance check
c) Testing of torque by torque-by-torque wrenches on all bus power connectors and other accessories.
d) Sag and tension check on conductors.

11.11.00 **INSULATORS**

Visual examination for finish damage, creepage distance, etc.

11.12.00 **WAVE TRAP**

a) Insulation resistance Test
b) Visual check

12.00.00 33kV System : GENERAL INFORMATION

In addition to the scope of work given in part-A of this specification, the following is the scope of work for associated 33kV overhead Transmission line . Contractor shall design the 33 KV line termination arrangement with Isolators, and surge arrestors.

12.01.00 Exposed live parts shall be placed high enough above ground to meet the requirements of Indian Electricity Rules and other statutory codes. All responsibilities regarding co-ordination with Electric Inspection agencies and obtaining clearance certificate from them, rests with the contractor.

12.02.00 The minimum phase to earth, phase to phase and section clearance for 33kV system are given below:

a)	**Phase to earth**	**320mm**
b)	**Phase to phase**	**400mm**
c)	**Sectional clearance**	**2800mm**

Parameters of 33kV System:

Rated Voltage	33kV
Highest system voltage	36kV
Impulse withstand voltage(Dry & Wet)	:± 170 kVp
Power frequency with stand voltage(wet)	70kV(rms)
Total creepage distance	31mm/kV, very Heavy
Rated short circuit current	25kA(rms) (for 3sec)

12.03.00 All equipment shall be supplied with suitable terminal connectors. The terminal connected shall be well coordinated with the type/size of conductor and equipment to be connected. The conductor terminations for equipment shall be either rigid or expansion type suitable for tube or horizontal or vertical take off suitable for conductor used.

13.00.00 33 KV SWITCH ISOLATORS

13.01.00 **GENERAL**

13.01.01 The isolators and accessories shall conform in general to IEC600129 / IS 9921 except to the extent explicitly modified in specification. Earth switches shall be provided on isolators wherever called for. The isolators and earth switches shall be manually operated type.

13.02.00 DUTY REQUIREMENTS

13.02.01 Isolators and earth switches shall be capable of withstanding the dynamic and thermal effects of the maximum possible short circuit current of the system in their closed position. They shall be constructed such that they do not open under influence of short circuit current and wind pressure together. The earth switches wherever provided shall be constructional interlocked so that the earth switches can be operated only when the isolator is open and vice-versa. The earthing switches shall be capable of discharging trapped charges of the associated lines.

13.02.02 The isolator shall be capable for making / breaking normal currents when no significant change in voltage occurs across the terminals of each pole of the isolator on account to making / breaking operation.

13.03.00 CONSTRUCTIONAL FEATURES

13.03.01 The isolators shall be provided with high pressure current carrying contacts on the hinge/ jaw ends and all contact surface shall be silver plated. The thickness of silver plating should not be less than 25 microns. The contacts shall be accurately machined and self aligned.The isolator shall be provided with a galvanized steel base provided with holes and designed for mounting on a four pole structure with rail pole by mounting suitable channels and angles. The base shall be rigid and self supporting. The position of movable contact system (main blades) of each of the isolator and earthing switch shall be indicated by a mechanical indicator at the lower end of the vertical rod of shaft for the isolator and earthling switch. The indicator shall be of metal and shall be visible from operating level.

13.03.02 All metal parts shall be of non-rusting and non-corroding metal. Current carrying parts shall be from high conductivity electrolytic copper/aluminium Keys or equivalent locking facilities, if provided on current carrying parts, shall be made of copper silicon alloy or equivalent. The bolts or pins used in current carrying parts shall be made of copper silicon alloy or equivalent.

13.03.03 The isolators shall be so constructed that the switch blade will not fall to the closed position if the operation shaft gets disconnected. Isolators and earthling switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by gravity, wind pressure, vibrations shocks or accidental touching of the connecting rods of the operating mechanism. The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals. The insulator of the isolator shall have a min. cantilever strength of 500 kg. Pressure due to the contact shall not be transferred to the insulators after the main blades full close. The insulators shall be so arranged that leakage current will pass to earth and not between terminals of the same pole or between phases.

13.03.04 Isolator current carrying parts shall be painted with heat dissipating paint. Proper treatment shall be done so that painting quality and uniformity are maintained. Contractor shall furnish the details of painting procedure adopted to the Owner for approval.

13.04.00 EARTHING SWITCHES

13.04.01 Where earthing switches are specified these shall include the complete operating mechanism and auxiliary contacts. The earthing switches shall form an integral part of the isolator and shall be mounted on the base frame of the isolator. Earthing switches shall be suitable for local manual operation only. The earthing switches shall be constructional interlocked with the isolator so that the earthing switches can be operated only when isolator is open and vice versa.

13.05.00 OPERATING MECHANISM AND CONTROL

13.05.01 The Contractor shall offer, hand operated switches having padlock arrangement on both ‘ON’ and ‘OFF’ positions.Limit switches for control shall be fitted on the isolator/ earth switch shaft, within the cabinet to sense the open and close positions of the isolators and earth switches.

13.05.02 Control cabinet/operating mech. box shall conform to requirements stipulated elsewhere in this specification and IS: 5039/IS 8623/IEC60439 as applicable.

13.06.00 OPERATION

13.06.01 Isolator shall be gang operated for main blades and earth switches. The operation of the three poles shall be well synchronised and interlocked.

13.06.02 The design of linkages and gears be such so as to allow one man to operate the handle with ease for isolator and earth switch.

13.07.00 TESTS

13.07.01 In continuation to the requirements stipulated elsewhere in this specification and approved MQP, the isolator alongwith operating mechanism shall conform to the type tests and shall be subjected to routine tests and acceptance tests in accordance with IEC600129. Power frequency voltage withstand tests (routine test) shall be performed on one completely assembled isolator pole. Minimum 50 nos. mechanical operations will be carried out on 1 (one) isolator assembled completely with all accessories as acceptance test. During final testing of isolator sequential closing/ opening of earth switch shall also be checked only after isolator is fully open/close. Acceptance test shall be carried out with relevant operating box.

13.07.02 The insulator shall conform to all the type tests as per IS/IEC60168. In additional to all type, routine and acceptance tests, as per IS/IEC60168 and as per approved MQP, the following additional routine/ acceptance tests shall also be carried out.

a) Bending load test in four directions at 50% min. bending load guaranteed in all insulators. Bending load test in four directions at 100% min. bending load guaranteed on sample insulators in a lot. Torsional test on sample insulator of a lot.

13.08.00 PARAMETERS:

Operating mechanism of isolator and earth switch	Out door , Manually operated
Rated current at rated ambient temperature	400A
Rated short circuit current of isolator and earth switch	25kA(rms) (for 3sec)
Rated dynamic short circuit withstand current of isolator and earth switch	62.5kA(Peak)
No of auxiliary contacts isolator & earth switch	6NO+6NC

14.00.00 SURGE / LIGHTNING ARRESTER

14.01.01 **GENERAL:** The arresters (LAs) shall conform in general to IEC60099-4 or IS:3070 except to the extent modified in the specification. Arresters shall be of hermetically sealed units, self supporting construction, suitable for mounting on Rail pole.

14.02.00 DUTY REQUIREMENTS

14.02.01 The LAs shall be of heavy duty station class and gapless Metal Oxide type without any series or shunt gaps. The LAs shall be capable of discharging lightening over voltage and over-voltages occurring during switching of unloaded transformers, and long lines.

14.02.02 The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage. The duty cycle of circuit breaker installed in the system shall be 0-3 min.CO-3 min-CO. The LA shall be suitable for such circuit breaker duties in the system.

14.02.03 Lighting arresters shall be capable of discharging severe re-energisation switching surges on 33kV lines upto 50 km. length. Lighting arrester shall be capable of discharging energy equivalent to class- 3 of IEC of a 33kV system of two successive operations.

14.03.00 CONSTRUCTIONAL FEATURES

14.03.01 The non-linear blocks shall be of sintered metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent stable mechanical and electrical properties even after repeated operations.

14.03.02 Seals shall be provided in such a way that these are always effectively maintained even when discharging rated lightning current. Polymer housing shall be so co-ordinated that external flashover will not occur due to application of any impulse or switching surge voltage upto the maximum design value for arrester. The end fittings shall be made of non-magnetic and corrosion proof material. The base of the LA shall be provided with two separate terminals distinctly marked for connection to earth.

14.04.00 PARAMETERS

Sl.no	Description	Parameter
a)	Nominal discharge current	10kA of 8/20 microsec.wave
b)	Maximum continuous operating voltage	25kV rms
c)	Long duration discharge class	3
d)	Partial discharge	Less than 10pC
e)	Cantilever strength	Min.150kgf
f	Partial discharge at 1.05MCOV	Not >than 50pc

15.00.00 CLAMPS & CONNECTORS

15.01.00 Clamps & connectors shall conform to IS:5561.

15.02.00 **Constructional Features:** The clamps and connectors shall be made of materials listed below :

15.02.01 For connecting ACSR/AAAC conductors : Aluminium alloy casting, conforming to designation A6 of IS:617 and shall be tested for all tests as per IS:617

15.02.02 For connecting equipment terminals : Bimetallic connectors made from copper with aluminium alloy casting AAAC/ACSR conforming to designation A6 of IS:617 with 2 mm thick Bimetallic liner and shall be tested for all tets as per IS:617.

15.02.03 For connecting GS. shield wire :Galvanised mild steel

15.02.04 Bolts, Nuts & plain washers :Hot dip galvanised mild steel for sizes M12 and above, and electro-galvanised for sizes below M12.

15.02.05 Spring washers for items ‘a’ to ‘c’ :Electro-galvanised mildsteel

16.00.00 INSULATORS, AND SUPPORT POST INSULATORS

16.01.00 Bushings shall be manufactured and tested in accordance with IS:2099 & IEC:60137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS 5284. The support insulators shall be manufactured and tested as per IS: 2544 / IEC60168/IEC60273. The insulators shall also conform to IEC60815 as applicable.

16.02.00 Bushings, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests and acceptance test/ sample test in accordance with IS:2099 & IS:2544.

17.00.0 COMPOSITE INSULATORS:

Bidder May offer composite long rod with silicon profile as an alternate to Antifog porcelain insulator with same creepage distance. Insulators shall have shed with good self-cleaning properties. Insulator shed profile; spacing, projection etc. and selection in respect of polluted conditions shall be generally in accordance with the recommendation of IEC-60815/IS: 13134. The composite insulators offered shall be suitable for use of hot line maintenance technique so that usual hot line operations can be carried out with ease,

speed and safety.The bidder shall submit type test reports as per IEC 61109 including , Acceptance test, routine tests for approval.

18.00.00 **33 kV HG FUSE (if applicable)**

18.01.00 The fuse shall, in general, conform to IS: 9385.Insulators used for the Horn Gap Unit shall conform to IS: 2544, in all respect with regard to mechanical and electrical requirements. The bidder shall submit type test reports as per IE9385/80 (Part 2) or latest version thereof including , Acceptance test, routine tests for approval.

19.00.00 : 33**KV TRANSMISSION LINES – GENERAL**

19.01.01

This specification covers detailed survey, tower spotting, optimization of tower location, soil resistivity measurements and geo-technical investigation, tower design, fabrication and supply of all types of 33kV narrow based lattice with fully galvanized structure single circuit transmission line on towers(2nos) including tower which are already designed for equal or higher loads as specified in this specification, bolts, nuts and washers, hanger, D-shackle and all type of tower accessories like phase plate, number plate, danger plate, anti-climbing device, etc.; foundation design, selecting type of foundation for different towers and casting of foundation for towers and erection of towers, tack welding of bolts and nuts along with subsequent application of zinc coating on the welded portion, supply and application of zinc rich paint, tower earthing, fixing of insulator string, stringing of conductors and earth wires along with all necessary line accessories and testing and commissioning of the erected transmission lines.

The bidder shall furnish the design calculation for transmission line tower structures along with foundation design and drawing meeting the requirements of this technical specification. The following shall be considered for Transmission line,

i) Provision of sectionalization (pole mounter isolation) at 10 locations for each line for maintenance purpose.

ii) At locations of canal crossing, road crossing, submergence area, low corridor width etc., Cable is to be used. Minimum cable size is 19/33kV, 1c 150sqmm 4KA conductor/screen fault current. One Spare core shall be provided for each line wherever cable is used.

iii) Necessary provision for direct burying of cable , passage of roads, rails etc. though hume pipes, laying of cable trays in vertical formation in civil structure used for pipe laying is to be considered.

iv) EPC vendor shall optimize the corridor of MUW pipe and 33kV Transmission line in the width of the corridor.

v) Where ever sufficient ROW/ ROU is not available for narrow based lattice 33kV Transmission line in MUW corridor, steel rail poles shall be used.

vi) Typical Transmission line tower drawing is enclosed as Tender drawing for reference purpose.

19.01.02 The Contractor shall carry out the detailed survey , check survey and shall submit report/results for employer approval. No other details except those included in tender documents shall be furnished by the Owner. Also no topographical maps shall be furnished by Owner. However, Owner's assistance may be given in obtaining these maps from Survey of India.

19.01.03 The tree-cutting shall be responsibility of the Contractor. The Contractor shall count, mark and put proper numbers with suitable quality of paint at his own cost on all the trees that are to be cut. Contractor may note that Owner shall not pay any compensation for any loss or damage to the properties or for tree cutting due to Contractor's work.

19.02.00 **ROUTE AND TERRAIN**

19.02.01 Right of way and way leave clearance shall be arranged by the Owner.

To evaluate and tabulate the trees and bushes coming within ROW area on either side of the central line alignment, the trees will be numbered and marked with quality paint serially from angle point 1 onwards and the corresponding number will be painted on the stem of trees at a height of one meter from ground level. The trees list should contain the following:

a) Girth (circumference) measured at a height of 1 meter from ground level.
b) Approximate height of the tree with an accuracy of + 2 meters.
c) Name of the type of the species/tree.
d) The bushy and under growth encountered in the 1.5 meters belt should also be evaluated with its type, height, girth and area in square meters, clearly indicating the growth in the tree/bush statement.

19.02.02 Payment of compensation towards the clearances, etc. will be the responsibility of the Owner.

19.03.00 DETAILED SURVEY

19.03.01 The detailed survey shall be carried out along the Transmission Line alignment by successful bidder/contractor The report shall be in line with CBIP Manual -transmission Line -323 guidelines .

19.03.02 **Route Marking**

At the starting point of the commencement of route survey, an angle iron spike of 65 x 65 x 6 mm section and 1000 mm long shall be driven firmly into the ground to project only 150 mm above the ground level. A punch mark on the top section of the angle iron shall be made to indicate location of the survey instrument. Teak wood peg 50 x 50 x 650 mm size shall be driven at prominent position at intervals of not more than 750 meter along the transmission line to be surveyed upto the next angle point. At angle position stone/concrete pillar with "NTPC" marked on them shall be put firmly on the ground for easy identification.

19.03.03 Profile Plotting & Tower Spotting

From the field book entries the route plan with route details and level profile shall be plotted and prepared as per approved procedure. Reference levels at every 20 meters along the profile are also to be indicated on the profile besides R/Ls at undulations. Areas along the profile, which in the view of the Contractor are not suitable for tower spotting, shall also be clearly marked on the profile plots. If the difference in levels is too high, the chart may be broken up according to requirement.

19.03.04 Sag Template

Necessary data in respect of conductor, earthwire and insulator have been given in the specifications. On the basis of these, the Contractor shall prepare the sag template drawing and tower spotting data and submit the same alongwith sag tension calculations for the approval of the Owner. Sag template prepared based on the approved sag-template curve drawing shall only be used for tower spotting on the profiles.

19.03.05 Tower Spotting

With the help of approved sag template and tower spotting data, tower locations shall be marked on the profiles. While locating the towers on the profile sheet, the following shall be borne in mind:

a) Span :The number of consecutive spans between the section points shall not exceed 15 spans Section point shall comprise of tension point with B type, C type or D Type towers as applicable.

b) Extension :An individual span shall be as near to the normal design span as far as possible. In case an individual span becomes too short with normal supports on account of undulations in ground profile, one or both the supports of the span may be extended by inserting standard body extension designed for the purpose according to technical specification.

c) Road Crossing :At all important road crossings, the towers shall be fitted with double tension insulator strings depending on the type of towers but the ground clearance at the roads under maximum temperature and in still air shall be such that even with conductor broken in adjacent span, ground clearance of the conductor from the road surfaces shall be in line with IE rules. At all national highway crossings, tensions towers shall be used.

d) Railways Crossings: At the time of detail survey all the railway crossings coming enroute the transmission line shall be finalised as per the regulation laid down by the Railway Authorities. The following are the important features of the prevailing regulations (revised in 1987):

The crossing shall be supported on D type tower on either side of railway line with double tension insulator strings. The crossing shall normally be at right angle to the railway track. No crossing shall be located over a booster transformer, traction switching station, traction sub-station or a track cabin location in an electrified area. The approval for crossing railway track shall be obtained by the Owner from the Railway Authority. However, six copies of profile and plan, tower and foundation design and drawings, required for the approval from the Railway Authority shall supplied by the Contractor to the Owner.

e) River Crossings :In case of major river crossing, towers shall be of suspension type and the anchor towers on either side of the main river crossing shall be C type tower. Clearance required by navigation authority shall be provided. For non navigable river, clearance shall be reckoned with respect to highest flood level (HFL).

f) Power Line Crossing: Where this line is to cross over another line of the same voltage or lower voltage, towers with suitable extension shall be used. Provisions to prevent the possibility of its coming into contact with other overhead lines shall be made in accordance with the Indian Electricity Rules, 1956. The Contractor may be required to under-cross higher voltage lines by erecting gantry structures.

g) Telecommunication Line Crossing :The angle of crossing shall be as near 90 degree as possible. However, deviation to the extent of 30 degree may be permitted under exceptionally difficult situations. When the angle of crossing has to be below 60 degree, the matter will be referred to the authority incharge of the telecommunication system. On a request from the Contractor, the permission of the telecommunication authority may be obtained by the Owner.

h) Details Enroute:All topographical details, permanent features, such as trees, building etc. 17.5m on either side of the alignment shall be detailed on the profile plan.

i) Water / Ash Pipe Line (If applicable):Adequate clearances shall be maintained from existing pipe lines i.e water ,ash pipe line etc and adjacent road.

19.03.06 **Clearance from Ground, Building, Trees, etc.:** Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the Indian Electricity Rules, 1956 as amended upto date.

19.04.00 **CHECK SURVEY OF TOWER LOCATIONS**

19.04.01 The detailed survey shall be conducted to locate and peg mark the tower positions on ground conforming to the approved profile and tower schedule.

19.04.02 Changes, if required, after detailed survey in the preliminary tower schedule shall be carried out by the Contractor and he shall thereafter submit a final tower schedule for the approval of Owner. The tower schedule shall show position of all towers, type of towers, span length, type of foundation for each tower and the deviation at all angles as set out with other details.

LIST OF STANDARDS:

Sl.no			Other Standard
1)	IS:209	Specification for Zinc	ISO/R/752-1968,AST,B6
2)	IS:2062	Structural Steel(Standard Quality	ISO/R/6F30-1967 CAN/CSA G40.21, BS-4360
3)	IS:269	Ordinary rapid hardening & low heat Portland cement	ISO/R/597-1967
4)	IS:278	Specification for barbed wire	ASTM A 121
5)	IS:383	Coarse and fine aggregate from natural sources for concrete	CSA A23.1/A 23.2
6	IS:398	steel reinforced	
7	IS:406	Method of chemical Analysis of slab Zinc	
8	IS:432(part1&2)	Mild steel and medium tensile bars and hard drawn steel wire for concrete reinforcement	CSA-G-30
9	IS:456-1978	Code of practice for plan and reinforced concrete	
10	IS:731-1971	Porcelain insulators for overhead lines with nominal voltage greater than 1000volts	
11	IS:800-1984	Code of practice for use of structural steel in general building construction	CSA STEAM 16.1 steel
12	IS:802	Code of practice for use of structural steel in over head transmission line.	IEC:826, ASCE-52, BS-8100
13	IS:1139-1966	Hot rolled mild steel medium tensile steel and high yield strength deformed bars for concrete reinforcement	CAN/CSA-G:3018
14	IS;1367-1967	Technical supply conditions for threaded fastners	
15	IS:1489-1991	Portland Pozzolena cement	ISO/863-1968
16	IS:1521-1972	Methods of Tensile testing of steel wire	
17	IS:1573-1976	Electroplated coating of zinc on iron & steel	
18	IS:1778-1980	Reels and Drums of Barewire	
19	IS;1786-1985	High strength deformed steel bars and wires for concrete reinforcement	
20	IS:1893-1984	Criteria of earthquake resistant design of structures	IEEE-693
21	IS;2016-1967	Plain washers	ISO/R/887-1968
22	IS:2121-1981	Specifications for conductors and earthwaire Accessories for over head power lines	
23	IS:2551-1982	Danger Notice plates	
24	IS:2629=1985	Recommended practice for hot dip galvanizing of iron & steel	
25	IS:2633-1986	Method of testing uniformity of coating of zinc coated articles	
26	IS:3043-1987	Code of practice for earthing	

27	IS:4091-1979	Code of practice for design and construction for transmission line towers and poles	
28	IS:5613	Code of practice for design , installation & maintenance of over head power lines	

20.00.00 GENERAL DESCRIPTION OF TOWERS

20.01.01 The towers shall be of self supporting lattice steel type, designed to carry the line conductors with necessary insulators, earth wires and all fittings under all loading conditions. The tower shall be of a fully galvanised structure, using structural mild steel sections for members. Bolts and nuts with spring washers shall be used for connections.

20.01.02 THE TOWERS SHALL BE CLASSIFIED AS GIVEN IN TABLE: **TABLE :**

Type	Deviation limit (Degrees)	Typical use
A	0 to 2	To be used as tangent/suspension tower
B	0 to 15	a) Angle towers/Tension tower with tension insulator string. b) To be used where the towers are subject to uplift loads. c) To be used as section tower
C	15 to 30	a) Angle tower/Tension tower with tension insulator string
		b) To be used where the towers are subject to uplift loads.
		c) To be used as section tower
	NA	d) Complete dead end. (for 33kV line only)
D	30 to 60	a) Angle tower/Tension tower with tension insulator string
		b) To be used where the towers are subject to uplift loads.To be used as section tower
		c) Complete dead end.

NOTE:

1) For double circuit tower types, A, B, C and D shall be prefixed by 'D'.
2) Special type of tower/ higher voltage class towers, wherever required shall also be provided by the bidder under the contract at no extra cost.

20.01.04 **Extension:** The single circuit tower shall be designed with body extension so as to be suitable for adding 3M, 6M and 9M body extension for maintaining adequate ground clerance. In case of requirement of higher body extensions, the tower shall be designed for the highest extension required.

20.02.00 **SPANS AND CLEARANCES**

20.02.01 **Ruling Span :**The normal ruling span of the line shall be 80 meters for 33kV towers.

20.02.02 **Wind Span :**The wind span is the sum of the two half spans adjacent to the support under consideration. For normal horizontal spans this equals to normal ruling span.

20.02.03 **Weight Span:**The weight span is the horizontal distance between lowest point of the conductors on the two spans adjacent to the tower. For design of structures, the span limits shall be as per CBIP manuals prevail.

20.02.04 Electrical Clearance: **A) Ground clearance**
The minimum ground clearance from the bottom conductor shall not be less than 5.2mt at the maximum sag conditions i.e. at maximum temperature and still air. The minimum clearance along or across any street shall not be less than 6.1m. However, to achieve the above clearance the height of tower shall be increased.

B) Rail Crossing, Power Line crossings, Live Metal clearances, Angle of shielding, Mid span clearance as per the **CBIP Manual - Transmission lines-323 , as per the** regulations for Electrical Crossing of Railway tracks , IE Rules etc.as prevailing at the time of construction of line shall be applicable.

20.03.00 **LOADING CONDITIONS**

20.03.01 **Loads at Conductor And Earthwire Points:**
Contractor shall consider the ultimate external loadings at conductor and earthwire points base on IS 802-1, 2015. The Contractor shall develop the tower designs considering these loadings. The towers are to be designed to cater for the following loads:

a) Reliability Loads (Normal condition)
b) Security Loads (Broken wire condition)
c) Safety Loads (Construction & Maintenance loads)

20.03.02 **Suspension towers shall be designed for full wind load under security condition :** The wind load on tower body shall be calculated by the Contractor as per IS:802, Part-I, 2015.

20.03.03 **Maximum Tension :**a) at 0 deg C with 36% full wind pressure., or
b)at 32 deg C with full wind pressure .The value of drag co-efficient (Cd) shall be 1.2 for conductor/earthwire if the diameter of the conductor/earth is 15mm or less.

20.03.04 The initial conductor and earthwire tension at 32 degree C and without wind shall be 22% of the ultimate tensile strength of the conductor and 20% of the ultimate tensile strength of the Earthwire.

20.03.05 Limiting Tensions of conductor & Earthwire : The ultimate tension of conductor and ground wire shall not exceed 70 per cent of the ultimate tensile strengths.

20.03.06 **Broken Wire Condition**

The loads for broken wire conditions shall be considered as per clause 16 of IS 802 (Part I/ Sec 1): 2015. The tower type B & C shall be considered as small and medium angle towers whereas tower type D shall be considered as large angle tension tower/ dead end tower.

20.04.00 **DESIGN OF TOWERS: Design Temperatures : T**he following temperature range for the conductors and ground wires shall be adopted for line design:

a)	Minimum temperature	: 0 deg.C
b)	Everyday temperature of conductor	: 32 deg.C
c)	Max. temperature of Conductor	: 85 deg.C
d)	Max. temperature of Earthwire exposed to sun	: 53 deg.C

20.04.02 **Redundant Design :**All redundants in the towers are to be triangulated. Redundants, having an angle of 15 deg or less with horizontal are to be designed for a concentric vertical ultimate load of 1.5 KN acting at center of the unsupported length. The Contractor has to furnish the calculation for the same. The redundants shall also be designed for 2.5% of max. axial load of connecting members (i.e. leg members, bracing members etc.).

20.04.03 **Steel Sections :**For designing of towers, preferably rationalised steel sections shall be used.

20.04.04 **Thickness of Members :**The minimum thickness of angle sections used in the design of tower, unless otherwise specified elsewhere in this Specification, shall be kept not less than the following values:

a) Main corner leg members including the groundwire peak and main cross arm : 5 mm

b) For all other members : 4 mm

20.04.05 **Bolts & Nuts: F**or the purpose of calculating shearing stress and bearing stress for bolts, IS:802-Part-II-2015 may be referred.

20.04.06 **Slenderness Ratio:** A) Slenderness ratio for members shall be computed in accordance with IS:802, Part-II, 1993.

20.04.07 **Erection Stress:** Where erection stress combined with other permissible co-existent stresses could produce a working stress in any member appreciably above the specified working stress, such other provisions are to be made as may be necessary to bring the working stress within the specified limit.

20.05.00 **TOWER MATERIALS**

20.05.01 **Tower Steel Sections:** IS steel sections of tested quality in conformity with IS: 2062 are to be used in towers, extensions and stub setting templates. No individual member shall be longer than 6000mm. The Bidder can also use most efficient grades of structural steel angle sections and plates conforming to latest international standards. However, the Bidders are permitted to opt for not more than two (2) grades of steel for any particular package.

20.05.02 **Fasteners: Bolts, Nuts and Washers**

A) All bolts and nuts shall conform to IS: 6639. All bolts and nuts shall be galvanised and shall have hexagonal head and nuts, the heads being forged out of the solid, truly concentric, and square with the shank, which must be perfectly straight.

B) The bolt shall be of 16 mm dia and of property class 5.6 as specified in IS:1367 (Part-III) 1979 and matching nut of property class as specified in IS:1367 (Part-VI).

C) Bolts upto M16 and having length upto 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolts for 5.6 grade should be 310 MP a minimum as per IS:12427. Bolts should be provided with washer face in accordance with IS:1363 Part-I to ensure proper bearing.

D) To ensure uniformity of galvanizing, bolts and nuts should be galvanised by high temperature hot-dip galvanizing.

E) Nuts should be double chamfered as per the requirement of IS:1363 Part-III. It should be ensured by the manufacturer that nuts should not be overtapped beyond 0.4 MM oversize on effective diameter for size upto M16.

20.05.03 **Insulator Strings and Earthwire Clamps Attachments**

a) For the attachment of suspension insulator string a suitable dimensioned swinging hanger on the tower shall be provided so as to obtain requisite clearance under extreme swinging conditions and free from swinging of the string. The hanger shall be designed to withstand an UTS equivalent to that of insulators. The supply of design & supply of hanger is in the scope of the Contractor.

b) At tension towers strain plates of suitable dimensions on the underside of each cross-arm tip and at the top of earthwire peak, suitable plate should be provided for taking the hooks or D-

Shackle of the tension insulator strings or earthwire tension clamps, as the case may be. Full details of the attachments shall be submitted by the bidder for Owner's approval before starting the mass fabrication.

20.05.04 **Anti-climbing Device :** Barbed wire type anti-climbing device shall be provided and installed by the Contractor for all towers. The height of the anti-climbing device should be provided approximately 3m above ground level. The barbed wire shall conform to IS-278-1978. The barbed wires shall be given chromating dip as per procedure laid down in IS:1340-1959.

20.05.06 Danger plate, Number plates, Circuit Plate, Phase plate & Bird Guards.

a)Each tower shall be fitted with a number plate, and danger plate. Each tension tower shall be provided with a set of phase plates also. The arrangement for fixing these accessories shall not be more than 4.5m above the ground level.

b) To prevent birds from perching immediately above the suspension insulator strings and thus fouling it with droppings suitable birdguards shall be provided at cross arm tips of all suspension towers. The arrangement shall conform to IS:5613 part-2/Sec.I.

20.06.00 **TOWER FABRICATION**: Except where hereinafter modified, details of fabrication shall conform to IS:802 (Part-II) or the relevant international standards.

20.07.01 **Erection mark**

A) Each individual member shall have erection mark conforming to the component number given to it in the fabrication drawings. This mark shall be marked with marking dies of 16mm size before galvanising and shall be legible after galvanising.

B) Erection Mark shall be "A - BB- CC – DDD", where

A = Owner's code assigned to the Contractor Alphabet.
BB = Contractor's Mark-Numerical
CC = Tower Type-Alphabet
DDD = Number mark to be assigned by Contractor.

20.07.02 **Quantities and Weights:** The unit weight of each type of tower, stubs and extensions shall be furnished by the bidder.

20.07.03 **Galvanising :** Fully galvanised towers and stub shall be used for the line. Galvanisation of the member of the towers shall conform to IS:2629 and IS:4759. The minimum weight of galvanisation shall be 610 gms/sqm.Spring washers shall be electro-galvanised as per Grade 4 of IS:1573.

20.07.04 **TOWER EARTHING:** The footing resistance of all towers shall be measured by the Contractor in dry weather after tower erection but before the stringing of earthwire. All the tower are to be earthed. In no case tower footing resistance shall exceed 10 ohms. Pipe type earthing and counterpoise type earthing wherever required shall be provided in accordance with the stipulations made in IS:3043-1987 and IS:5613 (part-II/Section-2) 1985.

20.08.00 **TESTS**

20.08.01 **Tower Load Tests**

A) The Contractor shall submit one set of shop drawings alongwith the bill of materials. Further, Contractor shall submit one copy of test reports and final tracings of shop drawings and Bill of materials for Owner's reference and record.

B) The Contractor shall ensure that the specification of materials and workmanship of all towers actually supplied conform strictly to the towers which have successfully under gone the tests. In case any deviation is detected, the Contractor shall replace such defective towers free of

cost to the Owner. All expenditure incurred in erection, to and fro transportation and any other expenditure or losses incurred by the Owner on this account shall be fully borne by the Contractor. No extension in delivery time shall be allowed on this account.

20.08.02 **Tower Testing Procedure :**

A) **Bolt Slip Test:** In the bolt slip test, the test loads shall be gradually applied up to the 50% of design loads under normal condition and held for two (2) minutes at that loads and then released gradually.The initial and final readings on the scales (for measurement of defection) before application and after the release of Loads respectively shall be taken with the help of theodolite. The difference between these readings gives the values of the bolt slip.

B) **Normal/Broken Wire Load Tests:**All the loads, for a particular load-combination test shall be applied gradually upto the full design loads in the following steps and shall also be released in the similar manner:50%,75%,90%,95%,100%t

C) **Observation Periods :**a)Under normal and broken wire load tests, the tower shall be kept under observation for sign of any failure for two minutes (excluding the time for adjustment of loads) for all intermediate steps of loading upto and including 95 per cent of full design loads.

b) For normal, as well as broken wire tests, the tower shall be kept under observation for five (5) minutes (excluding the time for adjustment of loads) after it is loaded upto 100 percent of full design loads.

c) While the loading operation are in progress, the tower shall be constantly watched, and if it shows any tendency of failure anywhere, the loading shall be immediately stopped, released and then entire tower shall be inspected. The reloading shall be started only after the corrective measures are taken.

d) The structure shall be considered to be satisfactory, if it is able to support the specified full design loads for five (5) minutes, with no visible local deformation after unloading (such as bowing, buckling etc.) and no breakage of elements or constituent parts.

D) **Recording:** The deflection of the tower shall be recorded at each intermediate and final stage of normal load and broken wire load tests by means of a theodolite and graduated scale. The scale shall be of about one meter long with marking upto 5 mm accuracy.

E) **Destruction Test:** a)The destruction test shall be carried out under normal condition or broken wire condition. The Owner at the time of approval of rigging chart/test data sheet shall intimate the contractor. Under which load condition the destruction test is to be carried out.

b) The procedure for application of load for normal/broken wire test shall also be applicable for destruction test. However, the load shall be increased in steps of five (5) percent after the full design loads have been reached.

20.09.00 **PACKING:** The packings shall be properly done to avoid losses/damages during transit. Each bundle or package shall be appropriately marked.

20.10.00 DESIGN CALCULATION AND DRAWINGS

20.10.01 The following design calculation and drawings are required to be furnished during detailed engineering.

a) Computation of wind load
b) Sag-tension calculation
c) Tower loading
d) Single line diagram of towers slowing electrical clearances and steel sections.

20.10.02 The Contractor shall also furnish following to the owner:

a) Detailed design calculation and drawing for towers and foundations.

b) Detailed structural drawings indicating section size, length of members sizes of plate along with hole to hole distance, joint details etc.
c) Bill of materials, indicating cutting and bending details against each member.
d) Shop drawings showing all details relevant to fabrication.
e) All the drawings for the tower accessories.

21.00.00 TOWER FOUNDATIONS

21.01.00 **TYPES OF FOUNDATION :**General :A) Reinforced concrete footing shall be used for all type of normal tower in conformity with the present day practice followed in the country and the specifications laid herein.

21.01.02 Design criteria for Foundations:The foundation shall be designed for the actual soil parameters based on the soil investigation carried out by the bidder and approved by the owner. For design purposes:

(a) The angle of repose shall be considered as two-third (2/3) of the value as obtained from the soil investigation

(b) Water table shall be considered up to the ground level.

(c) The weight of soil shall be considered as 1440 Kg/m^3 under dry condition and 940 Kg/m^3 under wet condition.

Well foundation or pile foundation shall be provided by the bidder wherever necessitated.

21.02.00 **SOIL INVESTIGATION:** The Contractor is required to carry out detailed soil investigation at various tower locations along the corridor, one borehole at centre of the tower, angle points, crossings, etc. and also where soil strata is different from the other locations investigated. In addition the soil investigation may be required to be carried at other locations at the discretion of the Engineer.

The investigation comprises of field and laboratory testing. Field investigation includes boreholes, Standard Penetration Test (SPT), Static Cone Penetration Test (SCPT), Dynamic Cone Penetration Test (DCPT), collection of disturbed samples (DS) and undisturbed soil samples (UDS), Trial Pits (TP), Plate Load Tests (PLT), Electrical Resistivity Test (ERT), collection of water samples, etc. Laboratory tests shall include, Physical, chemical and engineering properties of soil/rock.

21.02.02 The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. Depth of bore holes at river/bridge crossings shall be 40m, at angle points depth shall be 15.0m and at the centre of tower along the corridor depth of BH shall be 10.0m. Boring shall be terminated at the above specified depth or 3.0m continuous in rock with RQD>25% for river crossings and for balance areas 3.0m in refusal whichever is earlier. Refusal means SPT 'N' value greater than 100.

SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery up to 20%, met within a borehole. This test shall be conducted at every 3.0 m interval or at change of strata, up to the final depth. At refusal penetration shall be measured and the same shall be reported in Borelog. UDS shall be collected at every 3.0 m interval or at change of strata up to depth of borehole. UDS may be replaced by additional SPT, if SPT'N' value in the strata is above 50. The diameter of UDS sampler shall be 100 mm minimum.

21.02.03 Laboratory tests shall be done as per relevant IS codes. The laboratory tests, not be limited to the following shall be conducted on disturbed and undisturbed soil samples, rock samples & water samples collected during field investigations in sufficient numbers.

a) Laboratory Tests on Soil Samples: Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined Compression Test, Free swell Index, Shrinkage Limit, Swell Pressure Test, Chemical Analysis test on soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel.

b) Laboratory Tests on Rock Samples : Moisture content, porosity & density, Specific Gravity, Hardness, Soundness, Slake durability index, Unconfined compression test (Both at saturated and in-situ water content), Point load strength index and deformability test (Both at saturated and in-situ water content) shall be carried out on rock samples.

21.02.04 Reference standards for Soil investigation :Indian Standard References

IS:1498 Classification and Identification of Soils for general Engineering Purposes.

IS:1892 Code of practice for Subsurface Investigation for Foundation.

IS:1904 Code of practice for design and construction of foundations in Soils: General Requirements.

IS:2131 Method of Standard Penetration Test for Soils.

IS:2132 Code of practice for Thin walled Tube Sampling of Soils.

IS:2470 Code of practice for design and construction of SepticTanks.
(Part-I)

IS:2720 Method of Test for Soils (Relevant Parts).

IS:5313 Guide for Core Drilling Observations.

IS:4968 Method for subsurface Sounding for Soils - Dynamic
(Part-II) method using Cone and Bentonite slurry.

IS:4968 Method for subsurface Sounding for Soils- Static Cone Penetration (Part-III) Test

21.03.00 **LOADS ON FOUNDATIONS:** The over load factor for foundation design shall be 1.10 for all loads except dead load. The reactions on the footings shall be composed of the following type of loads for which these shall be required to be checked :

i) Max. tension or uplift along the leg slope.
ii) Max. compression or down-thrust along the leg slope.
iii) Max. horizontal shear or side thrust.

21.04.00 **STABILITY ANALYSIS:** In addition to the strength design, stability analysis of the foundation shall be done to check the possibility of failure by over-turning, uprooting, sliding and tilting of the foundation.

21.05.00 **PROPERTIES OF CONCRETE:** The cement concrete used for the foundations shall be of grade M-20 corresponding to 1:1½:3 nominal mix ratio with 20mm coarse aggregate.All the properties of concrete regarding its strength under compression tension, shear, punching and bend etc. as well as workmanship will conform to IS:456-1978.

21.06.00	**DESIGN OF FOUNDATIONS:**
21.06.01	Structural design of the foundations shall be done by limit State method conforming to IS 456.The chimney should have all around clearance of 150mm from any part of stub angle limiting to 450mm sq. minimum.The chimney top or muffing must be at least 225 mm above ground level and also the coping shall be extended upto lower most joint level between the bottom lattices and the main corner legs of the tower. Minimum thickness of foundation shall be 300 mm.The minimum distance between the lowest edge of the stub angle and the bottom surface of concrete footing shall not be less than 150 mm or more than 200mm.
21.06. 02	The total depth of foundations below the ground level shall not be less than 1.5 meters. To maintain the interchangeability of stubs for all types of foundations, for each type of tower, the same depths of foundations shall be used for different types of foundations.
21.06.03	Minimum 50mm thick pad of lean concrete corresponding to 1:3:6 nominal mix shall be provided to avoid the possibility of reinforcement rod being exposed due to unevenness of the bottom of the excavated pit.
21.06.04	Over Load Factor :The overload factor for foundations shall be considered as 1.1 i.e. the reaction except due to dead loads on foundations shall be increased by 10 per cent.
21.07.00	**CONSTRUCTION OF TOWER FOUNDATION**
21.07.01	**Excavation :** Excavation work must not be started until the tower schedule & profile and foundation drawing are approved by the Owner.
21.07.02	**Rock excavation requiring Blasting:** Wherever blasting is required for excavation in rock, the same shall be done after obtaining license from the competent authority. Following shall be adhered to: i) All provisions of explosive acts shall be adhered to.ii) The magazine for the storage of explosive shall be to suit as per the requirements of explosive department. iii) Where blasting is required, same shall be controlled blasting. ii) The Contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per explosives act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive Materials. iii) Controlled blasting shall be done by a specialised agency duly approved by Engineer-in-charge. All controlled blasting shall be done by using time delay detonators (i.e. excel type). iv) All rules under the Explosives Act and other local rules in force shall be fully observed. All blasting works shall be done in accordance with the stipulations contained in IS: 4081.
21.07.03	Setting of Stubs A) The stubs shall be set correctly in accordance with approved method at the exact location and alignment and precisely at correct levels with the help of stub setting templates and leveling instrument. Stubs shall be set in the presence of Owner's representative available at site where required and for which adequate advance intimation shall be given to the Owner by the Contractor. C) Stub setting templates shall be designed and arranged by the Contractor at his own cost for all types of towers with or without extension and also for leg extension. Stub templates for standard towers and towers with extension upto 6M shall be of adjustable type. The stub templates shall be painted. Generally for each transmission line tower package, following numbers of stub setting templates shall be deployed by the Contractor:

For each A type tower : 3 Nos.
For each of B and C type : 2 Nos.

However, if Owner feels that more number of templates are required for timely completion of a particular line the Contractor shall have to deploy the same without any extra cost to Owner.

D) One set of each type of stub setting template as applicable, shall be supplied to the Owner, on completion of the project at no extra cost to Owner.

21.07.04 Protection of Tower Footing: A) The work shall include all necessary stone revetments, concreting and earth filling above ground level and the clearance from stacking on the site of all surplus excavated soil, special measures for protection of foundation close to or in nallahas, river bed hilly/undulated terrain etc, by providing suitable revetments or galvanised wire netting and meshing packed with boulders. The top seal cover of the stone revetments shall be done with M-15 concrete (1:2:4:mix). The Contractor shall furnish recommendations for providing protection at these locations wherever required.

B) The quantity of excavated earth obtained from a particular location shall generally be utilised in back-filling work in protection of tower footing of same locations, unless it is unsuitable for such purpose. In the latter case, the back-filling shall be done with borrowed earth of suitable quality irrespectively of lead as per the rate provided in the letter of award. The consolidation of earth shall however be done after backfilling free of cost.

22.00.00 TREATMENT OF MINOR GALVANISING DAMAGE

In case any minor damage to galvanising is noticed, the same shall be treated with zinc rich paint (having at least 90% zinc content) before erection.

22.01.00 **ASSEMBLY**

a) The bolt position in assembled towers shall be as per IS:5613 (Part-II/Section 2)-1976.

b) Tower shall be fitted with number plate, danger plate, phase plate and anti-climbing device as described.

c) All bank holes, if any left, after complete erection of the tower, are to be filled up by bolts and nuts of correct size.

22.02.00 **INSULATOR HOISTING:** SUSPENSION INSULATOR STRINGS SHALL BE USED ON SUSPENSION TOWERS AND TENSION INSULATOR STRINGS ON ANGLE AND DEAD END TOWERS. THESE SHALL BE FIXED ON ALL THE TOWERS JUST PRIOR TO THE STRINGING. DAMAGED INSULATORS AND FITTINGS, IF ANY, SHALL NOT BE EMPLOYED IN THE ASSEMBLIES..

22.03.00 **HANDLING OF CONDUCTOR AND EARTHWIRE**

22.03.01 Derricks shall be used where roads, rivers, channels, telecommunication or overhead power lines, railway lines, fences or walls have to be crossed during stringing operations. It shall be seen that normal services are not interrupted or damage caused to property. Shut down shall be obtained when working at crossing of overhead power lines. The Contractor shall be entirely responsible for the proper handling of the conductor, earth-wire and accessories in the field.

22.03.02 The proposed 33 kV transmission line may run parallel for certain distance with the existing Transmission lines which may remain energised during the stringing period. As a result there is a possibility of dangerous voltage build up due to electromagnetic and electrostatic coupling in the pulling wire, conductors and earthwires, which although comparatively small during normal operations can be severe during switching. It shall be the Contractor's

responsibility to take adequate safety precautions to protect his employees and others from this potential danger.

22.04.00 **STRINGING OF CONDUCTOR AND EARTHWIRE**

22.04.01 The stringing of the conductor shall be done by standard stringing method. After being pulled the conductor/earthwire shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.

22.04.02 Jointing: A)All the joints on the conductor and earthwire shall be of compression type, in accordance with the recommendations of the manufacturer for which all necessary tools and equipment like compressors, dies, processes etc. shall have to be arranged by the Contractor.

B) All joints or splices shall be made at least 30 meters away from the structures. No joints or splices shall be made in spans crossing over main road, railways, small rivers with tension spans. During compression or splicing operation the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After pressing the joint the aluminium sleeve shall have all corners rounded, burrs and sharp edges removed and smoothened.

C) During stringing of conductor to avoid any damage to the joint, the Contractor shall use a suitable protector with mid span compression joints in case joints are to be passed over pulley blocks/aerial rollers. The size of the groove of the pulley shall be such that the joint along with protection can be passed over it smoothly.

22.05.00 Sagging-in-Operation

22.05.01 The conductor shall be pulled upto the desired sag and left in running blocks for atleast one hour after which the sag shall be re-checked and adjusted, if necessary before transferring the conductor from the running blocks to the suspension clamps. The conductors shall be clamped within 36 hours of sagging in.

22.06.02 The sag will be checked in the first and the last span of the section in case of sections upto eight spans and in one intermediate span also for sections with more than eight spans. The sag shall also be checked when the conductors have been drawn up and transferred from running blocks to the insulator clamps.

22.06.03 At sharp vertical angles, the sags and tensions shall be checked on both sides of the angle, he conductor and earthwire shall be checked on the running blocks for equality of tension on both sides. The suspension insulator assemblies will normally assume vertical positions when the conductor is clamped.

22.06.04 Tensioning and sagging operations shall be carried out in clam weather when rapid changes in temperatures are not likely to occur.

22.06.05 Tensioning and Sagging of Conductors and Earthwire

The tensioning and sagging shall be done in accordance with the approved stringing charts before the conductors and earthwire are finally attached to the tower through the earthwire clamps for the earthwire and insulator strings for the conductor. The `Initial' stinging chart shall be used for the conductor and `final' stringing chart for earth-wire should be employed for this purpose. Dynamometers shall be employed for measuring tension in the conductor and earthwire. The dynamometers employed shall be periodically checked and calibrated with the standard dynamometer.

22.06.06 Clipping In

A) Clipping of the conductors in positions hall be done in accordance with the recommendations of the manufacturer. Conductor shall be fitted with armour rods where it is made to pass through suspension clamps.

B) The jumpers at the section and angle towers shall be formed to parabolic shape to ensure maximum clearance requirements and shall match the jumper drops shown in the tower drawings.

22.06.07 **Fixing of Conductor and Earthwire Accessories** : Vibration dampers for conductor and earthwire and other conductor and earthwire accessories shall be installed by the Contractor as per the design requirement and respective manufacturer's instructions within 24 hours of the conductor/earthwire clamping. While installing the conductor and earthwire accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and no damage shall occur to any part of the accessories.

22.07.00 **FINAL CHECKING TESTING AND COMMISSIONING :**

22.07.01 After completion of the works, final checking of the line shall be done by the Contractor to ensure that all the foundation works, tower erection, and stringing have been done strictly according to the specifications and as approved by the Owner.

23.00.00 TRANSMISSION LINE MATERIAL

23.01.00 **GENERAL:**

23.01.01 All the equipment shall be of the latest design and conform to the best modern practice adopted in the extra high voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory and suitable for 33 kV AC single circuit transmission and will give continued good performance.

23.01.02 The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continues and free from imperfection such as flux, ash, rust stains, bulky white deposits and blisters. The zinc used for galvanising shall be of grade Zn. 99.95 as per IS:209-1966.

23.02.00 **EARTHWIRE**

23.02.01 The galvanised steel earthwire shall generally conform to the specification of ACSR core wire as mentioned in IS 398 (Part-II)-1976 except where otherwise specified herein.

23.02.02 Parameters of the earthwire

(a) Size (strands & wire diameter)	7/3.15 mm
(b) Overall diameter	9.45 mm
(c) Stranded weight	428 Kg/km
(d) Minimum ultimate tensile strength	56 kN

23.03.00 **CONDUCTOR**

23.03.01 The conductor shall be Aluminium Core Steel Reinforced (ACSR) type. The conductor shall confirm to IS:398 (Part-II) except where otherwise specified herein.

23.03.02 Parameters of the conductor (Typical) : The type of conductor shall be finalized during detailed engg.

a) Code and standard ACSR " DOG" or suitable conductor
b) Number and diameter of Al.strands : 7/1.57
c) Overall diameter 14.15 mm
d) Weight 288 kg/m

23.03.03 The standard length of the conductor shall be 1600 meters for conductor and 2x2000 metres for earth wire. A tolerance of ± 5% on the standard length offered by the bidder shall be permitted. All lengths outside this limit of tolerance shall be treated as random lengths. Random lengths will be accepted provided no length is less than 70% of the standard length

and the total quantity of random lengths shall not be more than 10% of the total quantity ordered.

23.04.00 **CONDUCTOR ACCESSORIES**

23.04.01 **Mid Span Compression Joint for Conductor :**AS PER DETAILS GIVEN IN IS:2121 PART-2..

23.04.02 **Repair Sleeve :**

Repair Sleeve of compression type shall be used to repair conductor with not more than two strands broken in the outer layer. The sleeve shall be manufactured from 99.5% pure aluminium and shall have a smooth surface.

23.04.03 **Vibration Damper for conductor and Earthwire**

A) Vibration dampers of 4 R-Stock bridge type with four (4) different resonance spread within the specified aeolian frequency bandwidth shall be used at all suspension and tension points on each span to damp out the Aeolean vibrations of the conductors to the specified level as mentioned hereinafter. Two dampers minimum on each side per conductor/earthwire shall be used at tension points and one damper minimum on each side per conductor at suspension points for ruling design span.

B) The clamp of the vibration damper shall be made of high strength aluminium alloy of type LM-6 or equivalent.

C) The messenger cable shall be made of high strength galvanised steel/stainless steel with a minimum strength of 135 kg/mm^2. It shall be of pre-formed and post-formed quality in order to prevent subsequent droop of weight and to maintain consistent flexural stiffness of the cable in service. The number of strands in messenger cable shall be 19. The messenger cable other than stainless steel shall be hot dip galvanised in accordance with the recommendations of IS:4826-1979 for heavily coated wires.

D) The manufacturer must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 KN and 5KN. The clamp when installed on the conductor shall not cause excessive stress concentration on the conductor leading to permanent deformation of the conductor strands and premature fatigue failure in operation.

E) The vibration damper for conductor shall not have magnetic power loss more than 0.5 watt at 350 amps at 50 Hz alternating current.

23.05.00 **EARTHWIRE ACCESSORIES**

23.05.01 Mid Span Compression Joint for Earthwire :

It shall be used for joining two lengths of earthwire. The joint shall be made of mild steel. The steel sleeve should not crack of fail during compression in it or service period. The Brinnel Hardness of steel should not exceed 200. The steel sleeve shall be hot dip galvanised.

23.05.02 **Flexible Copper Bond**: As detailed in is:2121 part3.

23.05.03 Suspension Clamp for Earthwire : As Detailed in IS:2121 Part3

23.05.04 **Tension Clamp for Earthwire**

The details shall be as per IS:2121 part-3.

23.06.00 **INSULATOR STRING (33KV)**

Insulator string (for 33kV)

a)	Rated Voltage	33 KV
b)	Impulse withstand voltage (Dry & Wet)	± 170 kVp
c)	Power frequency withstand voltage (dry and wet)	130 kV & 80 kV (rms)
d)	Total creepage distance	31mm/kV

Bidder May offer composite long rod with silicon profile as an alternate to Antifog porcelain insulator with creepage distance. Refer Clause No:17.00.00 of this chapter or elsewhere in the specification.

23.07.00 Tests for Transmission LINE MATERIAL:

23.07.01 The materials shall conform to all the type tests as per relevant standards. The acceptance, routine tests and tests during manufacturer shall be carried out on the line material as per relevant standards.

24.00.00 RAIL POLES AND FOUNDATION

24.01.00 GENERAL REQUIREMENTS:

The design, supply, erection stringing and painting of Rail Poles, Line Materials and accessories for 33 kV four pole / double shall be strictly in accordance with latest REC (Rural Electrification Corporation Ltd.) specification and construction standards and specified herein..

24.02.00 RAIL POLES : The Rail Poles shall be 52 kg/m size and minimum 13.0 m long and of following types:

a) DP (Double Pole support) 0° - 60° deviation

b) FP (Four Pole support) 60° - 90° deviation

Typical arrangement for rail poles is shown in the enclosed drawings. The dimensions and sizes of rail pole, bolts, bracings, etc. are indicative only. The Contractor is required to design the poles cross-arms and bracings and submit design calculations for Owner's approval. In case of special locations like road crossing etc, 13mts or higher supports are recommended to be used in line with REC specification, to achieve minimum clearance from road surface as per IE rules 6.1m.

24.02.01 **Design Parameters :***a) Wind span - 40 m b) Weight span -60 m*

c) Factor of safety 2.0 in Normal condition d) Ground clearance shall be minimum 5.2m. (e)The live metal clearance shall be as per IS: 10118 and shall be min. 320mm.

24.02.02 Pole accessories like danger plates, phase plates and number plates shall be provided.

24.02.03 **Fabrication :** The Rail Poles shall be min. 11.0/13.0 metre long and of single piece. The welding of Rail Poles are not allowed. The clamp of Rail Poles shall be as per REC specifications.

24.02.04 **Painting & Galvanizing:** The Rail Poles shall be painted by Epoxy based aluminum paint as per REC specification & construction standards. Other steel parts like angle, clamp flat etc. shall be galvanized as per IS: 2629, IS4759 & 5358.

24.02.05 **Design & Poles:** The poles shall be designed for *maximum bending* moment arising due to wind load on poles, conductors, insulators, cross arms and conductor deviation loads with all conductor intact. *All poles shall be guyed on both sides*. Terminal poles shall be designed for conductors strung on one side only. Guy wire shall conform to IS-2141 and

Guy insulator shall conform to IS-5300. Two strain insulators in series shall be provided on each guy.

24.03.00 **FOUNDATIONS :**The Contractor shall submit calculations for design of foundations of Poles and stay rods. Foundations shall be of pad and chimney type of concrete *grade M25.* For guy wires Block foundation shall be provided. Tentative sketches are enclosed for reference purpose only.

24.03.01 The factor of safety for foundations in normal condition shall be 2.2.The actual foundations design shall be based on geotechnical investigation on proposed line.

24.04.00 **EARTHING:** Earthing of Rail Poles shall be done as per REC specification and construction standards.

24.05.00 E**RECTION OF POLES:**

24.05.01 After the final survey of the line and approval of profiles, the pole locations shall be marked with peg. Subsequently the excavation work shall be commenced. Excavation should generally done by pick axes, crow bars and shovels, although sometimes earth augers may be used. Excavation of pole pits in very hard or rocky soil or in rock beds may involve blasting of rock by small charges of gun-powder. The depth of the foundation to be excavated for poles shall be1/6 of pole length.

24.05.02 The pits shall be excavated along the bisection of the angle of deviation. Double Poles shall also be provided to sectionalise the line.

24.05.03 After the poles are erected, the horizontal/cross bracings should be fitted and the supports held in a vertical position with the help of temporary guys of manila/sisal rope of at least 20/25 mm dia. Ensuring that the poles are held in a vertical position (checked with a spirit level), the concreting shall be done with M30 mix from the bottom of the support to the ground level. Before lifting the pole in the pit, concrete padding of not less than 75 mm thickness shall be put for the distribution of the load of the support on the soil.

24.05.04 Stays are to be provided for the support with 7/4.0mm GS stay wire and 25mm stay rods. Minimum 2 No. Guys shall be provided on poles (one on each side). The breaking load of the guy shall be 58.45 KN.

24.05.05 Guy Strain Insulator: Guy insulators conforming to IS-5300 shall be placed on all guys to prevent the lower part of the guy from becoming electrically energised by the contact of the upper part of the guy when the conductors snap and fall on them or due to leakage. No guy insulator shall be located less than 2.6 meters from the ground. The minimum breaking load of the guy insulator shall be 9900 Kg. The number of guy strain insulators to be placed shall be as per REC specification. Two insulators in series shall be used on each guy set.

SUB-SECTION-B – 12

FIRE PROOF CABLE PENETRATION SEALING SYSTEM

1.00.00	**CODES AND STANDARDS**
1.01.00	The fire proof cable penetration (FPCP) sealing system shall conform to the requirement of latest edition including amendments of BS:476 Part-20 Fire tests on Building materials and structures.
1.02.00	Fire penetration seal complying with any other international standards will also be considered if it ensures performance equivalent or superior to standard listed above.
1.03.00	The Bidder shall clearly indicate the standards adopted and furnish a copy of the English version of the latest editions of standards along with the bid, and shall clearly bring out the salient features for comparison.
2.00.00	**SYSTEM DESCRIPTION**
2.01.00	The fire proof cable penetration sealing system shall be of the following types; i) Type - A Type A fire sealing system is either Silicone foam or equivalent foam system or using individual blocks for each cable along with suitable frame work rated for one hour. Type A is to be implemented at floor openings below C&I panels, control panels/Boards etc. in CER & CCR/Control Room. ii) Type-B Type B fire sealing system is any proven fire sealing system rated for one hour. This will comprise of rest of wall and floor crossings of cables/cable trays, opening below HT/LT Switchgears/board other than those covered under Type A.
2.02.00	The penetration system, shall be installed immediately after the completion of cable termination in a particular switchboard/control panel/area after clearance from the Project Manager.
3.00.00	**GENERAL INFORMATION**
3.01.00	The cables shall generally be laid in cable trays/racks, conduits, ducts. The fire proof cable penetration system shall be designed in such a way that the existing supporting structure/cable is not disturbed.
3.02.00	The penetration system shall be suitable for site condition at 50^0C ambient temperature and relative humidity of 100%.
3.03.00	The penetration system of each wall/floor crossing shall be adequately designed/sized such that 20% addition of cables is possible at any later date without disturbance/wastage of material in the penetration system.
3.04.00	Contractor shall plan the schedule of supply of the materials in consultation with Project Manager and use the material within stipulated shelf life of material. After award of work, drawings for each penetration seal shall be prepared by the contractor after verifying the

	actual installation of cables at site and approval shall be taken from the Project Manager's representative before proceeding with the actual work. The requirement of fire sealing material shall be quantified accordingly. Fire sealing material to be supplied shall be based on the net area to be sealed, wastage, thickness, density and other parameters as per the type test report approved under this contract.
4.00.00	**TECHNICAL REQUIREMENTS**
4.01.00	The fire proof cable penetration system shall fully comply with the requirements of BS:476 Part-20 and also to the requirements specified in this specification.
4.02.00	The penetration system shall prevent spreading of fire in cable beyond the seal system in case of fire and shall have minimum 1 hour fire resistance rating.
4.03.00	The penetration system shall be physically, chemically, thermally stable and shall be mechanically secure to the masonry/concrete/structural members. The system shall be mechanically robust and capable of giving satisfactory performance under vibrations encountered in power stations.
4.04.00	The penetration system shall be capable of withstanding mechanical loads, foot traffic drop loads, vibrations, wind pressure, etc.
4.05.00	The penetration system shall be completely gas and smoke tight.
4.06.00	The penetration system shall retain integrity and perform satisfactorily even after remaining in water for long period.
4.07.00	The materials used in FPCP sealing system shall be non-toxic and harmless to the working personnel.
4.08.00	The penetration materials shall have no reaction with cable sheath/galvanising/painting of structural steel.
4.09.00	The penetration materials shall have anti-rodent and anti-termite properties.
4.10.00	The penetration materials shall have no shrinkage or cracking after the setting for the complete life of the power Plant.
4.11.00	Under normal load, short circuit and fire conditions, cables may be subjected to movement and vibration. The FPCP sealing system shall be designed to withstand and perform satisfactorily under these conditions.
4.12.00	The penetration system shall not affect the current carrying capacity of cables passing through it.
4.13.00	Asbestos shall not be used in the construction of fire penetration seal system.
4.14.00	The penetration system shall have life expectancy of 40 years.

4.15.00	The penetration system shall not emit any corrosive or toxic fumes or smoke on the unexposed face of the barrier.
4.16.00	Any wastage of the compound during the process of mixing for preparing the FPCP sealing compound shall be to Contractor's account.
4.17.00	For foam type of systems, only the foam shall form the penetration seal of specified rating, having the damming board removed after curing of the foam.
5.00.00	**PACKING AND STORAGE**
5.01.00	All materials and components of penetration system shall be supplied in packing to avoid contamination of materials due to dust/moisture and temperature during transit and storage. All packing shall be of durable quality and the date of expiry and the date of manufacture shall be printed on it.
6.00.00	**INSTALLATION**
6.01.00	The contractor shall take adequate care to ensure that cables are not damaged in any manner during penetration system installation.
6.02.00	Wherever the floor/wall opening provided in the vicinity of penetration seals larger or smaller than that required for the cable fire penetration, these opening size can be reduced or increased in an approved manner by the contractor using the same materials as provided around the opening and of the same thickness. Generally the walls in the power station comprises of brickwork and the floors are made of RCC/steel work.
6.03.00	The work to be carried out under this specification shall be done under the supervision of Project Manager's representative.
6.04.00	All work shall be carried out in accordance with the agreed "field quality plan" and approved drawings. The "field quality plan" shall additionally specify the fire sealing material thickness, minimum cured density and other related parameters achieved in the approved type tests for the contract. The work shall be done to the satisfaction of the Project Manager and the same shall be subject to Project Manager's approval for acceptance.
6.05.00	The installation shall be carried out in a neat workmen like manner by the skilled, experienced and competent workmen.
6.06.00	Installation work at site shall be properly coordinated with other services.
6.07.00	All materials being supplied or consumed during installation by the Contractor in the process of installation shall be of the best quality and according to standards. All materials shall be inspected and approved by the Project Manager before the same is used for installation work. Also regarding inspection of work, the engineer shall have the right to inspect at any stage during installation, testing and commissioning.
6.08.00	The drilling and welding of building-steel or fixing supports etc. shall be carried out by contractor after taking prior approval of Project Manager.

7.00.00	**TYPE TESTS, ROUTINE & ACCEPTANCE TESTS**
7.01.00	All equipment to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.
7.02.00	However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval.
7.03.00	All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.
7.04.00	The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and “No design change”. Minor changes if any shall be highlighted on the endorsement sheet.
7.05.00	Following Type test reports as per the setup and procedures given in subsequent clauses for the Fire proof cable penetration sealing system shall be submitted: a) The accelerated ageing test b) Water absorption test c) Fire rating test d) Hose stream test e) Vibration test followed by fire rating test
7.05.01	Tests a, b, c and d should have been carried out on same test sample subsequently one after the other without any touching up/repair/modifications in the same sequence and in accordance with the clause 9.00.00. The test sample shall be assembled as per clause 8.00.00.
7.05.02	Test indicated in clause 7.05.00 (e) above should have been carried out on a separate sample and as per the procedure indicated under clause 9.05.00.
7.05.03	Physical, chemical and mechanical properties of various components/ingredients used should have been also be tested as a part of type tests.
7.05.04	Test reports shall contain the following information: 1. Type of penetration material tested

2. Details of various components/ingredients used alongwith their catalogue.

3. Physical, chemical and mechanical properties of various components/ ingredients used.

4. Description of the various test assemblies tested.

5. Details of method of conditioning.

6. The observations as called for in BS:476 Part-20 and technical specification.

7.06.00 **ROUTINE & ACCEPTANCE TESTS**

Routine and acceptance tests to be carried out on Type-A and Type-B cable fire sealing system shall be mutually agreed based on the type of fire sealing material offered before placement of award.

8.00.00 TEST SPECIMEN ASSEMBLY

8.01.00 The test specimen shall be assembled as per enclosed drawing and shall resemble typical floor crossing cable penetration system.

8.02.00 The test specimen shall be designed to seal an opening of adequate size in a concrete slab of 200 mm thickness. Two lengths of 300/600 mm wide ladder type cable tray shall be assembled with required layer of XLPE/PVC insulated, PVC sheathed unarmoured cables in touching formation. Type and number of cables in the cable tray shall be as per enclosed drawing. Cables shall be adequately clamped with tray at both the sides of the penetration as shown in the drawings. However, for penetration system with blocks which require staggered arrangement, cables can be clamped at an adequate distance from the penetration and the tray need not pass through the penetration seal.

8.03.00 The opening in the test specimen then shall be sealed with fire proof cable penetration sealing materials.

9.00.00 TEST PROCEDURES

9.01.00 **ACCELERATED AGEING TEST**

The test specimen assembled as per clause 8.01.00 with damming board removed shall be subjected to accelerated ageing test by storing in air furnace where the temperature of the inside air shall be maintained at 85 degree centigrade for 168 hours. The temperature controlled furnace should have 7 air changes per hour approx.

9.02.00 **WATER ABSORPTION TEST**

9.02.01 The test specimen shall be immersed in fresh clean water at a temperature of 20 deg. C $\pm$ 2 deg 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 hour soak period the specimen shall be removed from water and mopped up with a damp cloth.

9.03.00	**FIRE RATING TEST**
9.03.01	The test specimen after withstanding water absorption test shall be subjected to fire rating test as per BS: 476 part-20.
9.03.02	Oil/Gas fired furnace shall be used for heating. The furnace shall have achieved standard time/temperature characteristics for fire tests as per BS:476 part-20.
9.03.03	The pressure inside the furnace at the time of test shall be within 1.5 $\pm$ 0.5 mm water gauge.
9.03.04	Cables in the test specimen shall be anchored on the hot side to a structure independent of the barrier and its penetrations. This is to ensure that any differential movement between the penetration and the cable that could occur during a fire, is produced in the type tests and the reliability of the integrity of the penetration is checked.
9.03.05	Cables shall be protruding between 1 to 2 metre, from the penetration face on the unexposed side and protruding into the furnace as far as it is practicable with a minimum length 750 mm. The ends of the cables shall be capped on the unexposed face to prevent gases and fumes to escape from the furnace during the fire.
9.03.06	The test specimen shall be subjected to fire test with surface exposed to controlled fire in the furnace confirming to time/temperature characteristics specified in BS:476(20).
9.03.07	During the test the temperature of both the faces of the fire stop i.e. one which is exposed to fire and other unexposed shall be measured by calibrated thermo couples after regular interval of 5 minutes.
9.03.08	Atleast 3 thermo couples shall be provided for temperature measurement of each face. The results at the end of the test shall be interpreted for failure criteria as under. 1. The system is deemed to have failed to maintain stability if there is a total collapse of the fire proof seal. 2. In case cracks are seen on the face of the fire stop or cracks through which the flame/ hot gas can pass the systems deemed to have failed to maintain integrity. The development of crack is characterised by appearance of black soot on cotton wool held near the penetration on the unexposed surface at a distance of about 100mm. 3. Failure shall be deemed to have occurred when the mean temperature of the unexposed surface of the specimen assembly increases by more than 140^0C above the initial temperature or if the temperature of the unexposed surface is increased at any point by more than 180^0C above the initial temperature. During the test the specimen shall meet all the three criteria simultaneously.
9.03.09	Temperature measurement on the unexposed side of penetration seal shall be measured by thermocouples at a distance of 25 mm from unexposed side of fire stop.
9.04.00	**HOSE STREAM TEST**

9.04.01	A hose stream test shall be conducted on the test specimen immediately following a fire resistance test on that assembly. The specimen must first be removed from the furnace since the hose stream is to be applied to the exposed face. This must be done quickly since it is the intention of the test that the stream be applied to the specimen whilst it is hot.
9.04.02	The hose stream shall be long range narrow angle, (20^0 - 90^0 set at 30^0 included angle). High velocity water spray provided from a 28 mm hose discharging through an appropriate nozzle. The water pressure shall be 5 bar calculated at the base of the nozzle and the minimum flow rate shall be 4.7 litres/second. The stream shall be supplied perpendicularly to the exposed face of the test specimen with nozzle 3 m away from the exposed face.
9.04.03	Application shall be for minimum of two and a half minutes per 9 sq.m. of the test specimen including the barrier.
9.05.00	**VIBRATION TEST**
9.05.01	The test assembly is to comprise a single ladder rack penetration in 1 m x 1m high normal section of fire barrier which is securely supported. The penetration seal shall be formed in the middle of the barrier around 1 m length of 600 mm ladder rack. The tray shall be fully loaded with cables in touching formation. The penetration assembly shall be formed symmetrically through the fire barrier as in service. The penetration sealant material shall then be allowed to cure for atleast as long as the time required for conditioning to constant mass. A vibration test shall then be conducted on the sample as set out below.
9.05.02	The vibration shall be of 100 Hz frequency and of 0.5 mm amplitude (1.0 mm peak to peak) and this shall be applied to one rail of the ladder rack or the centre of a cross member secured to the two rails at 250 mm from the centre line of the penetration. This vibration shall be applied to the sample for the minimum period of 3 hrs. Immediately following this vibration test the barrier/ penetration assembly shall be successfully subjected to a fire test in accordance with clause no. 9.03.00.

SUB-SECTION-B – 10

CABLING EARTHING AND LIGHTNING PROTECTION

1.00.00 CODES AND STANDARDS

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

IS:513	Cold rolled low carbon steel sheets and strips.
IS:802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.
IS:1079	Hot Rolled carbon steel sheet & strips
IS:1239	Mild steel tubes, tubulars and other wrought steel fIttings
IS:1255	Code of practice for installation and maintenance of power cables upto and including 33 KV rating
IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:2309	Code of Practice for the protection of building and allied structures against lightning.
IS:2629	Recommended practice for hot dip galvanising of iron & steel
IS:2633	Method for testing uniformity of coating on zinc coated articles.
IS:3043	Code of practice for Earthing
IS:3063	Fasteners single coil rectangular section spring washers.
IS:6745	Methods for determination of mass of zinc coating on zinc coated iron & steel articles.
IS:8308	Compression type tubular in- line connectors for aluminium conductors of insulated cables
IS:8309	Compression type tubular terminal ends for aluminium conductors of insulated cables.
IS:9537	Conduits for electrical installation.
IS:9595	Metal - arc welding of carbon and carbon manganese steels - recommendations.
IS:13573	Joints and terminations for polymeric cables.
BS:476	Fire tests on building materials and structures
IEEE:80	IEEE guide for safety in AC substation grounding
IEEE:142	Grounding of Industrial & commercial power systems
DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.
DIN 46329	Cable lugs for compression connections, ring type ,for Aluminium conductors
BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables.
	Indian Electricity Act.
	Indian Electricity Rules.

1.02.00 Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE, NEMA etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards alongwith copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

2.00.00 DESIGN AND CONSTRUCTIONAL FEATURE

2.01.00 **Inter Plant Cabling**

2.01.01 Interplant cabling for main routes shall be laid along overhead trestles/duct banks. Cables from main plant to switchyard control room shall be laid in overhead trestles or duct bank. In case of Duct banks, pull-pits shall be filled with sand and provided with a PCC covering. Directly buried cables, if essential, shall not have concentration of more than 4 cables in one route. Cables crossing Railway line (if applicable) shall be laid underground through nearest culvert. Necessary statutory clearance if required shall be taken by Bidder. All HT, LT and control cable shall be armoured.

2.01.02 **Transformer yard**
In transformer yard cables shall be laid in overhead trestle. The main cable routes coming out from Main plant building and crossing the Transformer yard shall be laid in overhead trestles. In transformer yard, trestle height for rail/road crossing shall be suitable for movement of Generator Transformer with bushing.

2.01.03 **Trenches**
PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.

2.01.04 No sub zero level cable vault/trenches shall be provided below control building/switchgear rooms in main plant.

2.01.05 **Cable Vault**
The cable vault/ / cable spreader room space below the HT / LT switchgear room, Control Rooms, unit control equipment room, Programmer room, UPS, Charger & Battery Rooms, shall have **800 mm wide** and 2.1 m high movement passage all around the cable trays in the cable vault/ cable spreader room for easy laying/maintenance of cables

Cable vaults shall be provided with adequate drainage facilities for drainage of fire water.
Each cable vault should have at least two doors.
Exit signs shall be provided near doors for personnel escape in case of emergency

2.01.06 **Boiler Area**
Cable trays in boiler & ESP area shall be supported from the boiler and ESP structures. The same shall be coordinated with SG/ESP contractor.
Cable trays in these areas shall be in vertical formation to avoid dust accumulation. No cable trenches shall be provided in boiler/ESP area.

2.01.07 Two separate cable routes shall be provided for cable routing of working and standby drives or different set/group (say 50% capacity) of auxiliaries.

2.01.08 **OffSite Area**
For feeder in bidder's scope for offsite areas, overhead cable tray arrangement shall be followed. However cable trenches/slit may also be acceptable, for some areas, if found to be required during detailed engineering.
Cable trenches provided shall be separated from fuel oil area to avoid oil accumulation.

2.01.09 The cable slits to be used for motor/equipment power/control supply shall be sand filled & covered with PCC after cabling.

2.01.10 Sizing criteria, derating factors for the cables shall be met as per respective chapters. However for the power cables, the minimum conductor size shall be 6 sq.mm. for aluminium conductor and 2.5 sq.mm. for copper conductor cable.

2.01.11 Conscious exceptions to the above guidelines may be accepted under special conditions but suitable measures should be taken at such location to:

- Meet all safety requirements
- Safeguard against fire hazards, mechanical damage, flooding of water, oil accumulation, electrical faults/interferences, etc

3.00.00 EQUIPMENT DESCRIPTION

3.01.00 **Cable trays, Fittings & Accessories**

3.01.01 Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.) accessories (like side coupler plates, etc. and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.

3.01.02 Cable trays, fittings and accessories shall be fabricated out of rolled mild steel sheets free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per Clause No. 3.13.00 of this chapter.

3.01.03 Cable trays shall have standard width of 150 mm, 300 mm & 600 mm and standard lengths of 2.5 metre. Thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be 3 mm.

3.01.04 Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of thickness 2 mm and shall be hot dip galvanised as per Clause No. 3.13.00 of this chapter. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm.

3.01.05 The tolerance for cable tray and accessories shall be as per IS 2102 (Part-1).
Tolerance Class: - Coarse

3.02.00 **Support System for Cable Trays**

3.02.01 Cable tray support system shall be pre-fabricated out of single sheet as per enclosed tender drawings.

3.02.02 Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types : (i) C1:- having provision of supporting cable trays on one side and (ii) C2:-having provision of supporting cable trays on both sides. The support system shall be the type described hereunder

a. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardwares such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.

b. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardwares fitings and accessories shall be prefabricated factory galvanised.

c. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvansied surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied

d. All steel components, accessories, fittings and hardware shall be hot dip galvanised after completing welding, cutting, drilling and other machining operation.

e. The typical arrangement of flexible support system is shown in the enclosed drawings and described briefly below:
The main support channel and cantilever arms shall be fabricated out of 2.5 thick rolled steel sheet conforming to IS 1079.

f. Cantilever arms of 320 mm, 620mm and 750 mm in length are required, and shall be as shown in the enclosed drawing. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.

g. Support system shall be able to withstand
- weight of the cable trays
- weight of the cables (75 Kg/Metre run of each cable tray)
- Concentrated load of 75 Kg between every support span.
- Factor of safety of minimum 1.5 shall be considered.

3.02.03 The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above or in the enclosed drawings are indicative only. Nevertheless, the support system shall be designed by the bidder to fully meet the requirements of type tests as specified. In case the system fails in the tests, the components design modification shall be done by the Bidder without any additional cost to the Employer. The bidder shall submit the detailed drawings of the system offered by him alongwith the bid.

3.02.04 Four legged structure shall be provided wherever there is change in elevation and change in direction

3.02.05 FOR COAL HANDLING PLANT/**FGD PLANT/ ESP AREA** THE FOLLOWING SHALL ALSO BE APPLICABLE**:**

a) All overhead cable routes shall be along the route of the conveyor gallery on separate supporting structures and cables shall be laid in vertical trays. The bottom of the steel shall be such that the existing facilities, movement of trucks/human beings etc. does not get affected. The cable trestle shall have a minimum 600mm clear walk way and shall have maintenance platforms as required. The bottom of the steel supporting structure shall be generally at 3.0M above the grade level except for rail/road crossings where it shall be at 8.0M above grade level. Tap offs from the overhead cable trestle can be through shallow trenches with prior approval of the Employer. Directly buried cable, if essential, shall not have concentration of more than 4 cables on one route.

b) Cable trenches shall be provided only in Switchgear/MCC rooms.

c) Cables shall not be routed through the conveyor galleries except for the equipment located in the conveyor galleries for a particular conveyor i.e. protection switches, receptacles etc.

d) Cables for PCS and BSS shall be routed along the conveyors through GI conduits.

3.03.00 **Pipes, Fittings & Accessories**

3.03.01 Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria

3.03.02 GI Pipes shall be of medium duty as per IS: 1239

3.03.03 Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.

3.03.04 Hume pipes shall be NP3 type as per IS 458.

3.03.05 TERNE Coated Flexible Steel Conduits shall be water proof and rust proof made of heat resistant lead coated steel. Conduit diameter shall be uniform throughout its length. Internal surface of the conduit shall be free from burrs and sharp edges. Conduits shall be complete with necessary accessories for proper termination of the conduit with junction boxes and lighting fixtures

3.03.06 HDPE pipes and conduits shall be PE-80, PN-10 type as per IS 4984/IS 8008 part-I.

3.04.00 **Junction Boxes**

3.04.01 Junction box shall be made of Fire retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type. The box shall be provided with the terminal blocks, mounting bracket and screws etc. The cable entry shall be through galvanized steel conduits of suitable diameter. The JB shall have suitable for installing glands of suitable size on the bottom of the box. The JB shall be suitable for surface mounting on ceiling/structures. The JB shall be of grey color RAL 7035. All the metal parts shall be corrosion protected. Junction box surface should be such that it is free from crazings, blisterings, wrinkling, colour blots/striations. There should not be any mending or repair of surface. JB's will be provided with captive screws so that screws don't fall off when cover is opened. JB's mounting brackets should be of powder coated MS. Type test reports for the following tests shall be furnished:-

(a) Impact resistance for impact energy of 2 Joules (IK07)as per BS EN50102

(b) Thermal ageing at 70deg C for 96 hours as per IEC60068-2-2Bb.

(c) Class of protection shall be IP 55.

(d) HV test.

3.04.02 Terminal blocks shall be 1100V grade, of suitable current rating, made up of unbreakable polyamide 6.6 grade. The terminals shall be screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals the screw shall be captive, preferably with screw locking design. All terminal blocks shall be suitable for terminating on each side the required cables/wire size. All internal wiring shall be of cu. Conductor PVC wire.

3.05.00 **Terminations & Straight Through Joints**

3.05.01 Termination and jointing kits for 33kV, 11 kV, 6.6 KV and 3.3 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be Pre-moulded type or heat shrinkable type. Further Cold shrinkable type termination and jointing kits are also acceptable. The Cold shrinkable type kits shall be type tested as per relevant standards. Calculation to withstand the required fault level shall also be furnished in case of cold shrinkable type kits. 33 kV, 11 kV, 6.6 KV and 3.3kV grade joints and terminations shall be type tested and Type test reports as per IS:13573 Part-II and IEC60502 shall be furnished. Also, heat shrink material shall comply with requirements of ESI 09-13 (external tests). Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Cable joints and terminations should be with FRLS properties as per IEC 60754-1&2. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the tinned copper solderless

crimping type cable lugs & ferrule or mechanical connectors (wherein bolts are tightened that shear off at an appropriate torque) as per DIN standard suitable for aluminium compacted conductor cables.

3.05.02 Straight through joint and termination shall be capable of withstanding the fault level of 21 KA for 0.12 Sec. with dynamic peak of 52 KA for 33 KV system & of 40 kA for 0.12 sec with a dynamic peak of 100 kA for 11 kV, 6.6 KV & 3.3 KV system. Straight through joints shall have provisions for shield connection and earthing wherever required and complete with all accessories and consumables suitable for storage without deterioration at a temperature of 50 deg. C with shelf life of more than five years. 1.1 kV grade straight through joints shall also be of proven design

3.05.03 1.1 KV grade Straight Through Joint shall be of proven design.

3.06.00 **Cable glands**

3.06.01 Cable shall be terminated using double compression type cable glands. Testing requirements of Cable glands shall conform to BS:6121 and gland shall be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall be suitable for the sizes of cable supplied/erected.

3.07.00 **Cable lugs/ferrules**

3.07.01

Cable lugs/ferrules shall be solderless crimping type suitable for power and control cables as per the DIN 46239. Aluminium solderless crimping lugs/ ferrules shall be used for Aluminium cables and Copper lugs/ferrules shall be used for Copper cables. Bimetallic washers or bimetallic type lugs shall be used for bimetallic connections.

Crimping tool for crimping (from 1.5sqmm cable to 630sqmm cables) above mentioned lugs shall be of Hexagonal Type crimp profile, with suitable die of crimp match code.
Characteristics of crimping tool:

1) To should generate enough pressure to pass pull out test as per IEC 61238-1. Relevant type test to be produced for the sizes specified in the tender.
2) Tool die shall be replaceable for assorted sizes and crimp code to be mentioned on both part the die.
3) Tool should be compliant of testing according to IEC, UL and GS standards.

Tool shall have features such as:

- Auto retraction system
- Manual retraction stop.
- Feedback signals for improper pressure
- Better battery capacity and with status display
- Flexible and rotating head for easy crimping.

3.08.00 **Trefoil clamps**

3.08.01 Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength, when installed at 1 mtr intervals, to withstand the forces generated by the peak value of maximum system short circuit current.

3.09.00 **Cable Clamps & Ties**

3.09.01 The cable clamps/ties required to clamp multicore cables shall be of SS-316 material, 12mm wide, polyster coated ladder lock type. The clamps/ties shall have self locking arrangement

& shall have sufficient strength. The cable clamps/ties shall be supplied in finished individual pieces of suitable length to meet the site requirements.

3.10.00 **Receptacles**

3.10.01 Receptacles boxes shall be fabricated out of MS sheet of 2mm thickness and hot dipped gavanised or of die-cast aluminium alloy of thickness not less than 2.5 mm. The boxes shall be provided with two nos. earthing terminals, gasket to achieve IP55 degree of protection, terminal blocks for loop-in loop-out for cable of specified sizes, mounting brackets suitable for surface mounting on wall/column/structure, gland plate etc. The ON-OFF switch shall be rotary type heavy duty, double break,AC23 category, suitable for AC supply. Plug and Socket shall be shrouded Die-cast aluminium. Socket shall be provided with lid safety cover. Robust mechanical interlock shall be provided such that the switch can be put ON only when the plug is fully engaged and plug can be withdrawn only when the switch is in OFF position. Also cover can be opened only when the switch is in OFF position. Wiring shall be carried out with 1100 V grade PVC insulated stranded aluminium/copper wire of adequate size. The Terminal blocks shall be of 1100 V grade. The Terminal blocks shall be of 1100 V grade made up of unbreakable polymide 6.6 grade with adequate current rating and size. The welding receptacles shall be provided with RCCB/RCD of 30mA sensitivity having facility for manual testing/checking of operation of RCCB/RCD. Location and Minimum no of RC type receptacle TG and SG area shall be provided as per Annex-I attached.

3.11.00 **Cable Drum Lifting Jack**

The jack for cable drum lifting shall be of screw type with 10 ton capacity. The cable drum jacks shall be manufactured from fabricated steel. The spindles supplied with the cable drum jack shall be manufactured using BSEN-24 grade steel bar with locking collars. Jack nests shall be of SG cast steel. Cable drum jack supplied shall have undergone load testing and reports for the same shall be submitted. At least Two Nos. of jacks shall be supplied for NTPC use. Contractor has to make arrangements for his own jacks for cable reeling/unreeling under his scope of installation.

3.12.00 **Galvanising**

3.12.01 Galvanising of steel components and accessories shall conform to IS:2629 , IS4759 & IS:2633. Additionally galvanising shall be uniform, clean smooth, continuous and free from acid spots.

3.12.02 The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS:1367 . The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified

3.13.00 **Welding**

3.13.01 The welding shall be carried out in accordance with IS:9595. All welding procedures and welders qualification shall also be followed strictly in line with IS:9595

4.00.00 INSTALLATION

4.01.00 **Cable tray and Support System Installation**

4.01.01 Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures.

4.01.02 Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 2000 mm in general. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm in general. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted.

Cable tray installation shall generally be carried out as per the approved guidelines/ drawings. Vendor shall design the support system along with tray, spacing etc in line with tray loadings/drawings.

4.01.03 The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated.

4.01.04 The contractor shall fix the brackets/ clamps/ insert plates using anchor fasteners. Minimum size of anchor fasteners shall be M 8 X 50 and material shall be stainless steel grade 316 or better. Anchor fastener shall be fixed as recommended by manufacturer and as approved by site engineer. For brick wall suitable anchor fasteners shall be used as per the recommendations of manufacturer. Make of anchor fasteners subject to QA approval and the same shall be finalized at pre-award stage.

4.01.05 All cable way sections shall have identification, designations as per cable way layout drawings and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/stenciled with identification numbers at every floor.

4.01.06 In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. Fabricated sections of trays, supports and accessories to make the installation complete at site shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.

4.01.07 In fire prone areas, like Boiler, TG, fuel oil area and any other strategic location etc, fire retardant paint to be applied after installation cables.

4.02.00 **Conduits/Pipes/Ducts Installation**

4.02.01 The Contractor shall ensure for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/roof/wall / cable tunnel/cable trenches made for conduit installation shall be sealed and made water proof by the Contractor.

4.02.02 GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.

4.02.03 Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material

4.02.04 Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise

Conduit /pipe size (dia).	**Spacing**
Upto 40 mm	1 M
50 mm	2.0 M
65-85 mm	2.5 M
100 mm and above	3.0 M

4.02.05 For bending of conduits, bending machine shall be arranged at site by the contractor to facilitate cold bending. The bends formed shall be smooth.

4.03.00 **Junction Boxes Installation**

4.03.01 Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the drawings and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.

4.04.00 **Cable Installation**

4.04.01 Cable installation shall be carried out as per IS:1255 and other applicable standards.

4.04.02 For Cable unloading, pulling etc following guidelines shall be followed in general:

a) Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, 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 cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.

b) While laying cable, ground rollers shall be used at every 2 meter interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables. If any particular cable is damaged, the same shall be repaired or changed to the satisfaction of Project Manager.

4.04.03 Cables shall be laid on cable trays strictly in line with cable schedule

4.04.04 Power and control cables shall be laid on separate tiers inline with the approved guidelines/drawings. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.T. cables shall be laid on top most tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every one metre. All multicore cables shall be laid in touching formation. Power and control cables shall be secured fixed to trays/support with cable clamps/ties with self locking arrangement. For horizontal trays arrangements, multicore power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multicore power cables and control cables shall be secured at every one meter. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by cable clamps/ties with self locking arrangement at every five meter interval and at every bend.
Fibre Optical cable shall be laid in trenches/trays or as decided by Employer.

4.04.05 Bending radii for cables shall be as per manufacturer's recommendations and IS:1255.

4.04.06 Where cables cross roads/rail tracks, the cables shall be laid in hume pipe/ HDPE pipe.

4.04.07 No joints shall be allowed in trip circuits, protection circuits and CT/PT circuits. Also joints in critical equipment in main plant area shall not be permitted. Vendor shall identify and accordingly procure the cable drum length.

4.04.08 In each cable run some extra length shall be kept at suitable point to enable one LT/two HT straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.

4.04.09 Wherever few cables are branching out from main trunk route troughs shall be used.

4.04.10 Wind loading shall be considered for designing support as well Cable trays wherever required.

4.04.11 Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures.

4.04.12 The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.

4.04.13 **Separation**

At least 300mm clearance shall be provided between:

- HT power & LT power cables,
- LT power & LT control/instrumentation cables,

4.04.14 **Segregation**

1) Segregation means physical isolation to prevent fire jumping.
2) All cables associated with the unit shall be segregated from cables of other units.
3) Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set.
4) In switchyard, control cables of each bay shall be laid on separate racks/trays.

4.04.15 Minimum number of spare cores required to be left for interconnection in control cables shall be as follows:

Minimum number of spare cores required to be left for interconnection in control cables shall be as follows:

No. of cores in cable	No. of spare cores
2C,3C	NIL
5C	1
7C-10C	2
14C and above	3

4.04.16 **Directly Buried Cables**

a) Cable trenches shall be constructed for directly buried cables. Construction of cable trench for cables shall include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of brick or concrete protective covers, back filling and compacting, supply and installation of route markers and joint markers. Laying of cables and providing protective covering shall be as per IS:1255 and the enclosed drawings showing cabling details.

b) RCC cable route and RCC joint markers shall be provided wherever required. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint". The marker shall project 150 mm above ground

and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker.

4.04.17 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties with cable number heat stamped on the cable tags. The cable tag requirements mentioned above shall prevail over Tag requirements mentioned elsewhere in this document for HT power, LT power & control cables.

4.04.18 While crossing the floors, unarmoured cables shall be protected in conduits upto a height of 500 mm from floor level if not laid in tray.

4.05.00 **Cable Terminations & Connections**

4.05.01 The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer" instructions, drawings and/or as directed by Project Manager. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.

4.05.02 Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Project Manager.

4.05.03 The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.

4.05.04 Control cable cores entering control panel/switchgear/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self locking type nylon cable ties with de interlocking facility to keep them in position.

4.05.05 All the cores of the control cable to be terminated shall have identification by providing ferrules at either end of the core, each ferrule shall be indelible, printed single tube ferrule and shall include the complete wire number and TB number as per the drawings. The ferrule shall fit tightly on the core. Spare cores shall have similar ferrules with suffix sp1, sp2, ---etc along with cable numbers and coiled up after end sealing.

4.05.06 All cable terminations shall be appropriately tightened to ensure secure and reliable connections.

5.00.00 EARTHING SYSTEM

5.01.00 Earthing system shall be in strict accordance with IS:3043 and Indian Electricity Rules/Acts

The earthing system shall be designed for a life expectancy of at least forty (40) years, for a system fault current of 63 kA for 1.0 sec. The minimum rate of corrosion of steel for selection of earthing conductor shall be 0.12mm per year.

Earthing system network/earthmat shall be interconnected mesh of mild steel rods buried in ground in the plant. All areas under contractor scope of supply shall be interconnected together by minimum two parallel conductors. The Contractor shall furnish the detailed design and calculations for Employer's approval. Contractor shall obtain all necessary statutory approvals for the system. All the columns shall be earthed by nearby risers and earthmat grid spacing shall be maximum 10 mts. Minimum two nos of risers shall be provided for each equipment in SG area. Separate dedicated riser shall be provided for C&I earthing purpose and also for Lightning down conductor connection purpose. Sufficient nos of risers near the equipment shall be provided as per the system requirement. Ring type earthing around the offsite building shall be provided with interconnection of with main grid at minimum two points.

5.02.00 The earth conductors shall be free from pitting, laminations, rust, scale and other electrical, mechanical defects

5.03.00 The material of the earthing conductors shall be as follows:

1)	Conductors above ground level and in built up trenches.	-	Galvanized steel
2)	Conductors buried in earth	-	Mild steel
3)	Earth electrodes	-	Mild steel rod

5.04.00 The sizes of earthing conductors for various electrical equipments shall be as below:

	Equipment	Earth conductor buried in earth	Earth conductor above ground level & in built-up trenches
a)	Main earth grid	Min 40 mm dia. MS rod or as per actual calculation whichever is more	65 x 8mm GS flat
b)	33kV/11kV/6.6kV/3.3 kV/ switchgear equipment and 415V switchgear	---	65 x 8mm GS flat
c)	415 V MCC/ Distribution boards / Transformers	---	50 x 6mm GS flat
d)	LT Motors above 125 KW	---	50 x 6mm GS flat
	25 KW to 125 KW	---	25 x 6mm GS flat
	1KW to 25 KW	---	25 x 3mm GS flat
	Fractional House power motor	---	8 SWG GS wire
e)	Control panel & control desk	---	25 x 3 mm GS flat
f)	Push button station / Junction Box	---	8 SWG GI wire
g)	Columns, structures, cable trays and bus ducts enclosures	---	50 x 6mm GS flat
h)	Crane, rails, rail tracks & other non-current carrying metal parts		25 x 6mm GS flat

5.05.00 Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity, Crane rails, tracks, metal pipes and conduits shall also be effectively earthed at two points. Steel RCC columns, metallic stairs,

and rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing ensured by bonding the different sections of hand rails and metallic stairs. Metallic sheaths/screens, and armour of multi-core cables shall be earthed at both ends. Metallic Sheaths and armour of single core cables shall be earthed at switchgear end only unless otherwise approved. Every alternate post of the switchyard fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post. Railway tracks within the plant area shall be bonded across fish plates and connected to earthing grid at several locations. Portable tools, appliances and welding equipment shall be earthed by flexible insulated cable.

5.06.00 Each continuous laid lengths of cable tray shall be earthed at minimum two places by G.S. flats to earthing system, the distance between earthing points shall not exceed 30 meter. Wherever earth mat is not available, necessary connections shall be done by driving an earth electrode in the ground

5.07.00 Neutral points of HT transformer shall be earthed through NG resistors. The Contractor shall connect the NGR earthing point to earth electrodes by suitable earth conductors.

5.08.00 Neutral connections and metallic conduits/pipes shall not be used for the equipment earthing. Lightning protection system down conductors shall not be connected to other earthing conductors above the ground level.

5.09.00 Connections between earth leads and equipment shall normally be of bolted type. Contact surfaces shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti corrosive paint/compound.

5.10.00 Suitable earth risers as approved shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.

5.11.00 Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding.

5.12.00 Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.

5.13.00 Earthing conductors buried in ground shall be laid minimum 600 mm below grade level unless otherwise indicated in the drawing. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm.

5.14.00 Earthing conductors embedded in the concrete floor of the building shall have approximately 50 mm concrete cover.

5.15.00 A minimum earth coverage of 300 mm shall be provided between earth conductor and the bottom of trench/foundation/underground pipes at crossings. Earthing conductors crossings the road can be installed in pipes. Wherever earthing conductor crosses or runs at less than 300 mm distance along metallic structures such as gas, water, steam pipe lines, steel reinforcement in concrete, it shall be bonded to the same.

5.16.00 Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding / cleating at interval of 1000mm and 750mm respectively.

5.17.00 Earth pit shall be of treated type & shall be constructed as per IS:3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 600mm. Earth pits shall be treated with salt and charcoal as per IS:3043. Test links shall be

provided with bolted arrangement alongwith each earth pit, in order to facilitate measurement of earth resistance as & when required.

5.18.00 On completion of installation continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured and recorded. All equipment required for testing shall be furnished by contractor.

5.19.00 Earthing conductor shall be buried at least 2000mm outside the fence of electrical installations. Every alternate post of the fences and all gates shall be connected to earthing grid by one lead.

5.20.00 Other Requirements of Earthing System:

Standard/Code	IEEE 80, IS 3043
Earthing System	
Life expectancy	40 Years
System Fault Level	System Fault Level 63 KA for 1 sec
Soil resistivity	Actual as per site conditions.
Min. Steel corrosion	0.12mm/year
Depth of burial of main earth conductor	600mm below grade level; where it crosses trenches, pipes, ducts, tunnels, rail tracks, etc., it shall be at least 300mm below them.
Conductor joints	By electric arc welding, with resistance of joint not more than that of the conductor.

Welds to be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection.

Surface resistivity	- Gravel	3000 ohm-meter
	- Concrete	500 ohm-meter

6.00.00 LIGHTNING PROTECTION SYSTEM

6.01.01 Lightning protection system shall be in strict accordance with IEC : 62305 and latest IS standards.

6.01.02 Lightning conductor shall be of 25x6mm GS strip when used above ground level and shall be connected through test link with earth electrode/earthing system

6.01.03 Lightning system shall comprise of air terminations, down conductors, test links, earth electrode etc. as per approved drawings.

6.02.00 **Down Conductors**

1. Down conductors shall be as short and straight as practicable and shall follow a direct path to earth electrode.
2. Each down conductor shall be provided with a test link at 1000 mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point.
3. All joints in the down conductors shall be welded type.
4. Down conductors shall be cleated on outer side of building wall, at 750 mm interval or welded to outside building columns at 1000 mm interval.
5. Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PCC/insulating compound shall be used for conductor fixing at an interval of 1500 mm.
6. All metallic structures within a vicinity of two meters of the conductors shall be bonded to conductors of lightning protection system.
7. Lightning conductors shall not pass through or run inside GI Conduits.
8. Testing link shall be made of galvanized steel of size 25x 6mm.
9. Pulser system for lightning shall not be accepted.
10. Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths.

7.00.00 **TESTS**

7.02.00 **Type Test reports shall be furnished for the following**

7.02.01 Type tests on Cable Trays support system

a) **Test 1A:**

On main support channel type-C2 for cantilever arms fixed on one side only. A 3.5 meter length of main support channel shall be fixed vertically at each end to a rigid structure as per the fixing arrangement as shown in the enclosed drawing. Eight (8) nos. 750 mm cantilever arms shall be fixed to the main channel and each arm shall be loaded over the outboard 600 mm with a uniform working load of 100 kg. Subsequently a point load of 100 kg shall be applied on arm 2. A uniform proof load on all the arms equal to twice the working load shall be then be applied. Deflections shall be measured at the points shown in the enclosed drawings and at the following load intervals:

i) Working load
ii) Working load + point load
iii) Off load
iv) Proof load + point load
v) Off load

The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied.

B) **Test 1B:**

Test 1A shall be repeated with Eight Cantilever arms uniformly loaded and with the same point load on arm 2

Test 2: **On Main support channel type -C2 for cantilever arms fixed on both sides**

a) Test 2A: A 3.5 m length of main support channel C2 for cantilever arms fixing on both sides shall be fixed at each end to rigid structure as per the fixing arrangement as shown in the enclosed drawing. Six (6), 750 mm cantilever arms shall be attached to each sides and each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of 100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at points shown in the enclosed drawings at the following load intervals.

i) Working load
ii) Working load + Point load
iii) Off load
iv) Proof load + Point load
v) Off load

The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied

b) Test 2 B: The test 2 A shall be repeated with the assembly but with an asymmetrical load on the C2 column and point load applied to arm 8. The 100 kg and 200 kg uniformly distributed loads shall be applied to the upper three arms on one side and the lower three arms on the opposite side.

Test 3 : **Tests on Channel Fixed on Beam/Floor**

A length of main support channel section shall be fixed to steel structure/floor and have loads applied as shown in the drawing enclosed and as detailed below

a) Test 3A : A length of steel structure shall be rigidly supported. It should be fitted on a meter length of channel section using beam clamps welded/bolted. A point load of 1200 kg shall be applied to the centre point via two brackets. No distortion or pulling of the components shall take place.

b) Test 3B: With the components assembled as in Test 3A, two perpendicular point loads of 600 kg shall be simultaneously applied at positions 150 mm either side of the centre line, no distortion or pulling of the components shall take place.

c) Test 3C: With the components assembled as in Test 3A, a perpendicular point load shall be applied at a point 150 mm on one side of the centre line.

The load shall be gradually increased to the maximum value that can be applied without causing distortion or pulling of the components. This value shall be recorded.

Test 4 : Channel Insert Test

A 2.5 m length of C1 channel fixed to the concrete wall/ steel structure as per actual site installation conditions. 6 nos. of 750 mm cantilever arms shall be attached to C1 channel as shown in enclosed drawing. Each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of 100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at points shown in the enclosed drawings at the following load intervals.

i) Working Load

ii) Working Load + Point Load

iii) Off Load

iv) Proof Load + Point Load

v) Off load

The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied

Test 5 : Channel nut slip characteristics (what ever applicable)

Tests 5A1,5A2,5A3 : A length of channel C1 section 200mm long shall have fitted bracket with the two bolt fixing as shown in drawing enclosed.
With loads applied at the position shown in drawing enclosed nut slip shall be determined with bolt torque of 30NM, 50 NM and 65 NM No fewer than three measurements shall be made for each torque setting.

A minimum loading of 720 kg shall be obtained before nut slip with bolt torque of 65 NM.

Tests 5B1,5B2,5B3: The length of channel C1 section 200 mm long shall have fitted bracket with the one bolt fixing as shown in drawing enclosed. With loads applied at the position shown in drawing, nut slip shall be determined with bolt torques of 30 NM, 50 NM and 65 NM. No fewer than three measurements shall be made for each torque setting.

A minimum loading of 350 kg shall be obtained before nut slip with a bolt torque of 65 NM.

Test 6 Weld Integrity Test

After deflection test as per test 1A, 1B, 2, 3 & 4 weld integrity shall be checked by magnetic particle inspection to detect sub-surface cracks developed, if any.

7.02.02 Cable termination kit and straight through joints should have been tested as per IS:13573 for 3.3kV grade & above.

7.03.00 **Routine/ Acceptance Tests**

7.03.01 Routine Tests

a) Routine tests as per specification and applicable standards shall be carried out on all requirements/items covered in the specification.
b) Physical & dimensional check on all equipments as per approved drawings/standards
. c) HV/IR as applicable.
d) Check/measurement of thickness of paint/zinc coating/nickel-chrome plating as per specification & applicable standard.

7.03.02 Acceptance Test

a) Galvanising Tests as per applicable standards
b) Welding checks
c) Deflection tests on cable trays:

One piece each of 2.5m length of cable tray of 300mm & above shall be taken as sample from each offered lot. It shall be supported at both end & loaded with uniform load of 76 kg/meter along the length of cable tray. The maximum deflection at the mid-span of each size shall not exceed 7mm.

d) Proof load tests on cable tray support system

i) Tests on Main Support Channel shall be done if only C1 Channel are in scope of supply and cantilever arms shall be fitted on one side. This test shall be same as test 4 of type test.
ii) Test on Main Support Channel shall be done with C2 channel and cantilever arms fitted on both sides, if C2 channels are in scope of supply. This test shall be same as test 2A of type test. Then test (i) above shall not be done.
iii) Nut slip characteristic test (it shall support minimum load of 350kg before nut slips with a bolt torque of 65 NM). This test shall be same as test 5B3 of type test.

The procedure for carrying out tests at "d" above shall be as per details given in Type Tests in specification thereafter Die-Penetration test shall be carried out to check weld integrity.

e) The above acceptance tests shall be done only on one sample from each offered lot.

8.00.00 COMMISSIONING

8.01.01 The Contractor shall carry out the following commissioning tests and checks after installation at site. In addition the Contractor shall carry out all other checks and tests as recommended by the Manufacturers or else required for satisfactory performance..

8.01.02 **Cables**

a) Check for physical damage
b) Check for insulation resistance before and after termination/jointing.

c) HT cables shall be pressure tested (test voltage as per IS:7098) before commissioning.
d) Check of continuity of all cores of the cables.
e) Check for correctness of all connections as per relevant wiring diagrams. Any minor modification to the panel wiring like removing/inserting, shorting, change in terminal connections, etc., shall be carried out by the Contractor.
f) Check for correct polarity and phasing of cable connections.
g) Check for proper earth connections for cable glands, cable boxes, cable armour, screens, etc.
h) Check for provision of correct cable tags, core ferrules, tightness of connections.

8.02.00 **Cable trays / supports and accessories**

1) Check for proper galvanizing/painting and identification number of the cable trays/supports and accessories.
2) Check for continuity of cable trays over the entire route.
3) Check that all sharp corners, burrs, and waste materials have been removed from the trays supports.
4) Check for earth continuity and earth connection of cable trays.

8.03.00 **Earthing and Lightning protection system**

1) Earth continuity checks.
2) Earth resistance of the complete system as well as sub-system.

9.00.00 ELECTRICAL LAYOUT PHILOSOPHY:

While developing the layout the bidder must give due consideration to the following requirements:

a) Adequate distance shall be maintained between the transformers. As basic guidelines following norms will be adhered to:

1) Transformers shall be separated from the adjacent building/structures and from each other by a minimum distance as defined below or by a fire wall of two hours of fire resisting of height at least 600 mm above bushing / pressure relief vent whichever is higher.

Oil capacity of individual transformer (in liters)	Clear separating distance (in meters)
5,000 to 10,000	8.0
10,001 to 20,000	10.0
20,001 to 30,000	12.5
Over 30,001	15.0

2) In case of auxiliary transformers having an aggregate oil capacity in excess of 2300 liters but individual oil capacity of less than 5000 liters, the maximum separating distance between transformers and surrounding building shall be at least 6M unless they are separated by fire separating walls or are protected by high velocity spray system.

3.) Rail track shall be provided in Transformer yard for movement of each transformer. The rail track in Transformer yard shall be connected with TG area rail track The Foundation top of transformer & rail top shall be at EL +/- 0.0M. Bus duct support or Transformer body shall be at least 8.0M from A-Row of TG building to clear the movement of GT/ Stator/UT/ST/UAT on rail line. Jacking pads shall be provided where the rail track changes the direction. Mooring post shall be provided on rail track for handling the transformers.

4) For each transformer a pit shall be provided all around at a distance of 1.5 m (minimum) from transformer outer edge. A sump pit shall be provided for each pit. A common oil retention pit per unit shall be provided to hold oil quantity of the largest transformer (by volume) & 10 minutes of water quantity of HVW spray system for the largest transformer. Sump pit of individual transformer shall be connected to common oil retention pit of that unit.

5) Rail track shall be provided for all outdoor transformers up to road for movement of each transformer of size more than or equal to 7.5MVA Transformer. Jacking pads shall be provided where the rail track changes the direction. Jacking pad shall also be provided at the location of installation of transformer and mooring post shall be provided on rail track for handling the transformers.

6.) The Transformer fencing shall be at 1.0 M (minimum) distance from the pit wall. The Height of fencing shall be 2.5 M (minimum) and fencing shall have personal entry gate and removable type fencing/gate for transformer withdrawal.

7) The transformer firewall, pit sizing and clearances from adjacent building/structures etc. shall be as per IS 1646/CBIP manual on Transformer

8) However, for all outdoor transformers of oil capacity less than 2000 litre, a trench of suitable size shall be provided all around at a distance of 1.0 m (minimum) from transformer outer edge. A sump pit shall be provided for each trench.

b) Layout requirements for Electrical MCC/switchgear rooms

1. Separate Switchgear Rooms shall be provided for each unit. For TG building, all HT boards shall be provided in HT switchgear room at only one floor and all LT boards shall be provided in LT switchgear room at only one floor

2. The following clearances shall be maintained for HT Switchboard.

a.) Front Clearance

i) For one Row of Swgr. - 2.0 M (Min)

ii) For two Rows of Swgr. - 2.5 M (Min)

b.) Back Clearance - 1.5 M (Min.)

c.) Side Clearance

Min. 800 mm, however provision to be made for any additional panel in future at both ends. Therefore end clearance shall be 800+width of panel (including spare panels/dummy panels etc.)

3. The following clearances shall be maintained for LT Switchboard.

a.) Front Clearance

i) For one Row of Swgr - 1.5M (Min)
ii) For two Rows of Swgr - 1.5/1.75M depending upon the depth of panels etc

b.) Back Clearance
i) For single front - 1.0M (Min)
ii) For double front - 1.5M (Min)

c.) Side Clearance:Min. 800 mm, however provision to be made for any additional panel in future at both ends. Therefore end clearance shall be 800 mm + width of panel.

For offsite areas, HT Switchboard clearances shall be followed wherever both LT & HT switch boards are in the same MCC room.

4. Height of HT/LT Switchgear Room and Boiler MCC room

i) With Bus Duct – 4.5 m (min)
ii) Without Bus Duct – 4.0 m (min)

Further no vertical bracings shall be envisaged in HT/LT switchgear room and associated cable vault area.

5. Cable trench/Cable vault

For LT switchgear/MCC room at EL 0.0M, 1400 wide x 1400 deep cable trench shall be provided to route the cables. Horizontal cable trays shall be routed in cable trenches.

c) Minimum clear working space around the equipment 1200mm

d) In buildings having MCC, minimum 2 fire door along with one rolling shutter of adequate size/capacity shall be provided.

e) The cable entry and exit from switchgear room shall be from 1.5 mtr (minimum) above FGL.

f) Wash basin with mirror shall be provided in battery room.

Annexure-I

1.0 LOCATION OF LP3 :-

One number LP3 to be located in boiler MCC room at 28.0m in BC bay to supply RC receptacles in TG area.

Location of RC Receptacles in Turbine hall

Sl. No.	Name	Location of RC	No. of RC
1	Hot Well	0m (Near CEP)	2
2	Main Oil Tank	8.5m (AB Bay)	1
3	NGT Cubicle/ Gen Bushing	8.5m (AB Bay)	2
4	LAVT	7.5m (AB Bay)	2
5	HP-IP Turbine	17.0m (AB Bay)	2
6	LP Turbine	17.0m (AB Bay)	1
7	TD BFP	17.0m (AB Bay)	1
8	HP Heater - 5	17.0m (BC Bay)	2
9	Deaerator	38.0m (BC Bay)	2
10	LP Heater- 2	8.5m (BC Bay)	1
11	Valve Room	8.5m (AB Bay)	2

Total - 18 nos. RC Receptacles in Turbine Hall.

2.0 LOCATION OF RC RECEPTACLES

Location of Receptacles and Socket in Boiler area

FLOOR	63A WELDING RECEPTACLES		20A, 240V AC INDUSTRIAL SOCKET RA		20A, 24V AC INDUSTRIAL SOCKET RC	
	PROPOSED		PROPOSED		PROPOSED	
	QTY	LOCATION	QTY	LOCATION	QTY	LOCATION
GL-200	10	S7L,R MILL-B,E,G S17 P3L,R ID-A,B	7	S8L,R S21L, P3L,R ID-A,B	4	P2L,R ID-A,B
4710	3	MILL-A,D,J	3	MILL-A,D, MILL-J	8	MILL-A,E,C,D,F,G,H,J
8900	1	S18	1	S18, S14R	1	S12L
9700	2	S7L,R	2	S9L,R	2	S8L,R
11450	2	S8L,R	3	S9L,R S21	4	S10L,R S22L,R
17600					1	P1L
20500(APH BOTTOM), 21850	4	S18(2) S19L,R	7	S9L,R S17, S19L,R S6L,R	7	S9L,R S12L,R S18, S20L,R
21700(FEEDER FLOOR)	2	FEEDER A,J	4	FEEDER-A,C,F,J	4	FEEDER-A,C,F,J
23000	1	S17	2	S13L, S19		
25000(BURNNER BOTTOM, SPRAY STATION)	4	S8L,R S11L,R	5	S1L,R S11L,R S17	5	S1L,R S11L,R S17
28000(APH)	2	S19L,R	2	S19L,R	2	S19L,R
29200(APH, WIND BOX's	4	S20L,R S9L,R	4	S9L,R S20L,R	4	S8L,R S10L,R
32200	2	S9L,R	2	S9L,R		
33400	2	S12L,R	2	S8L,R S19L,R	2	S19L,R
38500	2	S9R, S10L				
42500	2	S10L,R	3	S9L,R S17	3	S9L,R S17
45300	2	S10L,R	4	S9L,R S11L,R	4	S8L,R S10L,R
48000	1	S1R	2	S14R S15L	2	S9L,R
48900	4	S18(2) S12L,R	4	S11L,R S12L,R	2	S11L,R
53600	2	S5L,R	3	S14R S10L,R	2	S5L,R
58000	4	S11L,R S14L S15R	4	S14R S15L S11L,R	2	S11L,R
59200(TRIPPER FLOOR)	2	LEFT, RIGHT	2	L,R		
61400	4	S11L,R S14L S15R	3	S14R S11L,R	2	S11L,R
68100	2	S11L,R	2	S9L,R		
77300	2	S10L,R	4	S9L,R S11L,R	2	S4L,R
83500	2	S10L,R	2	S12L,R		
86700	2	S3L,R	2	S11L,R	2	S11L,R
88600	1	S11L	2	S8L,R	2	S8L,R
95900	1	S1R	1	S1L		
ESP/FG I/L DUCT	4		2		4	
ESP/FG O/L DUCT	2		1		2	
ESP AT MANHOLE DOOR FLOOR	4	IN BETWEEN TWO PASS	4		4	
ESP AT TOP	2		1			
ESP AT -200	2	AT FRONT SIDE BOTH L&R	2			
TOTAL	86		92		77	

SUB-SECTION-B – 11

LIGHTING

1.00.00 **GENERAL**

1.01.00 This specification covers the general description of design, manufacture and construction features, testing, supply, installation and commissioning of the Station Lighting system equipment.

2.00.00 **CODES AND STANDARDS**

2.01.00 All standards and codes of practice referred to herein shall be the latest edition including all applicable official amendments & revisions as on date of bid opening. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards & codes.

2.02.00 Lighting Fixtures and Accessories

IS:1913	General and safety requirements for luminaries.
IS:2148	Flame proof enclosures of electrical apparatus.
IS:1534	Ballast for fluorescent lamps.
IS:1777	Industrial luminaire with metal reflectors.
IS:2418	Tubular fluorescent lamps for general lighting services.
IS:4013	Dust-tight electric lighting fittings.
IS:8224	Electric Lighting fittings for Division 2 areas.
IS:10276	Edison screw lamp holders.
IS:10322	Luminaires.
IS:13021	AC Supplied Electronic Ballasts for tubular fluorescent lamps.
IS 16103	LED Luminaire Standards

2.03.00 Lighting Panels, Switch-boxes, Receptacles and Junction Boxes

IS:2147	Degree of protection provided by enclosures for low-voltage switchgear and control gear.
IS:1293	Plugs & socket outlets of rated voltage upto and Including 250volts & rated current upto and including 16 Amps.
IS:2551	Danger notice plates.
IS:13947	Low voltage switchgear and control-gear
IS:3854	Switches for domestic and similar purposes.
IS:6875	Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto and including 1000 V AC and 1200 V DC.

	IS:13703	Low voltage fuses for voltages not exceeding 1000V AC or 1500 V DC.
2.04.00	**Conduits, Pipes and Accessories**	
	IS:2667	Fittings for rigid steel conduit for electrical wiring.
	IS:3837	Accessories for rigid steel conduits for electrical wiring.
	IS:9537	Conduits for electrical installations.
2.05.00	**Lighting Wires/Cables**	
	IS:694	PVC insulated cables for working voltages upto and including 1100 V
	IS:3961	Recommended current ratings for cables.(PVC Insulated and PVC sheathed heavy duty cables and light duty cables).
	IS:8130	Conductors for insulated electric cables and flexible cords.
	IS:10810	Methods of tests for cables.
2.06.00	**LED Luminaries**	
	16101:2012	General Lighting. LEDs and LED modules Terms and definitions
	16102(Part 1):2012	Self Ballasted LED Lamps for General Lighting Services. Part-1 Safety Requirements.
	16102(Part 2):2012	Self Ballasted LED Lamps for General lighting Services. Part-2 Performance Requirements.
	16103(Part I):2012	LED modules for General lighting Safety Requirements.
	15885(Part 2/Sec. 13) :2012	Lamp control gear Part 2 particular Requirements Section 13 d.c. or a.c. Supplied Electronic control gear for LED modules
	16104:2012	d.c. or a.c. Supplied Electronic control gear for LED modules - Performance Requirements.
	16105:2012	Method of Measurement of Lumen maintenance of Solid-state Light (LED) Sources.
	16106:2012	Method of Electrical and photometric Measurements of Solid State Lighting (LED) Products
	16107:2012	Luminaires Performance
	16108:2012	Photo-biological safety of Lamps and Lamp Systems

	IS 513	Cold rolled low carbon steel sheets and strips
	IS 12063	Classification of degree of protection provided by enclosures.
	IS 14700 (Part 3/Sec. 2)	Electro magnetic compatibility (EMC) – Limits for Harmonic current emission – THD < 15% (equipment, input current < 16 Amps. per phase.
	IS 9000 (Part 6)	Environment testing: Test Z – AD: composite temperature/humidity cyclic test.
	IS 15885 (Part 2/Sec. 13)	Lamp control gear: particular requirements for DC or AC supplied electronic control gear IS 16004 – 1 and 2) for LED modules.
	IS 4905	Method for random sampling

2.07.00 **Electrical Installation Practices & Miscellaneous**

IS:1944	Code of practice for lighting of public thorough fare
IS:3646	Code of practice for interior illumination.
IS:5572	Classification of Hazardous areas (other than Mines) having flammable gases and Vapours for electrical installation
S:6665	Code of practice for industrial lighting.
.	National Electrical Code
-	Indian Electricity Rules.
IS:5	Indian Electricity Act Colour for ready mixed paints & enamels.
IS:280	Mild steel wires for general engineering purposes.
IS:374	Electric ceiling type fans & regulators.
IS:732	Code of practice for electrical wiring installations.
IS:1255	Code of practice for installation and maintenance of power cables Upto and including 33KV rating.
IS:2062	Steel for general structural purposes
IS:2629	Recommended practice for hot-dip galvanizing of iron and steel.
IS:2633	Methods for testing uniformity of coating of zinc coated articles.

	IS:2713	Tubular steel poles for overhead power lines.
	IS:3043	Code of practice for earthing
	IS:5216	Guide for safety procedures and practices in electrical work.
	IS:5571	Guide for selection of electrical equipments for hazardous areas.
	BS:6121	Mechanical cable glands

3.00.00 LIGHTING SYSTEM DESCRIPTION

3.01.00 The illumination of various indoor and outdoor areas in the main plant & offsite area shall be provided as described here. The lighting system of various areas shall comprise of the following systems as identified in Annexure-B:

(a) Normal AC Lighting System

(b) Emergency AC Lighting System

(c) DC Lighting System

3.02.01 **Normal AC Lighting System**

Normal AC lighting system 415V, 3Phase, 4wire, will be fed from lighting panels (LPs) which in turn will be fed from the lighting distribution boards (LDBs)/Switch board MCC.

3.02.02 **Emergency AC Lighting System**

This system shall be provided for certain important areas in the main plant. The lighting fixtures connected to this system shall be normally "ON" along with the normal AC system. These will be fed from emergency lighting panels (ELPs) which in turn will be fed 3-phase, 4-wire supply from the emergency lighting distribution boards (ELDB'S). These lights will go off for a few seconds in case of AC supply failure at Emergency Switchgear, but shall be automatically restored when Emergency Switchgear is energised by Diesel generator set.

3.03.00 **DC Lighting System**

3.03.01 At strategic locations in the main plant, a few lighting fixtures fed from 220V, DC supply, shall be provided to enable safe movement of operating personnel and access to important control points during an emergency, when both the normal AC and Emergency Lighting system fail. These lighting fixtures will be fed from 220V DC LDBs which in turn will be fed from DC lighting panels.

3.03.02 The supply to the DC lighting panels shall be automatically switched ON in case of loss of AC supply at station service switchgear as well as Emergency switch-gear. The DC supply will be automatically switched OFF after about 3 minutes following the restoration of supply to normal AC or emergency AC lighting system.

3.03.03 Emergency DC lighting is to be provided, through self-contained DC emergency fixtures with four hours back-up duration, at strategic locations, in auxiliary/offsite buildings wherever DC supply system is not available. The fixtures shall be switched 'ON' automatically in case of failure of AC supply.

3.03.04 For Coal Handling plant/FGD Plant Area
18W, 220V DC Lighting fixture shall be provided in underground portion of conveyor, each switchgear room, control room, office room, pump house, each drive floor of TPs, staircases of various TPs and buildings and each local control area. DC lighting fixtures shall be fed from 220V DC LDB which in turn will be fed from CHP DC system. The supply to the DC lighting panels shall be automatically switched ON in case of loss of normal AC supply.

4.00.00 DESIGN PHILOSOPHY

1. A comprehensive illumination system shall be provided in the entire project areas under bidder's scope.

2. All outdoor lighting system shall be automatically controlled by synchronous timer. Provision to bypass the timer shall be provided in the panel.

3. The system shall include distribution boards, normal/ emergency lighting panels, lighting fixtures, junction boxes, receptacles, switch boards, lighting pole/masts, conduits, cables and wires, etc. The system shall cover all interior and exterior lighting such as area lighting, including Transformer yard & Switch yard area, aviation obstruction lighting, Street lighting, security lighting, etc. The constructional features of lighting distribution boards shall be similar to AC/DC distribution boards described in chapter of LT Switchgear. Outgoing circuits in LPs shall be provided with MCBs of adequate ratings.

4. The illumination system shall be designed on the basis of best engineering practice and shall ensure uniform, reliable, aesthetically pleasing and glare free illumination. The lighting fixtures shall be designed for minimum glare. The design shall prevent glare/luminous patch seen on VDU/ Large video screens, when viewed from an angle. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection. The diffusers/ louvers used in fixtures shall be made of impact resistant polystyrene sheet and shall have no yellowing property over a prolonged period. The Lux levels to be adopted for various area are indicated at Annexure - A. (placed at the end of this Chapter).

5. Different Lighting Systems envisaged for various plant areas are indicated in Annexure-B: While finalizing the detailed layout of lighting fixtures, the position/location and layout of equipments should be taken into account to have adequate illumination at desired locations. For CCR room Dimmable and Tunable downlighter fittings to be provided.

6. **LED Luminaires:**

   LED Luminaires shall be used for the lighting of all the indoor & outdoor areas in bidder's scope. However for DC lighting, hazardous areas & aviation lighting etc. conventional type luminaires shall be used. However, aviation light in Lighting Mast shall be of LED type. In false ceiling area LED luminaires shall be recessed mounting type & in non-false ceiling area the LED luminaires shall be surface mounting type.

   The individual lamp wattage for LED shall be upto 3 watt. Fractional wattage LEDs are also acceptable. The LED chip efficacy shall be min 120 Lm/W. The luminaire efficacy shall be not less than 100 Lm/W. Suitable heat sink shall be designed & provided in the luminaire. The LED used in the luminaires shall have colour rendering index (CRI) of Min 80. Colour designation of LED shall be "cool day light" (min 5700K) type for indoor areas. However for outdoor areas, the colour temperature of LED shall be min. 4000K, including rough & dust prone areas. The

LED luminaries shall have a minimum life of 25000 burning hours with 80% of lumen maintenance at the end of the life. LED shall conform to the LM 80 requirements.

The max. junction temperature of LED shall be 85 deg C. Further the lumen maintenance at this temperature shall be min 90%. The THD of LED Luminaires shall be less than 10%. Further the EMC shall be as per IS 14700. The power factor of the luminaire shall not be less than 0.9. The marking on luminaire & safety requirements of luminaire shall be as per IS standards. Suitable heat sink with proper thermal management shall be designed & provided in the luminaire.

The connecting wires used inside the system, shall be low smoke halogen free, fire retardant type and fuse protection shall be provided in input side specifically for LED luminaires.

Care shall be taken in the design that there is no water stagnation anywhere in the housing of luminaire. The entire housing shall be dust and water proof protection as per IS 12063.

7. **Driver Circuit**

LED modules and drivers shall be compatible to each other. The LED module driver's ratings and makes shall be as recommended by corresponding LED chip manufacturer.

LED Drivers shall have following control & protections:-

- Suitable precision current control of LED.
- Open Circuit Protection
- Short Circuit Protection
- Over Temperature Protection
- Surge Protection

8. Apart from maintenance factor as given below, Temperature correction factor shall be considered in the lighting design for fixtures located in non air conditioned area.

(a.)	Office area (air conditioned)	:	0.8
(b.)	Office area (non air conditioned) and other indoor area	:	0.7
(c.)	Dust prone indoor and outdoor area	:	0.6
(d.)	Coal Handling area, Ash Handling Conveyor /Transfer Points etc.	:	0.5
e.)	Boiler Area	:	0.6

Reflectance Factor:-

Ceiling :0.8
Wall : 0.5
Floor : 0.2

Reflectance factor for CHP areas such as Bunker floor, TPs etc and AHP outdoor areas :-

Ceiling :0.3
Wall :0.3
Floor :0.1

9. (i) All outdoor fixtures shall be weather proof and of min. IP65 degree of protection.

(ii) For Indoor type of fixtures:-

(a) Surface/Pendent mounting: - IP 54 class of protection.

(b) Recess Mounting (False ceiling):- IP 20 class of protection.

10. (a) Lighting panels shall be constructed out of 2 mm thick CRCA sheet steel. The door shall be hinged and the panel shall be gasketted to achieve specified degree of protection. Lighting panels shall be powder coated with color shade RAL9002. Lighting panels shall have min. IP55 degree of protection.

(B) All MCBs/Isolators/Switches/Contactors etc. shall be mounted inside the panel and a fibre glass sheet shall be provided inside the main door such that the operating knobs of MCBs etc., shall project out of it for safe operation against accidental contact.

(c) Terminal bocks shall be 1100 V grade, clip-on stud type, made up of polymide 6.6 or better suitable for terminating multicore 35 or 70 Sq. mm. stranded aluminium conductor incoming cable and 10 Sq. mm. stranded aluminium conductor for each outgoing circuits voltage. All terminals shall be shrouded, numbered and provided with identification strip for the feeders.

(d) MCB's shall be current limiting type with magnetic and thermal release suitable for manual closing and automatic tripping under fault condition. MCB's shall have short circuit interrupting capacity of 9 KA rms. MCB knob shall be marked with ON/OFF indication. A trip free release shall be provided to ensure tripping on fault even if the knob is held in ON position. MCB terminal shall be shrouded to avoid accidental contact.

(e) Contactors of AC lighting panels shall be 3 no's,63 A, single pole continuous duty MCB, with neutral link,load make-break type suitable for 415 V, 3 phase 4 wire system.

(f) DC switches shall be rotary type, 2 pole, continuous duty, load break type, quick make quick break, suitable for 220 V DC, 2 wire system. Switch knob shall be provided with ON/OFF indication.

(g) Programmable Digital Timer shall be Electronic Astronomical Almanac Time switch with battery backup of min. TEN years, 4 Digit LED display, 24 hours range, manual override facility, 10 Amp 3 relay output, with NO/NC Contacts suitable for operation on 240V single phase AC supply.

(h) Each lighting panel (LP-3) shall be fed from a 415V/42V, 3 phase-4 wire, 3 KVA transformer. The transformer shall be located inside the lighting panel itself. Transformers shall be dry type, natural air cooled with class F insulation or better. Impedance of transformer shall be 5%. Transformers shall be tested as per IS:11171. Off-circuit tap changer with +/- 5% in steps of +/- 1.25% tapping shall be provided. One minute power frequency withstands voltage for lighting transformer shall be 2.5 KV.

(i) Lighting Panels shall have 20% spare outgoing feeders and shall be of following types:-

TYPE	INCOMER FEEDER	OUTGOING FEEDERS	DETAILOFCONTENTS
LP-1	3No. 415V, 63 A, SP MCB (31/2Cx70sq.mm cable)	18Nos.,20A, 240V MCB	415V, 63A(min.), AC2 duty contactor and Programmable Digital Timer of 24 hour range 10A, 240V selector switch, fuse, etc. outdoor type and IP:55 degree of protection
LP-2	3No. 415V, 63 A, SP MCB (31/2Cx70sq.mm cable)	9 Nos.,20A, 240V MCB	415V, 63A(min.), AC2 duty contactor and Programmable Digital Timer of 24 hour range 10A, 240V selector switch, fuse, etc. outdoor type and IP:55 degree of protection
LP-3	1 No., 4A fuse 3 KVA transformer,40A TPN MCB	24 Nos., 16A, 45V MCB	IP 55 degree of protection. Incomer shall be suitable for receiving 4Cx16 sq. mm cable and outgoing circuit shall be suitable for 2Cx16 sq. mm cable.
LP-D1	1No. 220V,32 A, DP Isolator (2Cx35sq.mm cable)	6Nos.,16A, 220V DP Switch & Fuse	220V,32A DC Fuse, etc. outdoor type IP:55 degree of protection.

11. Wires of different phase shall normally run in separate conduit.

12. Power supply shall be fed from 415 / 240 V normal AC supply, emergency AC supply and 220V DC supply through suitable number of conveniently located lighting distribution boards (LDB) and lighting panels (LP). AC lighting supply shall be isolated from main supply by 2x100% isolation transformers of max. rating of 50 KVA for 10/15 nos. outgoing feeder with changeover switch facility. The isolation transformer shall be fed from two different bus sections of MCC and fault level restricted to 3 KA at Lighting Panels.

13. Atleast one 6/16A, 240V AC universal socket outlet with switch shall be provided in offices, cabins, etc. Further 20A, 240V AC industrial receptacle with switch shall be provided strategically in all industrial areas.
Suitable number of 63A, 3ph, 415V AC industrial receptacles shall be provided for entire plant for welding purposes, particularly near all major equipment and at an average distance of 50m. Atleast one 63A, 3ph, 415V AC receptacle shall be provided in each floor of off-site buildings/ structures.
Receptacles boxes shall be fabricated out of 2 mm thick MS steel hot dip galvanized or of not less than 2.5 mm thick die-cast aluminium alloy or fabricated out of 2 mm thick CRCA sheet with electro static powder coating. IP-degree of protection shall be applicable to receptacles Type 'RA &''RC' only.
Minimum no of receptacle in TG and SG area shall be provided as per Annex-I, of chapter B-10.

Receptacles shall be of following types:

Type	Switch rating	Socket & plug rating	Type & make of plug & Socket	Terminal Block size
RA	20 A, SP240V AC(Industrial)	20A, 3 pin240 V AC	NTPC appd. make	1-4 way, suitable for loop-in loop- out of 10 sq.mm. Al. Conductor
RB	16A, S.P240V AC	6A+16A6 Pin decorative Piano-key Type Switch	NTPC appd.make	1-4 way, suitable for loop-in loop- out of upto 10 sq.mm. Al. Conductor
RC	20 A, SP24 V AC(Industrial)	20A, 3 pin24 V AC	NTPC appd. make	1-4 way, suitable for loop-in loop- out of 2 core -16 sq.mm. Al. Cable.

14. In the hazardous areas like Hydrogen generation plant, fuel oil handling areas or any other gas/ liquid fuel storage/ handling areas in bidder's scope, lighting shall be flame proof.

15. The type of fixtures, LP, JB, and receptacle used in Hydrogen generation plant building shall be suitable for group II C as per IS: 2148 or class I, Division II as per NEC 70-428.

16. All fluorescent lamps shall be have "Cool day light" colour designation. The mirror optics type fluorescent fixtures shall have no iridescence effect. Fixtures with better efficiency and upgraded proven system may also be considered
In candescent lamps may be used only with DC Lighting.

17. Aviation warning lights shall be provided as per the recommendations of ICAO and Director general of civil aviation, India. The arrangement of light should be marked such that the object is indicated from every angle in azimuth. The aviation warning lighting system shall also conform to the latest Indian standard IS 4998.

18. Contractor shall demonstrate the average lux level achieved for different areas as per specification requirements, after completion of the lighting work, at site to the satisfaction of engineer-in-charge.

4.01.00 -**NOT USED**.

4.02.00 All luminaires and their accessories and components shall be of type readily replaceable by available Indian makes.

4.03.00 **Fans & Regulator**

4.03.01 Ceiling Fans, to be provided in non air-conditioned office/control room area. Further tentatively one (1) no. ceiling fan shall be provided for 10 sq.m area, at suitable mounting height. The ceiling fans shall be suitable for operation on 240 V +/-10%, 50 Hz, AC supply comprising of class 'E' or better insulated copper wound single phase motor, 1200mm sweep, aerodynamically designed well balanced AL blades (3 Nos.), down rod, BEE 5 star rated,die cast aluminium housing, capacitor, suspension hook, canopies etc. finished in stove enameled white or with electro static powder coating. Power factor of fans shall not be less than 0.9. Fan regulators shall be stepped electronic type suitable for operation on 240V +/-10% AC supply.

4.04.00 Junction Boxes, Conduits, Fitting & Accessories, Pull Out Boxes:

Junction box for indoor lighting shall be made of fire retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type.

Junction boxes for street lighting poles and lighting mast if applicable , shall be deep drawn or fabricated type made of min. 1.6 mm thick CRCA Sheet. The box shall be hot dip galvanized. The degree of protection shall be IP55.

All switches and receptacles upto 16A shall be modular type. These shall be provided with pre-galvanized/galvanized modular switchbox & plate.

Conduits, Pipes and Accessories Galvanised heavy duty steel conduits for normal area and galvanised heavy duty steel conduits with an additional epoxy coating for corrosive area shall be offered. Alternatively glass reinforced epoxy conduits with comparable compressive and impact strength with that of heavy duty steel conduits may be offered.

Conduits in walls and ceilings in buildings with RCC and masonry structure such as Administrative, Service, Canteen, Time Office, Auditorium, IT building etc shall be concealed.Rigid steel conduits shall be heavy duty type,hot dip galvanised conforming to IS : 9537 Part-I & II shall be suitable for heavy mechanical stresses, threaded on both sides and threaded length shall be protected by zinc rich paint. Conduits shall be smooth from inside and outside.

Flexible conduit shall be water proof and rust proof made of heat resistant TERNE coated steel.

Pull out boxes shall be provided at suitable interval in a conduit run .Boxes shall be suitable for mounting on Walls, Columns, Structures, etc.. Pull-out boxes shall have cover with screw and shall be provided with good quality gasket lining. Pull out boxes used outdoor shall be weather proof type suitable for IP: 55 degree of protection and those used indoor shall be suitable for IP: 52 degree of protection. Pull out box & its cover shall be hot dip galvanized.

4.05.00	**Lighting Wires**
4.05.01	Lighting wires shall be 1100 V grade, light duty PVC insulated unsheathed, stranded copper/aluminium wire for fixed wiring installation. Colour of the PVC insulation of wires shall be Red, Yellow, Blue and Black for R, Y, B phases & neutral, respectively and white & grey for DC positive & DC negative circuits, respectively. Minimum size of wire shall not be less than 1.5.sq.mm. for copper and 4 sq.mm. for aluminium.
4.06.00	**Lighting Poles**
4.06.01	The Street Light system and peripheral lighting shall be designed generally in line with design guidelines. The Poles shall be mounted above ground using base plate and minimum height of pole shall be 8 mtrs The poles shall be hot-dip galvanized as per IS2629/ IS2633/ IS4759. The average coating thickness of galvanizing shall be min. 70 micron. The System shall be capable of withstanding the appropriate wind load etc as per IS 875 considering prevailing soil/ site condition considering all accessories mounting on pole. The street light poles shall have loop in loop out arrangement for cable entry and light fixture / wiring protected with suitably rated MCB.
4.07.00	**Lighting Masts**
4.07.01	Suitable number of lighting masts shall be provided for entire plant..Lighting Mast shall be of continuously tapered polygonal cross section hot dip galvanised. The Mast shall be of 30 M or suitable height with lantern carriage to enable raising/lowering for ease of maintenance, including the Head Frame, Double Drum Winch, continuous stainless steel wire rope, in built power tool, luminaires, suitable aviation warning light, lightning alongwith necessary power cables within the mast. The mast shall be delivered in not more than three sections & shall be joined together by slip stressed fit method at site. No site welding or bolted joints shall be done on the mast The Mast together with the fixtures shall be capable of withstanding the appropriate wind loads as per IS: 875. The Mast shall be fabricated from special steel plates conforming to BS-EN10-025 and folded to form a polygonal section. Suitable feeder pillar with TPN MCB, contactors, timer, MCB and other necessary accessories for operation & protection of the mast and fixtures shall be provided.
4.08.00	Lighting fixtures shall generally be group controlled directly from lighting panel. However, in office areas, control shall be provided through switch boxes. Each switch shall control a maximum of three fluorescent fixtures.
4.09.00	A.C. normal, AC emergency and DC system wiring shall run throughout in separate conduits. Wires of different phase shall run in different conduits.
4.10.00	Lighting panels, etc. shall be earthed by two separate and distinct connections with earthing system. Switch boxes, junction boxes, lighting fixtures, fans, single phase receptacles etc. shall be earthed by means of separate earth continuity conductor. The earth continuity conductor 14 SWG GI wire shall be run alongwith each conduit run. Cable armours shall be connected to earthing system at both the ends.
4.11.00	Alternately Vendor may offer technically superior and proven product subject to approval of employer.
4.12.00	**Occupancy based Passive Infra-red sensors** The sensors shall be recess mounted, programmable type suitable for lighting load of 6A with variable off delay settings. The detection area shall be minimum 5 metres for standard

room height of 3mt. All the calibrated settings shall be stored in non-volatile memory of PIR sensor which shall be unaffected by power supply fluctuations. Necessary 16A contactor shall be supplied alongwith each sensor & shall be located inside the switch box

5.00.00 **TESTS**

5.01.00 **For LED Fixture**

a) The contractor shall carry out the type tests as listed in this specification on the following types of LED fixtures to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant price schedule of bid document and the same shall be considered for the evaluation of the bids.

LED fixtures (Type test shall be conducted on one rating each of following type of LED fixtures. Rating for test conduction shall be decided by the employer during detailed engineering)

a) High bay fixture.
b) Well glass fixture.
c) Street light fixture
d) Surface mounted type fixture.
e) Recessed mounted type fixture.

The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.

5.02.00 **For all other Station lighting equipment:**

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

5.04.00 Selection of samples for type test, acceptance test & routine test and acceptance criteria for all the items shall be as per relevant I.S

5.05.00 Type test reports of the following items as per technical specification requirements/ standards shall be submitted for approval.

SL NO.	DESCRIPTION
i.	Lighting fixtures of each type
ii.	Lighting panel of each type (Degree of Protection)
iii.	Junction Box of each type.

Type test reports for LED as per standards for following shall be submitted for approval.

1. Visual and Dimension check
2. Proof of procurement of LEDs
3. Safety tests
a) Marking

b) Construction
c) Provision for Earthing
d) External and Internal wiring
e) Protection against electrical shock
f) Endurance and Thermal
g) Insulation resistance & electrical strength
h) Resistance to heat fire & tracking
i) Resistance to Humidity
4. Fire Retardant test
5. Performance tests (electrical, Photometric color and Life)
6. Burn-in Test
7. Power Cycling
8. Temperature rise test
9. Emission Tests
a) Radiated & conducted emission
b) Harmonics & flickers
10. Immunity tests

In addition, following test reports to be submitted for LED chip/LED luminaire:

a) LED parameters like Lumen per watt, CRI, Beam angle from manufacturer.

b) LM 80/IS: 16105 report.

c) LM 79/IS: 16106 report.

5.06.00 Acceptance Test and Routine Test

5.06.01 All lighting fixtures, lamps and other items shall be subjected to acceptance and routine test, as per relevant specified standards.

5.06.02 Junction boxes, switch boxes, receptacle enclosure etc. shall be subjected to physical and dimensional checks also. Switch boxes shall be made of 1.6 mm thick MS sheet with 3 mm thick decorative, Perspex cover. Switch box shall be hot dip galvanized.

Switch boxes shall be of following types :

TYPE No.	Switch	Fan Regulator*	Socket
SWB 1	5 A - 2 Nos.	-	-
SWB 2	5 A - 3 Nos.	-	5A - 1.No.
SWB 3*	5 A - 5 Nos.	1	5A - 1.No
SWB 4*	5 A - 7 Nos	3	5A - 1.No.
SWB 5**	5 A - 5 Nos	-	5A - 1.No.

* Space provision shall be kept for fan regulator in switch boxes.

** Shall have the provision for mounting the 16 A contactor.

5.07.00 **Galvanizing Tests**

5.07.01 The quality of galvanizing shall be smooth, continuous, free from flux stains and shall be inspected visually.

5.07.02 In addition following tests shall be conducted as acceptance tests.

(a) Uniformity of coating - The coating of any article shall withstand for one (1) minute dips in standard copper sulphate solution without the formation of an adherent red spot of metallic copper upon the basic metal.

(b) The quality of cadmium/zinc plating on items with screw threads shall be free from visible defects such as unplated areas, blisters and modules and shall be inspected visually.

(c) In addition, the plating thickness shall be determined microscopically/ chemically or electronically.

6.00.00 COMMISSIONING CHECKS

1. On completion of installation work, the Contractor shall request the Project manager for inspection and test with minimum of fourteen (14) days advance notice.

2. The Project manager shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Contractor.

3. The installation shall be then tested and commissioned in presence of the Project manager.

4. The contractor shall provide all, men material and equipment required to carry out the tests.

5. All rectifications repair or adjustment work found necessary during inspection, testing and commissioning shall be carried out by the Contractor without any extra cost. The handing over the lighting installation shall be effected only after the receipt of written instruction from the Employer/his authorized representative.

6. The testing shall be done in accordance with the applicable Indian Standards and codes of practices. The following tests shall be specifically carried out for all lighting installation.

   (a) Insulation Resistance.

   (b) Testing of earth continuity path.

   (c) Polarity test of single phase switches.

   (d) Functional checks.

7. The lighting circuits shall be tested in the following manner:

   (a) All switches ON and consuming devices in circuit, both poles connected together to obtain resistance to earth.

   (b) Insulation resistance between poles with lamps and other consuming devices removed and switches ON.

ANNEXURE-A

Sl No.	**Location****	**Average Illumination Level (Lux)**	**Type of Fixture**
(a)	Turbine Hall operating floor	200	High/medium bay LED luminaire
(b)	Turbine Hall Other Platforms	200	LED high/medium bay, LED well glass fixtures
(c)	Switchgear rooms, Charger, Rectifier room	200	Industrial type LED Luminaire
(d)	Control room, computer room, control equipment room	350	LED luminaire equivalent to Mirror optics with anti-glare features or down-lighter.
(e)	Offices, conference rooms, etc.	300	Decorative mirror optics Type LED luminaire or LED down-lighter
(f)	Battery rooms	100	Totally enclosed corrosion Proof LED Luminaire
(g)	Transformer yard	20 (general) 50 (on equipment)	LED Luminaire
(h)	Boiler platforms	100	LED well glass fixtures,

(i)	Diesel generating room /enclosure, Compressor room, pump house etc.	150	LED medium bay/ Industrial type LED Luminaire
(j)	Fuel oil pump house	150	Flame proof fluorescent fixtures suitable for division-2 hazardous area
(k)	Cable galleries/vault	50	Industrial type LED Luminaire
(l)	Street lighting- primary roads secondary roads	 20 10	LED street lights
(m)	Outdoor storage handling and unloading area	20	LED Luminaire
(n)	Cement stores	150	Industrial dust proof type LED Luminaire
(o)	Chemical stores/House	150	Corrosion proof LED Luminaire
(p)	Permanent stores	150	LED high/medium bay / Industrial trough LED Luminaire
(q)	Workshop. Building	150	LED high/medium bay / Industrial trough LED Luminaire
(r)	Laboratory General Analysis area	 150 300	Corrosion proof LED Luminaire
(s)	Garage/Car Parking	50	Industrial type LED Luminaire
(u)	AIS Switchyard and Substation	20(general 50(on strategic equipment)	LED Luminaire
(v)	Transfer points, Sheds, tunnels, bunker house, Crusher house, Conveyor Gallery etc. in bidders scope	100	LED Dust tight/Well glass type Luminaire
(w)	Facility building, canteen etc	150	Industrial type LED Luminaire
(x)	Hydrogen Plant Building	150	Explosion proof HPMV/ Fluorescent fittings suitable for class-I and Division –IIC
(y)	DC Lighting- Control room	-	LED down light

			fixtures, Decorative recessed type with cylindrical reflector
(z)	DC Lighting- Other Area	-	LED Industrial Bulkhead
(aa)	Corridors, Walkways	50	LED Luminaire
(ab)	Building Periphery Lighting	10	LED Street Light fixture/ LED Luminaire
(ac)	Security Lighting along Boundary	10	LED Street Light fixture/ LED Luminaire
(ad)	ESP platform	150	LED well glass fixtures
(ae)	Gate complex/Time Office	150	LED Luminaire
(af)	GIS Hall	150	LED medium bay/ Luminaire
(ag)	DM plant, water treatment plant CW Pump house, Raw water PH, Fire Water PH	150	LED high/medium bay / Industrial trough LED Luminaire

ANNEXURE-B

Sl.	Plant Areas	Normal AC Lighting System	Emergency AC Lighting System	220 V DC Lighting System	Portable DC Fixtures
1	TG Building(turbine hall, switchgear room etc)	80%	20%	√	—
2.	Boiler Platform	80%	20%	√	
3	DG Area/ Room	80%	20%		
4	Compressor Room				√
5	ESP Control Room	80%	20%		√
6	Unit Control Room	70%	30%		
7	Switchyard Control Room	80%	20%		
8	Battery Room	80%	20%		
9	Cable Spreader Room/ Vault	80%	20%	√	
10	Hydrogen Plant	100%			√
11	Chemical House	100%			√

12	Fuel Oil Pump House	100%			√
13	Ash Handling Plant	100%			√
14	Water Treatment Plant	100%			√
15	CT Switchgear Room	100%			√
16	Cooling Towers	100%			
17	Workshop	100%			√
18	Service Building	100%			
19	Area Lighting	100%			
20	Street Lighting	100%			
21	Transformer Yard and Storage Yard	100%			
22	Coal Handling Plant	100%		√	
23	GIS Hall	80%	20%		
24	AIS Switchyard	80%	20%		

DC Emergency Lighting:

Sl.	Area	Average Lux Level
1	Unit Control Room	100
2	Control Equipment Room	100
3	Switchyard Control Room	20
4	Strategic Control Points (In TG Building & Boiler Area, Switchgear room, SWAS, Battery Room, UPS Area, TG Hall, Lube oil Room etc	20
5	Cable Vault & Galleries	1 fixture at every 20 metres spacing along walkways
6	Boiler Stair Case	1 fixture at every 20 metres spacing along walkways
7	Exit/ Entry of Main Plant Building	1 fixture
8	Fire Exit Sign	1 fixture

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