INDRADHANUSH GAS GRID LIMITED (IGGL)
(Joint Venture of IOCL, ONGC, GAIL, OIL and NRL)
GUWAHATI, ASSAM

NORTH -EAST GAS GRID PIPELINE PROJECT

BID DOCUMENT FOR

INCOMING POWER CABLE LAYING WORKS FOR RT NRL UNDER NORTH EAST GAS GRID (NEGG) PROJECT OF M/S INDRADHANUSH GAS GRID LIMITED (IGGL)

OPEN DOMESTIC COMPETITIVE BIDDING

Tender ID: 2024_IGGL_205135_1

Bid Document No.: 05/51/23VC/IGGL/001(i)-6

VOLUME – II OF II

PREPARED AND ISSUED BY

MECON LIMITED
(A Govt. of India Undertaking)
Delhi, India

TABLE OF CONTENT

INDRADHANUSH GAS GRID LIMITED

SCOPE OF WORK FOR
INCOMING POWER SUPPLY CABLE WORK
AT RT NRL

NORTH EAST GAS GRID PIPELINE PROJECT

(ELECTRICAL SECTION)

MECON LIMITED DELHI

Document No.	Revision No.	Date
MEC/23UU/05/E9/E/001-RT NRL	0	08.04.2024

Contents

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0	08.04.2024	Aashis Moyal, AGM	M.K.Jaiswara, AGM	Pankaj Srivastava, Sr GM

1.0 GENERAL

1.1 Introduction

M/s Indradhanush Gas Grid Limited (IGGL), a Joint Venture of IOCL, ONGC, IGGL, OIL and NRL, is in the process of implementing the North East Gas Grid (NEGG) with a vision to connect all the eight (08) north eastern state capitals and major consumption centers in the region. The NEGG will be connected to National gas grid at Guwahati through Barauni-Guwahati pipeline (already under execution by M/s IGGL).

M/s IGGL has awarded M/s MECON Limited Project Management Consultancy (PMC) services for North-East Gas Grid pipeline Project.

The intent of this specification is to define the requirements for incoming power supply for RT NRL and including associated work for installation and laying, testing and commissioning.

The work shall be carried out in the best workmanship – like manner, in conformity with these specifications, approved drawings and the instructions of the Engineer-in-charge from time to time.

In case of any conflict between the codes and standards listed, the same shall be brought to the notice of Owner/Consultant for final decision, which shall be binding.

1.2 Standards

The work shall be performed in conformity with, standard specifications and installation standards enclosed and code of practices of the Bureau of India Standards. In case of any conflict, the stipulations under this specification shall govern.

In addition, the work shall also conform to the requirements of the following:

The Indian Electricity Act, and the rules framed there under
The fire Insurance Regulations
The regulations laid down by the Chief Electrical Inspector of the state government / Central Electricity Authority (CEA).
The regulations laid down by the Factory Inspector.
The regulations laid down by the Chief Inspector of Explosives.
Any other regulations laid down by the Central, State or Local Authorities from time to time during the pendency of this contract.
M.B.Lal Committee recommendations for electrical design & installation.

1.3 Guarantee

The Bidder shall guarantee the installation against any defects of workmanship and materials (supplied by the Bidder) for a period of 12 months from the date of commissioning. Any damage or defects connected with the erection of materials, equipments or fittings supplied by the Bidder that may be undiscovered at the time of issue of the completion certificate, or may arise or come to light thereafter, shall be rectified or replaced by the Bidder at his own expense as deemed necessary and as per the instruction of the Engineer-in-charge within the time limit specified by the Engineer-in-charge.

The above guarantee shall be applicable for the quality of work executed as well as for the equipment / cable / fittings/ other material supplied by the Bidder.

1.4 **Site Conditions**

The equipment offered and the installation shall be suitable for continuous operation under the following site conditions.

Max. / Min temperature	:	$50^0C/2^0C$
Max. Relative humidity	:	95 %
Altitude	:	less than 1000 m
Atmosphere	:	To withstand site condition (Humid, Heavy rainfall during monsoon & low temp during winter)

1.5 **Power Supply Parameters:**

i) RT NRL-

NORMAL POWER	415V AC, 3 Phase & Neutral from Refinery substation

2.0 SCOPE

The Bidder's scope of work includes following:

2.1 **SCOPE OF DESIGN & ENGINEERING**

2.1.1 Cable route survey, Submission of electrical equipment design calculations (Power JB, bus bar extension etc), cable route drawings for review and approval, preparation of cable schedules, BOM, preparation of as built site engineering drawings and details for installation works wherever applicable or required by the Engineer-in-charge, and submits to the Engineer-in-charge for review.

2.1.2 Correction, updating and submission of all Owner's drawings for as-built status.

2.1.3 Obtaining clearance for energizing the complete electrical facilities covered under this tender and approval of installation and drawings from the Chief Electrical Inspector of the State Government/Central Electricity Authority and other statutory authority as required. This includes equipments installed or commissioned by others within the battery limit. This is for the purpose of obtaining a comprehensive approval in one go.

2.2 **SCOPE OF SUPPLY, LAYING, TERMINATION, TESTING AND COMMISSIONING OF INCOMING POWER CABLE AT RT NRL-**

Following electrical equipment and material are in the Bidder's scope of supply, laying, termination, installation, testing and commissioning in this tender.

2.2.1 415 V, 30 KA single front type outdoor Power JB to receive input power at SS#5 from PCC 314 of M/s NRL consisting of Cu bus bar, 400 Amp TPN MCCB (with LSIG & Shunt trip) complete

with wiring, indication lamp, ammeter, voltmeter, MFM (Multi-Function Meter with RS485) etc including all materials & accessories, with operating mechanism as per technical specification, data sheet.

2.2.2 MV power and control cable (XLPE – insulated armoured Al/Cu conductor 3.5 core cables).

a) 3.5CX240 A2XFY FRLS Cable as per BIS 7098 Part-1
b) 3.5CX120 2XFY CU, FRLS Cable as per BIS 7098 Part-1

2.2.3 GI Earth strip (25x3 mm), Hume pipe (min 500mm), GI Cable-trays and accessories, support structures, angle & channels, cable markers, identifier tags, GI saddles, Cable ties and all other associated accessories for cable-laying on cable trays, underground, though the culverts.

2.2.4 Advance maintenance free earthing system with 3mtr earth electrode of low carbon steel with 250-micron copper coating with carbon based backfill compound (Resistivity of compound shall be less than 1 ohm-m) as per IS 3043/IEEE-80.

2.2.5 FLP (CMIFR tested, PESO approved) type double-compression nickel-plated brass cable glands, tinned- copper lugs, clamping material etc. for cable termination.

2.2.6 Bidder shall provide the calculation of each support with considering of 100 Kg/mtr load of cables on cable tray, however support shall be provided at every 2 mtr interval minimum.

2.2.7 Fabrication and supply of MS frames, angles, supports, canopy and brackets for miscellaneous electrical equipments, including welding, supply of bolts, nuts etc for mounting and other necessary supplies, all inclusive of painting as specified. All supports, angles shall be property painted by the anti-corrosive paints of black colour.

2.2.8 *CO-ORDINATION WITH OTHER CONTRACTORS*

Contractor shall be entirely responsible for Co-ordination with other contractors working in the refinery area and it is responsibility of the contractor to take all permissions from the NRL & contractors working in refinery area it should be responsibility of the contractor to complete the work in contractual time period.

If the contractor fails to timely execution of the terminal work, necessary penalty clause shall be applied as per the direction of the Engineer-in-Charge.

2.2.9 All works relating to statutory approvals of the complete installation, from competent authority like CEA, DGMS, State electricity authority/Board etc, if any, shall be in the scope of contractor including permission and approvals from the refinery statutory authority.

2.2.10 Height of cable tray & support installations shall be same of existing cable trays installation in the same route.

3.0 OTHER MISCELLANEOUS WORKS

3.1 Preparation of buried cable trenches, including, back filling, compacting providing of brick protection by second-class bricks, spreading of fine river sand, including all supplies wherever required.

3.2 The job includes repairing of all civil works damaged during the installation work.

3.3 The scope of work under this contract shall be inclusive of breaking of walls, floors and chipping of concrete foundations necessary for the installation of equipment, materials, and making good of the same.

3.4 Minor modifications wherever required to be done in the owner free supplied equipments / devices to enable cable entry, termination, etc.

3.5 Sealing of opening made in the walls / floors for cables trays, cables, bus ducts, etc using acceptable practice and standards.

3.6 Supply and installation of all other accessories not specifically mentioned herein, but never the less necessary for completion of the job.

4.0 AREA CLASSIFICATION

Hydrocarbon handling areas have been generally classified as zone 1 & 2, gas group IIA/IIB as per IS: 5572, API RP-500, OISD - 113 and IP Rules. All equipments to be installed in these areas shall be suitable for the area classification with temperature class T3 (200^0C), CMIFR testing and approved by CCOE, PESO, DGFAS and having BIS license.

5.0 JOB SPECIFICAITONS

Various electrical works covered under this contract like equipment erection, civil & mechanical work including welding, cable laying, earthing work etc. shall be performed in accordance with specifications attached with this tender & applicable Indian standard. (Certain clauses of specifications, which are applicable to equipments or system not covered under this contract, shall not be applicable).

Erection and commissioning of certain special equipments shall be performed in accordance with supplier's instructions and directions of the Engineer-in-charges under supervision by equipment supplier/s.

The equipments/materials to be supplied by the Bidder shall conform to the requirements of the applicable specifications enclosed in the tender document.

6.0 STATUTORY APPROVAL OF WORKS

All works relating to statutory approvals of the complete installation, from competent authority like CEA, DGMS, State electricity Authority/Board etc including the permission from statutory authority of refinery shall be in the scope of Bidder before charging of the cables.

The application on behalf of the owner for submission to Electrical Inspector / DGMS etc. along with copies of required certificates and drawings, complete in all respects, shall be prepared by the Bidder and submitted to the Engineer-in-charge for onward transmission well ahead of time so that the actual commissioning of equipment is not delayed for want of inspection by the Electrical Inspector / DGMS, if any. The actual Liaison work shall be arranged by the Bidder and necessary coordination and liaisons work in this respect shall be responsibility of the Bidder, if any. However, the Owner on submission of bills along with documentary evidence shall reimburse any fee paid to the statutory Authority in this regard.

7.0 MAKES OF EQUIPMENTS AND MATERIALS

All equipments / materials supplied by the Bidder shall be as per the list of approved makes enclosed with this document subject to submission of Certification and approvals.

8.0 INSPECTION, TESTING & COMMISSIONING

8.1 All the equipment supplied and installed by the Bidder shall be tested and commissioned as required and no separate payments shall be made for the same. Any damage or defect noticed shall be brought to the notice of the engineer- in-charge and will be rectified without any delay and no payments shall be made for rectification.

8.2 Any work not conforming to the execution drawings, specifications or codes shall be rejected forthwith and the Bidder shall carry out the rectification at his own cost.

8.3 The Bidder shall carry out all the tests as enumerated in the technical specifications and as per applicable codes and standards.

8.4 Before the electrical system is made live, the electrical Bidder shall carry out suitable tests to establish to the satisfaction of engineer-in-charge that the installation of equipments, wiring and connections have been correctly done and are in good working condition and that it will operate as intended.

8.5 All the tests shall be conducted in the presence of Owner/ Engineer-in/charge or his authorized representative unless he waives this requirement in writing. The Bidder shall arrange all testing equipment necessary to carry out the test. The tests shall be recorded on approved Performa and certified records of the tests shall be submitted to Owner/ Engineer-in-charge.

8.6 After the completion of all tests and rectification of all defects pointed out during final inspection, plant start-up trials would be commenced. During the start-up trials Bidder shall provide skilled / unskilled personnel and supervision round the clock at his cost. The number and category of workmen and duration up to which required, will be decided by the Engineer-in-charge. Any defects noticed during the start-up trial relating to the equipment supplied and work carried out by the Bidder, will be rectified by the Bidder at his own cost.

8.7 Engineer-in- charge shall have the right to get these defects rectified at the risk and cost of the Bidder if he fails to attend to these defects immediately as desired.

8.8 After the operating conditions are fully achieved in the plant and the other requirements as stated in the General Conditions of Contract are fulfilled, the Bidder would be eligible for applying for a completion certificate.

9.0 DRAWINGS, STANDARD SPECIFICATIONS AND INSTALLATION STANDARDS

9.1 The equipments / materials to be supplied by the Bidder shall conform to the requirements of the applicable specifications. Also, the installation of various material / equipment shall conform to the installation standards /norms.

9.2 The drawings accompanying the tender documents when read with specification shall depict the electrical system of the Terminal. These are indicative of the nature of work and issued for tendering purposes only. Purpose of these drawings is to enable the tendered to make an offer

in line with the requirements of the Owner. Construction shall be as per drawings / specifications issued / approved by the Engineer-in-charge during the course of execution of work.

9.3 After the job completion, Bidder shall prepare AS-BUILT drawings and documents, submit catalogues/manuals (O&M) of major brought out items like junction boxes, meters etc. Final certified as built drawings, documents and manuals etc shall be submitted by the Bidder to owner in bound volume with one set in soft copy (CD) plus five sets of prints.

10.0 TECHNICAL CRITERIA FOR ACCEPTANCE (ELECTRICAL) OF ELECTRICAL CONTRACTOR

Bidder shall be valid electrical contractor license from applicable statutory authority from Assam state along with all statuary requirements for work in the refinery shall be fulfilled by the Bidder prior to start of the work.

10.1 Copy of Electrical Contractor's license –from Electrical Licensing Board for electrical work execution shall be provided along with Bid**.**

10.2 Bidder shall also hire safety personnel as or when required to work in the refinery as per the NRL norms, price quoted for installation & commissioning activities shall be inclusive of this requirement.

10.3 Credential of Electrical Contractor which shows completion of electrical works like installation of Panel, electrical cable laying, Transformers, lighting, earthing etc

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REV: 0
EDITION: 2

SPECIFICATION

FOR

POWER AND CONTROL CABLES

SPECIFICATION NO.-MEC/TS/05/E9/09

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

C O N T E N T S

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

1.0 INTENT

The intent of this standard specification is to define the general requirements for design, manufacture, assembly and testing at manufacturer's works, packing, transportation and receipt at site with all materials and accessories of **Power and Control Cables.**

Bidder shall also refer SOR item for details/requirements as part of the project need.

2.0 CODES AND STANDARDS

The equipment shall comply with the requirements of latest revision of following standards issued by BIS (Bureau of Indian Standards), unless otherwise specified:

IS 209:2024	Zinc ingot
IS 1554: Part 1	PVC insulated (heavy duty) electric cables: Part 1 For working voltages upto and including 1100V
IS 3961: Part 2	Recommended current ratings for cables: Part 2 PVC insulated and PVC sheathed heavy duty cables
IS 3975	Mild steel wires, formed wires and tapes for armouring of cables
IS 5831	PVC insulation and sheath of electric cables
IS 7098	Cross linked polyethylene insulated PVC sheathed cables
IS 8130	Conductors for insulated electric cables and flexible cords
IS 10418	Drums for electric cables.
IS 10462: Part 1	Fictitious calculation method for determination of dimension of protective coverings of cables: Part 1 Electrometric and thermoplastic insulated cables
IS 10810: Part 41	Methods of test for cables Part 41: Mass of zinc coating on steel armour
IS 10810: Part 58	Methods of test for cables Part 58: Oxygen index test
IS 10810: Part 61	Methods of test for cables: Part 61 Flame retardant test
IS 10810: Part 62	Methods of test for cables: Part 62 Fire resistance test for bunched cables
IEC 60332-3	Tests on electric and optical fibre cables under fire conditions
IEC 60502	Power cables with extruded insulation and their accessories for rated voltages from 1kV (Um = 1.2kV) up to 30kV (Um = 36kV)
IEC 60811	Electric and optical fibre cables - Test methods for non-metallic materials
ASTM D2863	Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ANSI/NEMA WC 70-2009/ICEA S- 95-658-2009	Power cables rated 2000 volts or less for the distribution of electrical energy
ANSI/NEMA WC	Standard for non-shielded cables rated 2001-5000V for use in the

71- 1999/ICEA S-96-659-1999	distribution of Electric Energy
ANSI/NEMA WC 74/ICEA S-93-639-2012	5-46kV shielded power cable for use in the transmission and distribution of electric energy
WC 7-1988	Cross-linked thermosetting polyethylene insulated wire and cable for transmission and distribution of electrical energy

Wherever the requirements in this specification are in conflict with any of the above standards, the requirements under this specification shall be binding.

In case of any contradiction between various referred standards/ specifications/ data sheet and statutory regulations the following order of priority shall govern. However, stringent of the below shall be followed-

- Statutory regulations.
- Schedule of Rate.
- Scope of Work/ Job specification.
- Design Basis.
- Data sheets.
- Standard Specification.
- Codes and standards.

3.0 CONSTRUCTIONAL REQUIREMENTS

3.1 General

The cables shall be suitable for laying in trays, trenches, ducts, and conduits and for underground-buried installation with uncontrolled backfill and possibility of flooding by water and chemicals.

Outer sheath of all PVC and XLPE cables shall be black in colour and the minimum value of oxygen index shall be 29 at 27 $\pm$ 2 °C. In addition suitable chemicals shall be added into the PVC compound of the outer sheath to protect the cable against rodent and termite attack.

All cables covered in this specification shall be flame retardant (FR) unless specified otherwise in the data sheet. The outer sheath of PVC and XLPE cables shall possess flame propagation properties meeting requirements as per IS 10810 : Part-62 category AF.

Sequential marking of the length of the cable in metres shall be provided on the outer sheath at every one metre. The embossing / engraving shall be legible and indelible.

The overall diameter of the cables shall be strictly as per the values declared by the manufacturer in the technical information subject to a maximum tolerance of $\pm$ 2mm up to overall diameter of 60mm and $\pm$ 3mm for beyond 60mm.

PVC / Rubber caps shall be supplied free of cost for each drum with a minimum of eight per thousand metre length. In addition, ends of the cables shall be properly sealed with caps to avoid ingress of water during transportation and storage.

The cables used in installation under the jurisdiction of Director General of Mines and safety (DGMS) shall be of copper conductor only, and shall have valid DGMS approvals for the specified locations. The word “Mining Cable” shall be embossed / engraved on the cable outer sheath as per the applicable Indian Standards.

3.2 PVC cables

All control cables for use on medium voltage systems shall be heavy-duty type, 650/1100V grade with copper conductor, PVC insulated, inner-sheathed, armoured and overall PVC sheathed unless specified otherwise in the data sheet.

The conductors shall be solid circular shape.

The core insulation shall be with PVC compound applied over the conductor by extrusion and shall conform to the requirements of type ‘A’ compound as per IS 5831. The thickness of insulation and the tolerance on thickness of insulation shall be as per Table 2 of IS 1554 : Part 1. Control cables having 6 cores and above shall be identified with prominent and indelible English numerals on the outer surface of the insulation. Colour of the numbers shall contrast with the colour of insulation with a spacing of maximum 50mm between two consecutive numbers. Colour coding for cables up to 5 cores shall be as per Indian Standard.

The inner sheath shall be applied over the laid-up cores by extrusion and shall be of PVC conforming to the requirements of Type ST-1 PVC compound as per IS: 5831. The minimum thickness of inner sheath shall be as per IS 1554 : Part 1. Single core cables shall have no inner sheath.

If armouring is specified for multicore cables in the data sheet, the same shall be by single round galvanized steel wires where the calculated diameter below armouring does not exceed 13mm and by galvanized steel trips where this dimension is greater than 13mm. Requirement and methods of tests for armour material and uniformity of galvanisation shall be as per IS-3975 and IS 10810 : Part 41. The dimension of Armour shall be as per method (b) of IS 1554 : Part 1. If armouring is specified for single core cables in the data sheet, the same shall be with H4 grade hard drawn aluminium round wire of 2.5mm diameter.

For mining cables, the size and type of armour shall be such that the combined conductance of armour shall be equivalent to 75 percent of the conductance of the largest conductor of the cable.

The outer sheath for the cables shall be applied by extrusion and shall be of PVC compound conforming to the requirements of type ST-1 compound as per IS 5831. The minimum and average thickness of outer sheath for unarmoured cables and minimum thickness of outer sheath for armoured cables shall be as per IS 1554 : Part 1.

If heat resisting PVC cables are specified in the data sheet, the following shall be the requirements:

It shall be possible to continuously operate the cable at a maximum conductor temperature of 85°C. PVC compounds used for HR PVC cable shall be as follows:

a) Conductor insulation - Type C

b) Inner Sheath - Type ST-2

c) Outer Sheath - Type ST-2

3.3 XLPE Cables

Power cables from 650/1100V grade up to and including 33 kV systems shall be Aluminium / Copper conductor, XLPE insulated, sheathed, armoured and overall PVC sheathed.

The conductors shall be solid for conductor of nominal area up to and including 6mm^2 and stranded beyond 6mm^2. Conductors of nominal area less than 16mm^2 shall be circular only. Conductors of nominal area 16mm^2 and above may be circular or shaped as per IS 8130. Cables with reduced neutral conductor shall have sizes as per Table 1 of IS 1554 : Part 1.

The conductors of 3.3kV up to and including 33 kV systems shall be stranded and completed circular for all cables.

All cables rated 3.8 / 6.6 kV and above shall be provided with both conductor screening and insulation screening. The conductors shall be provided with non-metallic extruded semiconducting screen.

The core insulation shall be with cross linked polyethylene insulating compound dry cured, applied by extrusion. It shall be free from voids and shall withstand all mechanical and thermal stresses under steady state and transient operating conditions. It shall conform to the properties given in the Table -1 of IS 7098 : Part-2

The insulation screen shall consist of non-metallic extruded semi-conducting compound in combination with a non-magnetic metallic copper screen. Unless specified otherwise, the copper screen for all the three cores together for three core cables and individual core for single core cables shall be capable of carrying the single line to ground fault current value and the duration specified in the data sheet.

The conductor screen, XLPE insulation and insulation screen shall be extruded in one operation by 'Triple Extrusion' process to ensure perfect bonding between the layers. The core identification shall be by coloured strips or by printed numerals.

The inner sheath shall be applied over the laid up cores by extrusion and shall conform to the requirements of type ST-2 compound of IS 5831. The extruded inner sheath shall be of uniform thickness. In case of single core cables, there shall be extruded inner sheath between insulation metallic screen and armouring.

For multicore cables, the armouring shall be by galvanized steel strips as per method (b) of IS 7098 : Part 2. If armouring is specified for single core cables in the data sheet, the same shall be with H4 grade hard drawn aluminium round wire of 2.5mm diameter.

The outer sheath of the cables shall be applied by extrusion over the armouring and shall be of PVC compound conforming to the requirements of Type ST-2 compounds of IS 5831. The minimum and average thickness of outer sheath for unarmoured cables and minimum thickness of outer sheath for armoured cables shall be as per IS 7098 : Part 2.

The thickness of the insulation, inner sheath shall be governed by values given in IS 7098 : Part 2.

Where specified, 1100V grade power cables shall also be XLPE insulated and shall meet the requirements specified in IS 7098 : Part-1.

4.0 INSPECTION AND TESTING

During fabrication, cables shall be subject to inspection by Purchaser or by an agency authorized by the Purchaser. Vendor shall furnish all necessary information concerning the supply to Purchaser. The Purchaser shall have free access to the Vendor's works for the purpose of inspecting the process of manufacture in all its stages and he will have the power to reject any material, which appears to him to be of unsuitable description or of unsatisfactory quality.

Cables shall be tested in accordance with applicable standards. All acceptance, routine, type and special tests as follows shall be carried out at Vendor's work under his care and expense. Vendor's internal test reports shall be provided for Purchaser's review prior to inspection and testing.

All routine tests, acceptance tests, type tests and additional type tests for improved fire performance shall be carried out as listed in IS 1554 : Part 1, and IS 7098 : Part 2 on PVC and XLPE insulated cables respectively.

The test requirement for PVC insulation and sheath of cables shall be as per IS 5831.

Test for Resistance to Ultra Violet Radiation: This test shall be carried out as per DIN 53387 or ASTM G-53 on outer sheath. The retention value of tensile strength and ultimate elongation after the test shall be minimum 60% of tensile strength and ultimate elongation before the test. Test certificates with respect to this test (not older than one year) from recognized testing laboratory to be furnished for review by Purchaser before dispatch clearance of cables. In case test certificates are not available, test is to be conducted by vendor at his own cost in any recognized test laboratory or in house testing laboratory, before dispatch clearance of cables. Sampling for this test is to be done randomly once for each order, provided outer sheath remains same.

Acceptance tests as per IS 1554: Part 1 and IS 7098: Part 2 and the following special tests to be performed on the cables as per sampling plan.

a) **Accelerated water absorption test** for insulation as per NEMA WC-5 (For PVC insulated cables) and as per NEMA WC-7 (for XLPE insulated cables). Test certificates with respect to this test (not older than one year) from recognized testing laboratory to be furnished for review by Purchaser. In case test certificates are not available, test is to be conducted by Vendor at his own cost in any recognized test laboratory or in house testing laboratory, before dispatch clearance of cables. Sampling for this test is to be done randomly once for each order, provided type of insulation remains same.

b) **Dielectric Retention Test:** The dielectric strength of the cable insulation tested in accordance with NEMA WC-5 at 75 $\pm$ 1°C shall not be less than 50 % of the original dielectric strength. (For PVC insulated cables). Test certificates with respect to this test (not older than one year) from recognized testing laboratory to be furnished for review by Purchaser before dispatch clearance of cables. In case test certificates are not available, test is to be conducted by vendor at his own cost in any recognized test laboratory or in house testing laboratory, before dispatch clearance of cables. Sampling for this test is to be done randomly and once for each order.

c) **Oxygen Index Test:** The test shall be carried out as per ASTM D 2863 or applicable Indian Standard specifications. Sampling is to be done for every offered lot / size as per sampling plan.

d) **Flammability Test:** The test shall be carried out on finished cable as per IS 10810: (Part 61 & 62). Sampling for these tests is to be done randomly once for each order, provided outer sheath remains same. The acceptance criteria for tests conducted shall be as under:

Part 61- The cable meets the requirements if there is no visible damage on the test specimen within 300mm from its upper end.

Part 62- The maximum extent of the charred portion measured on the test sample should not have reached a height exceeding 2.5 m above the bottom edge of the burner at the front of the ladder.

e) Test for rodent and termite repulsion property: The vendors shall furnish the test details to analyse the property by chemical method. Sampling is to be done for every offered lot / size as per sampling plan.

Acceptance, routine, type and special tests shall be witnessed by Purchaser or an agency authorized by the Purchaser. Prior notice of minimum 4 weeks shall be given to the Purchaser for witnessing the tests.

5.0 PACKING AND DISPATCH

Cables shall be despatched in non-returnable wooden or steel drums of suitable barrel diameter, securely battened, with the take-off end fully protected against mechanical damage. The wood used for construction of the drum shall be properly seasoned, sound and free from defects. Wood preservatives shall be applied to the applied to the entire drum. Ferrous parts used shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage.

On the flange of the drum, necessary information such as project title, manufacturer's name, type size, voltage grade of cable, length of cable in metres, drum no., cable code, BIS certification mark, gross weight etc. shall printed. An arrow shall be printed on the drum with suitable instructions to show the direction of rotation of the drum.

Unless otherwise specified, cables shall be supplied in drum lengths as follows:

MV Cables

		1000m
- Multicore Power cables upto 6mm^2	:	
- Multicore Power cables from 10mm^2 up to 300mm^2	:	500m
- Single Core Power cables up to 630mm^2	:	1000m
- Control cables up to 61 cores	:	1000m

HV Power cables –up to 11k V (E) Grade

- Three Core cables up to 400mm^2	:	500m

- Single Core cables up to 400mm^2 : 1000m
- Single Core cables above 400mm^2 and up to 630mm^2 : 750m

HV Power Cables –Above 11 kV (E) Grade and up to 33kV (E) Grade

- Three Core cables up to 300mm^2 grade : 350m
- Single Core cables up to 400mm^2 : 1000m
- Single Core cables above 400mm^2 and upto 630mm^2 : 500m

A tolerance of plus 3% (no negative tolerance) shall be permissible for each drum. However, overall tolerance on each size of cable shall be limited to + 2%. Offers with short / non-standard lengths are liable for rejection. If non-standard drum lengths are specified in the data sheet, the same shall be supplied.

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Rev: 00
EDITION: 2

SPECIFICATION

FOR

INSTALLATION OF ELECTRICAL EQUIPMENTS

SPECIFICATION NO.- MEC/TS/05/E9/14

(ELECTRICAL SECTION)

MECON LIMITED

DELHI 110 092

C O N T E N T S

PREPARED BY:	CHECKED BY:	APPROVED BY:	ISSUED DATE
SHIFA JINDAL	SAURABH SINGH	A. BHOWMIC	MARCH 2022

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

1.0 CODES AND STANDARDS

The equipment shall comply with the requirements of latest revision of following standards issued by BIS (Bureau of Indian Standards), unless otherwise specified:

IS 5	Colours for ready mixed paints and enamels
SP30 (BIS)	National Electrical Code 2011
IS 816	Code of practice for use of metal arc welding for general construction in mild steel
IS 1239	Steel tubes, tubulars and other wrought steel fittings
IS 1255	Code of practice for installation and maintenance of power cables up to and including 33kV rating
IS 1364	Hexagon head bolts, screws and nuts of product grades A and B
IS 1573	Electroplated coatings of zinc on iron and steel
IS 2309	Code of practice for the protection of buildings and allied structures against lightning
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 3043	Code of practice for earthing
IS 3618	Phosphate treatment of iron and steel for protection against corrosion
IS 4759	Hot-dip zinc coatings on structural steel and other allied products
IS 6005	Code of practice for phosphating of iron and steel
IS 7689	Guide for the control of undesirable static electricity
IS 7816	Guide for testing Insulation resistance of rotating machines
IS 10028: Part 2	Code of practice for selection, installation and maintenance of Transformers: Part 2 - Installation
IS 10118: Part 3	Code of practice for selection, installation and maintenance of switchgear and control gear: Part 3 -Installation
OISD-RP-110	Recommended practices on static electricity
OISD-STD-137	Inspection of Electrical Equipment
OISD-RP-147	Inspection and safe practices during electrical installations

In addition to the above it shall be ensured that the installation conforms to the requirements of the following as applicable:

1.1.1 Indian Electricity Act and Rules.
1.1.2 Regulations laid down by CEA/Electrical Inspectorate.
1.1.3 Regulations laid down by PESO/ DGMS (as applicable).
1.1.4 The petroleum rules (ministry of Industry Government of India).
1.1.5 Any other regulations laid down by central/state/local authorities and Insurance agencies.

In case of imported equipment standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.

The equipment shall also confirm to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.

In case of any contradiction between various referred standards/ specifications/ data sheet and statutory regulations the following order of priority shall govern. However, the stringent of the below shall be followed.

- Statutory regulations.
- Schedule of Rate
- Scope of Work/ Job specification.
- Design Basis.
- Data sheets.
- Standard Specification.
- Codes and standards.

2.0 ELECTRICAL EQUIPMENTS:

Prior to start of installation of the electrical equipment contractor shall verify that equipment and complete materials have been received. Handling, shifting to required site location, installation, testing and commissioning of all electrical equipment shall be done by vendor/contractor with utmost care as per the scope matrix between the site installation contractor and respective equipment vendor attached in each tender. Manufacturer's instructions and the requirements given in their technical manuals shall be strictly adhered. The substation/switchgear room wherein the equipment shall be installed shall be kept clean, dry and free from all debris. Panel floor cut-outs not in immediate use shall be suitably covered to avoid any mishap. When handling the switchboard panels, care shall be taken to observe the correct lifting arrangements and to make sure that slings are attached to the manufacturer's designated lifting arrangements and to make sure that slings are attached to the manufacturer's designated lifting points. No parts shall be subjected to undue strains or sudden stresses which could cause damage to the equipment.

The lifting position mark indicated on packing casing shall be adhered to strictly, for keeping it in required vertical position.

Contractor shall check and report to the Purchaser about any damaged item and / or missing component for getting the same replaced as per specifications. During installation, all accessories and loose items shall also be inspected by the contractor before their assembly/mounting.

In case of any modifications/replacement of existing equipment or Tie-ins with existing Electrical

systems, approvals shall be obtained from Purchaser before any work to be implemented. The tie-in and shutdown philosophy shall be developed by Contractor in coordination with production, operation and maintenance department. Detailed Task Risk Assessment (TRA) shall be developed by the Contractor for all modifications/replacement or tie-ins activities and shall be approved by all concerned authorities.

The following philosophies provide the frame work for modifications/ replacement or tie-in approach:

a) The existing facilities shall continue to operate normally. Contractor shall verify the requirements for modifications, replacement and interface or tie-in with existing / new electrical systems.

In general, a planned construction campaign shall be scheduled to facilitate the modifications/replacement or tie-in work. However, preparation for modifications/replacement or tie-in work can be proceed on an opportunistic or scheduled shutdown prior to the planned construction campaign in consultation with Purchaser. Associated shutdown co-ordination shall be carried out by the Contractor as per Purchaser procedure to complete the modifications/replacement of existing electrical equipment or tie-in hook up for all electrical systems.

2.1 SWITCHBOARD:

The term switchboard here includes all HV / MV/ LV switchboard panels, motor control centres, power and lighting distribution boards, UPS panels, ACDB, charger panels, DCDB etc. The switchboard panels shall be handled with care, avoiding any impact to the equipment. Dragging of the panels directly on floor shall be avoided. Roller bars may be used for shifting of panels: Use of a crane and trailer shall be made for handling of equipment. The switchboard panels shall be properly supported on the truck or trailer by means of ropes to avoid any chance of tilting. The switchboards shall be lifted after ensuring that panel supports, nuts and bolts are all intact and tightened. While lifting the panels in packed conditions utmost care shall be taken to avoid any damage to insulators, bushings, metering and protective equipment. The panels shall be preferably kept inside the packing cases till foundations are ready.

The switchboard panels shall be installed on prepared foundations or floor cutouts. Steel base channels shall be welded to inserts provided in floor slab. Cross members shall be provided at the junctions of each shipping section and other places as required. Alternatively, when the floor is being-laid, base channel frame of panels supplied by the vendor shall be grouted and levelled in cement concrete. It shall be ensured that the base plate level of HV switchboard shall match with the finished floor level. The foundation pockets and the grouted bolts shall be cured for a minimum period of 48hours.

The switchboard panels shall be taken out from the packed cases and shifted one by one to its proper place. All the panels shall be assembled, aligned and levelled: Alignment of panels shall be checked in both longitudinal and lateral directions. It shall be ensured that panel to panel coupling bolts, bus bar links etc. fit properly without any strain on any part. No new holes for jointing of the panels other than those recommended by the vendor shall be drilled. No gaps shall be left between the panels. The lifting, racking in and out operation of the breaker and all other motions shall be free from any obstruction.

The panels shall be checked for correct vertical position using pendulum weight and spirit levels. The switchboard panels shall be tack welded at suitable intervals at base channel.

After erection of switchboard panels, all uncovered portions of floor cutouts shall be covered with 6 mm thick removable chequered plates finished with floor level. The design of the chequered plates shall be such that the maximum allowable deflection is L/200 (where L is the span of the chequered plates in metres) for a live load of 500 kg. /sq. meters. Suitable lifting arrangements shall be provided for chequered plates: The chequered plates shall be painted with a coat of red oxide zinc chromate primer after proper surface preparation as per specifications. Where specified, panels cutouts provided for future use shall be filled with lean concrete.

After completion of erection of switchboards, all the cubicles, switchboard components such as switches, starters, C.T. and P.T. chambers, busbar chamber shall be cleaned and checked for tightness of all the components. Vacuum circuit breakers shall be checked for integrity of bottle seals. All loosely supplied items shall be fitted up. Bus bar sections or links shall be inserted and where specified, of high voltage equipment shall be insulated. Interconnection wiring between shipping sections shall be made by vendor. All the wiring connections shall also be checked. Phase sequence and polarity of PTs and CTs shall be checked. Contact resistance of all busbar joints and contactors shall be checked. Insulator shall be checked for any damage. All the starters, switches, contacts shall be cleaned with C.T.C. where required. All the moving parts shall be checked for easy and free movement. Hinges of panel doors shall be lubricated to give free and noise free movement. All openings shall be kept completely closed to avoid ingress of any foreign particles inside the panel.

Functional scheme verification of individual feeder shall be carried out and minor wiring modifications in the panel wiring, if required shall be done as per the directions of Purchaser. Special attention shall be paid to CT circuits polarity, wiring continuity and correctness in the protection as well as measurement circuits. Auto transfer scheme shall be simulated and verified. During the course of scheme verification tests, defective components if any shall be taken out, after bringing to the notice of Purchaser. The same shall be replaced by component supplied by Purchaser.

Where switchboard is damp or having a low IR value due to damaged insulators/ bushings/any other insulated parts, or any other reason, the entire switchboard shall be dried. up according to the instruction of the Purchaser for the I.R value to improve to a state level for commissioning. Care shall be taken to protect the surrounding insulation from direct local heating during the drying up process.

All the metering instruments, protective relays and other relays and contactors shall be tested as per manufacturer's recommendations and according to the instructions of the Purchaser. Protection relays shall be inserted and connected and settings adjusted as required by the Purchaser.

All moving parts, of closing/tripping mechanism, racking in and racking out mechanism, spouts and shutter closing mechanism shall be checked for proper operation. All the auxiliary contacts of breaker shall be checked-up, cleaned and contact pressure measured.

All the control wiring, PTs, bushings, bus bars, other live parts of switchgear, incoming and outgoing cables shall be meggered.

Electrical simulation tests shall be carried out for all the protective, alarm and annunciation relays and external interfaces to ascertain proper functioning.

Safety insulation mats of approved make and of required voltage grade shall be provided in the

sub- Station.

Pre-Commissioning Checklist:

Before commissioning any switchboard, following points shall be checked and ensured for safe energizing of the switchboard:

That the installation of equipment to be commissioned is complete in all respects with its auxiliaries and all other mounting including earthing. Openings in floor within and outside panels have been sealed off. All cover and door gaskets are intact to make the enclosure vermin proof.

a) All the metering instruments have been checked and found in working order. Indicating lamps are healthy and are in correct position. All power and control fuses are of proper rating.

b) That the polarity test and ratio test of all the P.T.s and C.T.s is complete and phase sequence of C.T.s conforms to the correct vector group connections. Wiring continuity and correctness are ensured in the protection and measurement circuits. Polarity of D.C. supply for all the circuits is correct.

c) That the high voltage tests of incoming and outgoing cables have been conducted and results are satisfactory.

d) That all the protective relays including both conventional and microprocessor based numerical relays have been tested for secondary injection tests. (Primary injection tests shall be carried out for differential protection, Restricted Earth fault protection and thermal overload at full / reduced current to ensure correctness of complete wiring). Relay settings, status indications, fault annunciations, data logging, display of switchboard SLDs shall be verified from MMI in case the same is provided.

e) That I.R. Value has been recorded for bus bars, circuit breaker, incoming and outgoing cables, control wiring and potential transformers. Where required joint resistance of bus bars have been recorded and found to be satisfactory. All the surroundings and panels have been cleaned and temporary earth leads have been removed. Timing & CRM test for breakers to be conducted. Hi-Pot IR & PI wherever applicable to be done & recorded

2.2 BUSDUCT:

The bus ducts as per issued drawings will be supplied in parts and all the parts shall be assembled and the bus bar connections shall be made at site. The insulators in bus ducts shall be inspected for any possible damage during transit and the defective ones shall be replaced. The insulators shall be cleaned. Contact surface of bus bars, bus bar bolts and nuts shall be thoroughly cleaned. Petroleum jelly shall then be applied and bolted connection made. The bus duct enclosure shall be checked for earth continuity and then earthed at two places. The bus duct shall be properly supported between switchgear and transformer. The opening in the wall where the bus duct enters the switchgear room shall be completely sealed to avoid rain water entry. Expansion joints, flexible connections etc. supplied by the manufacturer of the bus duct shall be properly connected. The bus duct levelling shall be checked with spirit level and pendulum weight.

2.3 **TRANSFORMER:**

Transformers on receipt at site shall be unloaded by means of crane or lifting devices of adequate capacity. All lifting lugs shall be used to avoid unbalanced lifting and undue stresses on lugs. Lifting lugs if any provided for partial lifting (e.g., for active part, conservator) etc. shall not be used for lifting complete transformer. Parts other than those identified for lifting of the transformer shall not be used for lifting. While slinging, care shall be taken to avoid slings touching other

parts.

Before lifting transformer, it shall be ensured that all cover bolts are tightened fully. In case when it is necessary to use jacks for lifting, projections provided for the purposes of jacking shall be used.Liftingjacksshallnotbeusedunderthevalvesorradiatortubes.Fortransporting transformers from stores to site, the transformers shall be loaded on a suitable capacity truck or trailer. The transformers shall be properly supported by steel ropes and stoppers on the trailer to avoid tilting of the transformers in transit due to jerks and vibrations. At no instance the transformer shall be kept on bare ground. Where it is not possible to unload the transformer directly on a foundation, it shall be unloaded on a properly built wooden sleeper platform. A transformer shall never be left without putting stoppers to the wheels.

Transformer shall be examined, for any sign of damage in transit. Particular attention shall be given to the following in this regard:

a) Dents on tank wall or cooling tubes.

b) Damage to protruding parts like valves, sight glass etc.

c) Loosening of bolts due to vibration in transit.

d) Cracked or broken bushings.

e) Oil leakage particularly along welds.

If anything, adverse is noted the same shall be brought to the notice of Purchaser.

Contractor shall examine the transformer base, oil pit, tire walls and foundations laid by the civil contractor. It shall be ensured that oil spills cannot propagate along cable trenches. Any discrepancy noted will be brought to the notice of Purchaser. Transformers shall be placed on channels or rails over concrete foundations. The transformers shall be levelled, aligned and checked for free movement on the channels or rails. Stoppers shall be provided to the transformers immediately to prevent any movement. Normally transformers upto 1000kVA rating shall be received duly fitted with radiator tubes, conservator tanks, valves, wheels and other accessories. While the transformers of above 1000kVA rating may be supplied with loose accessories. All the accessories like radiators, cooling fans, valves, conservator tanks, explosion vent pipe, bushings and other devices which are supplied in different packages shall be checked for any transit damage and cleaned thoroughly before fixing on the transformer. All loosely supplied parts shall be assembled as per manufacturer's instruction manuals/ drawings and documents. All the connections for C.T.s bushings and other wiring shall be checked for tightness and correctness before replacing the lid or tightening all the bolts.

Topping of transformer with oil:

Before topping up with oil, transformer shall be fitted with all accessories such as valves, gauges, thermometers etc. Oil samples shall be taken from each drum and tested for determination of dielectric strength. Any sign of leakage of the barrel or of its having been opened shall be recorded and reported. It is necessary to filter the oil before the transformers are filled. It shall be ensured in oil filling operation that no air pockets are left in the tank and that no dust or moisture enters the oil. All air vents shall be opened. Oil shall be filled through a streamline oil filter using metal hose. To prevent aeration or the oil, the transformer tank shall be filled through the bottom drain valve. In a transformer with conservator tank, the rate of oil flow shall be reduced when the level is almost upto the bottom of the main cover to prevent internal pressure from rupturing the

pressure relief-pipe diaphragm. Sufficient time shall be allowed for the oil to permeate the transformers and also for the locked -up air bubbles to escape. Any air accumulation in the buchholz relay shall be released.

Transformer Oil

a) Sample of oil from the transformer shall be taken from the bottom of the tank.

b) Testing of Oil:

For dielectric test, the oil shall be tested as described in IS 335. The oil shall also be tested for acidity in accordance with the methods prescribed.

Drying out of the transformers, if required, shall be carried out and record maintained in accordance with IS 10028. Normally a streamline filter shall be used for drying-up. I.R. value versus time of both windings shall be recorded during the drying-up process.

Precautions when drying

a) The maximum sustained temperature to which transformer oil may be subjected shall be limited to80^0C.

b) The transformer shall be carefully monitored throughout the drying out process and all observations shall be carefully recorded.

c) Drying out shall be continued so that the insulation resistance as prescribed in the standard code of practice is attained and the value remains constant for more than 12 hours. However, a minimum number of cycles shall be done for each transformer as found necessary by the Purchaser. Generally, a megger reading of 2 megohms / kV at 60^0 C temp with a 5kV Megger may be a rough indication for stopping the dehydration.

The following work on transformers shall be performed by the vendor if specifically called for:

a) Before finally commissioning the transformer, it may sometimes be desired to run it for a few hours on short-circuit, applying a low voltage, approximately equal to the impedance voltage of the transformer. During this process, regular readings of the insulation resistance of the winding to earth and winding to winding and temperature against time shall be recorded.

b) Testing of radiator tubes for any leakage and rectifying these by welding/brazing.

Pre-commissioning Checklist:

Before commissioning of any transformer, the following points shall be checked for safe energisation of the transformer:

a) That all the accessories have been fixed properly and transformer body and neutral are properly earthed. The transformer dehydration is over and results are satisfactory and approved by the Purchaser. In case transformers are idle for more than one month after dehydration, transformer oil has been given at least two circulations.

b) That the oil level, in the transformer conservator tank and all the bushings is upto the marked point and the oil has been tested for dielectric strength and acidity.

c) That the silica gel is in reactivated condition. The breather pipe is clear from any blocking and

contains oil upto the proper level.

d) The explosion vent diaphragm does not have any dents. Accumulation of any oil and air had been released.

e) That the operation of off-load and on-load tap changers on all the tap positions is satisfactory. The mechanical parts of the on-load tap changer are lubricated. Motor IR value has taken and found satisfactory. Tap position mechanical indicator on the transformer and tap position indication meter on the control panel are reading the same tap positions. Tap changer limit switches are operating satisfactorily on the maximum and minimum tap positions. On-load tap changer contact pressure and resistance is as per manufacturers recommendations. Oil level of tap changer tank is upto the required level and oil has been tested for dielectric strength. The tap setting on which the off-load tap switch is locked shall be recorded. Generally, the off-load tap switch shall be kept on nominal tap.

f) That the buchholz relay has been tested and checked up for any friction in the movement, and floats are free, all the other protective relays, alarm and annunciation relays have been tested.

g) That all the metering equipment have been tested and polarity test of P. T's and transformer winding is satisfactory. Phase sequence and connections have been checked for proper vector group.

h) That the ratio test and winding resistance on all the tap positions is satisfactory.

i) That gaps of arcing horns for the bushings where provided are in order and earth connections for the surge diverters have been checked

j) That the winding and oil temperature thermometer pockets contain oil and the winding and oil temperature settings on dial gauges are in order.

k) That the transformers fitted with fans for forced air cooling have been checked up for automatic starting and stopping of the fans and air is placement as been verified (If applicable).

l) That the simulation tests for all external interface connection alarm, annunciation and trip circuits have been checked and are in order.

m) That the insulation resistance of all the control circuits and IR value of the transformer windings and all the incoming and outgoing cables have been checked.

n) That all the valves in the cooling system and valve between the buchholz relay and the conservator tanks are in open position.

o) That the setting of all the protective relays is at the desired value and D.C. Trip supply is healthy.

Observations after Commissioning

After switching on the transformer, the following points shall be observed and recorded.

a) The inrush magnetizing current and no-load current.

b) Alarm, if any, or if any relay flag has operated.

c) Voltage and current on all the three phases.

d) Transformer hum or abnormal noise.

e) Circulation of oil and leakages.

f) Record current, voltage, cooling air temperature, winding temperature and oil temperature readings, hourly for 24hours.

g) Cable end boxes, for any over-heating.

2.4 HV and MV MOTORS:

All the motors generally would be erected by the mechanical contractor.

Contractor shall keep the motor space heater energized as per the directions of Purchaser. Contractor shall measure the insulation resistance of motor windings. Insulation resistance of the motors shall be measured between the winding of the machine and its frame by means of a 500 / 1000V Meggar in case of 415V motors. A minimum value of 1 megohm for 415V motors shall be considered a safe value. In case of lower I.R. Value, the insulation value shall be improved by any of the following methods as directed by the Purchaser.

a) Blowing hot air from external source.

b) Putting the motor in oven:

c) Placing heaters or lamps around and inside after making suitable guarding and covering arrangements so as to conserve the heat.

In case the insulation is low, the following method of drying has to be adopted, after consultation with Purchaser. During drying the temperature rise of winding shall not exceed the permissible value for the class of insulation used:

a) By locking the motor so that it cannot rotate and then applying such a low voltage to the stator terminals so as to pass full load current in the stator keeping the stator winding temperature below 90° C. In this case a close watch shall be kept for any possible overheating and I.R. Values vs. temperature shall be plotted and heating continued till I.R. value becomes steady.

b) By blasting hot air from external source, Maximum temperature of winding while drying shall be 70° C to 80°C (thermometer) or 90° C to 95° C by resistance method. Heating shall be done slowly first till steady temperature of winding is reached after 4 to 5 hours, and for large machines after 10 hours. A record has to be kept for drying process, with half an hour reading and, till steady temperature is reached. In case it is essential, the drying process can be supplemented by blower.

It shall be sure that the motor leads are correctly connected in the terminal box, as indicated in the 'Name Plate'. The covers of all terminal boxes shall be properly fixed, the gaskets intact. The control circuit shall be tested for proper functioning as per circuit diagram.

In case of synchronous machines, slip rings and brush gear shall be polished and brushes shall be fixed in their holders with clearance and pressure as recommended by the manufacturers.

Before commissioning, the ventilation and cooling system of the motor must be inspected. In case of motor with forced ventilation the air inlet shall be examined to ensure that it is free from moisture and any foreign material. It shall also be ensured that recommended flow and pressure

of air is available to produce the required cooling effect.

The motor control gear shall also be carefully examined, the over-load settings may be reduced or time lags bypassed from protective gear to ensure rapid tripping of switchgear in event of faults. The direction of rotation of a new motor specially of large capacity, and phase sequence of supply shall be kept in view while joining and connecting to the motor terminals.

Finally, the motor shall be started on no-load after decoupling, and shall be allowed to run for a minimum period of 4 hours, or for a time as instructed by Purchaser. Attention shall be given to the proper running of the bearings, vibration or unusual noises if any. Voltage, starting current, no-load current, stator winding and bearing temperature & vibrations shall be recorded after every 1 hour during this test. Direction of rotation shall be checked and recorded. Normally the motors run in clockwise direction as viewed from the driving end with reference to the phase sequence R,Y,B.

After switching off the motor, the insulation resistance of the motor shall be recorded under hot and cold conditions.

If the no load test run is found satisfactory, the motor shall be allowed to run for 8 hours and all readings shall be recorded.

The following work on motors, may be performed by the contractor if specifically called for.

a) The proper level of bearing oil has to be checked. The condition of grease in bearings shall be checked and in case it is necessary, complete replacement of bearing with specified grade of grease after proper cleaning of the bearing shall have to be done. Wherever external greasing facility exists, the condition of grease may be checked by pumping some new grease of specified grade at start. If the grease coming out is deteriorated grease shall be replaced.

b) All the motors, motor exciter set and induction generators directly coupled or coupled through reduction gears shall be checked for abnormal vibration, if any Large rated HV motors with journal type bearings are liable to get damaged from shock, rough handling during transit. Any minor defect in a race or roller may give rise to considerable amount of vibration and noise. Contractor shall check and bring to the attention of Purchaser any defect noticed in this regard.

c) Due care shall be taken to avoid any damage to bearing insulation wherever provided.

2.5 CABLE INSTALLATION

General

Cable installation shall include power, control and lighting cables. These shall be laid in trenches/cable trays as detailed in the power layout drawings. Cable routing given on the power layout drawings shall be checked in the field so as to avoid interference with other services such piping, instrumentation, civil, structural, mechanical etc. Any change in routing shall be done to suit the field conditions suitably interfacing with other services wherever deemed necessary, after obtaining approval of Purchaser.

High voltage, medium voltage power and control cables shall be separated from each other by adequate spacing or by running through independent pipes, trenches or cables trays, as shown on power layout drawings/installation details. Details of cable routes and cable spacings not shown in detail drawing shall be determined by the Contractor and approved by the Purchaser.

When single core cables are laid in flat formation, the individual cable fixing clamps and spacers shall be of non-magnetic material. As a general practice, the sheath of single core cables shall be

earthed at one point to keep sheath at earth potential unless otherwise stated. Single core cables, when laid in trefoil formation shall be braced by suitable clamps at a distance, not exceeding 3 meters along the cable routing.

If straight through joints are required to be provided on single core cables, amour shall be broken at joints as per Supplier's recommendations. For single core cables, armour shall be earthed at one end for the cable run length as per Supplier's recommendation.

Minimum spacing of 300 mm between power, control cables and Telephone, Communication, Fire alarm cables shall be maintained.
The lengths indicated in the cables schedule are only approximate. The Contractor shall ascertain the exact length of cable for a particular feeder by measuring at site. All cable routes shall be carefully measured. Before the start of cable laying, the Contractor shall prepare cable drum schedule and get that approved by Purchaser to minimize/avoid straight though joints and then the cables cut to the required lengths, leaving sufficient lengths for the terminations of the cable at both ends. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. Extra loop length shall be given for feeder cables where required as per the directions of Purchaser to meet contingencies.

Cables shall be laid in directly buried trench or in RCC trench (underground trench) or in cable tray along pipe sleepers or in overhead trays as shown on power layout drawings.

Overhead trays shall be installed 2700 mm (minimum) above grade level. At road crossings overhead trays shall be installed at 7000 mm (minimum) above level or cables shall be routed cable tray culvert/Electrical Road crossings as per power layout drawings.

Sufficient care shall be taken while laying cables to avoid formation of twist, sharp bend etc. in order to avoid mechanical injuries to cables. Rollers shall be used for pulling of cables.

Cable installation shall provide minimum cable bending radii as recommended by cable Supplier.

Cables shall be neatly arranged in the trenches/trays in such a manner that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trenches/trays shall be in line with power layout drawings. Cable routing between cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 45 to the trench wall. Bending radii of pipes shall not be less than 8D. It is to be ensured that both the ends of GI pipe sleeves shall be sealed with approved whether proof sealing plastic compound after cabling. In places where it is not possible, cables shall be laid in smaller branch trenches.

All cables shall be identified close to their termination point by cable tag numbers as per cable schedule. Cable tag numbers shall be punched on aluminium straps (2mm thick, 20 mm wide and of enough length) securely fastened to the cable and wrapped around it.

Each underground cable shall be provided with cable tags of lead securely fastened every 30 m of its underground length with at least one tag at each end before the cable enters/leaves the ground. In unpaved areas, cable trenches shall be identified by means of cable markers as per installation drawing. These cable markers shall be placed at location of changes in the direction of cables and at intervals of not more than 20 m and also at cable straight through joint locations.

All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of cables shall be taped with an approved PVC end cap or

rubber insulating tape.

Each row of cables shall be laid in place and before covering with sand. All wall opening/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building /lined trench. Every cable shall be given an insulation test in presence of Purchaser before filling the cable trench with sand. Any cable which is found defective shall be replaced.

Where cables pass through foundation walls, the necessary openings shall be provided in advance for the same by another agency. However, should it become necessary to cut holes in existing structures for example floor slab etc., the Contractor shall determine their location and obtain approval of the Purchaser before carrying out the same.

Cables for road crossings shall be taken through ERC (Electrical Road Crossing) as shown in the power layout drawings.

At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.

Wherever cable trench crosses storm water, waste water channel/drain, cables shall be taken through PVC/RCC pipes. Where cables are required to cross drains of depth more than 1200 mm, cables shall be taken over the drain on cable trays supported suitably using ISMC 150/200 sections.

Ends of cables leaving trench shall be coiled & capped and provided with protective cover till such time the final termination to the equipment is completed.

Cables laid direct inground

Cables shall be laid underground in excavated cable trenches where specified in cable layout drawings. Trenches shall be of sufficient depth and width for accommodation of all cables. Cables shall be properly spaced and arranged with a view of heat dissipation and economy of design. Maximum number of cable layers in trench shall be preferably limited to 5 layers.

Minimum depth of cable trench shall be 750 mm for medium voltage and 900 mm for H.V. Cables. The depth and the width of the trench shall vary depending upon the number of layers of cables

Cables shall be laid in buried trenches at depth as shown in the power layout drawings. It is to be insured by the Contractor that the bottom of buried trenches shall be cleared of all rocks, stones and sharp objects before cables are placed. The trench bottom shall be filled with a layer of sand. This sand shall be levelled and cables laid over it. These cables shall be covered with 150 mm of sand on top of the largest diameter cable and sand shall be lightly compacted. A flat protective covering of 75 mm thick second-class red bricks shall than be laid and the reminder of the trench shall then be back – filled with soil, rammed and levelled.

Cables laid in concrete trench

Cables shall be laid in 3 or 4 tiers in concrete trench as shown on power layout drawings. Concrete cables trenches shall be filled with sand in hazardous area to avoid accumulation of hazardous gases and oil. RCC covers of trenches shall be effectively sealed to avoid ingress of chemical and oil in process area. Removal of concrete covers where required for the purpose of cable laying and reinstating them in their proper position after cables are laid shall be done by Contractor.

All wall opening /pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water.

Above ground cables

a) Cables installed above grade shall be run in cable trays, clamped on walls, ceiling or structures and shall be run parallel or at right angles to beams, walls or columns. Cable routing shall be planned to be away from heat sources such as hot piping, gas, water, oil drainage piping, air- conditioning duct etc. Each cable tray shall contain only one layer of cables as far as possible for power cables. However, control cables may be laid in double layer in the cable trays.

b) Individual cable or small group of cables (upto 3 to 4 cables) which run along structures/walls etc. shall be clamped by means of 16 SWG GI saddles on 25 x 6 mm saddle bars. Alternatively small group of cables can be taken through 100/150 mm slotted channel tray/ISMC100.

Cables shall be supported so as to prevent sagging. In general, distance between supports shall be approximately 300 mm for cables upto 25 diameters and maximum 450 mm for cables larger than 25 mm dia. To prevent the sagging of cables.

c) Cable laid on supporting angle in cable trenches, structures, columns and vertical run of cable trays shall be suitably clamped by means of G.I. saddles/clams, whereas cables in horizontal run of cable trays shall be tied by means of nylon cords. Distance between supporting angles shall not exceed 600mm.

d) All cable trays (other than galvanized trays) and supporting steel structures shall be painted before laying of cables. The under surfaces shall be properly degreased, derusted, descaled and cleaned. The painting shall be done with one coat of red oxide zinc chromate primer. Final painting shall be done with two coats of approved bituminous aluminum paint unless otherwise specified.

e) Where cables rise from trench to motor, lighting panel, control station, junction box etc., they shall be taken in GI pipe for mechanical protection upto a minimum of 300 mm above grade. Cable ends shall be carefully pulled through conduit to prevent damage to cable.

f) All G.I. Pipes shall be laid as per layout drawings and site conditions. Before fabrication of various profiles of pipes by hydraulically operated bending machine (which is to be arranged by the Contractor) all the burrs from the pipes shall be removed. GI Pipes having bends shall be buried in soil/concrete in such a way that the bend shall be totally concealed. For G.I. pipes buried in soil, bitumen coating shall be applied on the buried lengths. Installation of G.I. pipes shall be undertaken well before paving is completed and necessary co-ordination with paving agency shall be the responsibility of Contractor.

Following guide shall be used for sizing of G.I. pipe.

i) 1 cable in a pipe - 53 % of pipe cross-sectional area occupied by cables.
ii) 2 cables in a pipe - 31 % of pipe cross-sectional area occupied by cables.
iii) 3 cables in a pipe - 43 % of pipe cross-sectional area occupied by cables.
iv) 4 and above cables in a pipe - 40 % of pipe cross-sectional area occupied by cables.

After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound / bitumen / suitable sealing compound. Alternatively, rubber bushes shall be employed for the purpose of sealing

Terminations

a) All HV and MV cables shall be terminated at the equipment by means of single/double compression type cables glands as specified suitable for the cable size. They shall have a screwed nipple with conduit electrical threads and check nut. The cables shall be identified close to their termination points at both the ends of cable (cable numbers shall be punched on aluminium strips 2mm thick and securely fastened to the cables wrapped around it) and also along the route at recommended intervals, by cable tag numbers.

All cable entries for outdoor termination shall be preferably through bottom. Outdoor cable termination through top of equipment shall not be permitted.

b) Power cables cores wherever colour coding is not available shall be identified with red, yellow and blue PVC tapes. Where copper to aluminum connections are made, necessary bimetallic washers shall be used.

c) In case of control cables, all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules suitable for core size. Wire numbers shall be as per schematic/wiring/inter-connection diagram. All unused spare cores of control, cables shall be neatly bunched and ferruled with cable tag at both ends, for future use.

For trip circuit identification additional red ferules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.

d) Contractor shall drill holes for fixing glands wherever necessary. Gland plate shall be of non- magnetic material/aluminium sheet in case of single core cables. All unused cable entries on equipment/panels shall be plugged/sealed.

e) The cable shall be terminated at electrical equipment /switchboards through glands of proper size. The individual cores shall then be dressed and taken along the cables ways or shall be fixed to the panels with polyethylene straps. The cable glanding shall be done as per Supplier's instructions. Cable armour shall not be exposed after termination is complete. In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom close fit holes shall be drilled in the gland plate for all the cables in one line, and then gland plate shall be split in two parts along the centre line of holes. After fixing bottom plate, uncovered cable holes/gaps shall be sealed with cold setting compound.

f) Crimping of lugs to cable leads shall be done by hand crimping/hydraulically operated tool as per requirement. Insulation of the leads shall be removed before crimping. Conductor surface shall be cleaned and shall not be left open. Suitable conducting jelly shall be applied on the conductor lead. Lugs shall enclose all strands of cable core. Cutting of stands shall not be allowed.

g) HV cables shall be terminated with heat shrinkable termination kits, indoor or outdoor type as specified by approved HV cable jointers. Supplier's instructions shall be followed for applying heat shrinkable termination kits.

h) The Contractor shall bring to the notice of Purchaser any mismatch in cable glands, lugs provided with the equipment vis-à-vis to the cable size indicated in cable schedule for taking corrective action.

i) The cable joints in power and control cables shall be avoided as far as possible. In case a joint is unavoidable, the following shall be insured:

i) The number of joints shall be restricted to minimum as far as possible.

ii) The location of joints shall be identified with permanents markers.

iii) No joints shall be allowed in hazardous areas without the approval of Purchaser.

iv) No joints will be allowed in the Cable seller.

The jointing and termination of medium voltage power cables shall be carried out by trained personnel only. Jointing and termination of high voltage cables shall be done by skilled and experienced jointer duly approved by Purchaser. Only type tested termination kits of approved make shall be used.

j) No unauthorized repairs, modifications shall be carried out on the hazardous area equipment terminal boxes and junction boxes. Damaged enclosures of hazardous area equipment shall be brought to the notice of Purchaser by Contractor. After termination is complete, all the bolts, nuts, hard wares of terminal box shall be properly placed in its position and tightened.

k) Where required, cable sealing boxes intended to be used with the apparatus shall be filled with solid setting type bituminous compound unless otherwise specified

2.6 LIGHTING INSTALLATION

General

The lighting fixtures in the plant shall be fed from lighting and small power distribution board. All outdoor lighting shall be group controlled manually or through photoelectric synchronous timer. Lighting wiring between distribution boards and lighting fixtures shall be done with 3-core (phase, neutral and earth) Cu/XLPE/SWA/PVC cable for plant areas and substation building. Wiring in the other building shall be done by means of 3-core Cu/PVC cables, or PVC insulated copper conductor wires in conduit/Metsec channel as specified. All joints of conductors in Switch boards/JBs Fittings shall be made only by means of approved mechanical connectors (nylon/PVC connectors). Bare twisted joints shall not be permitted anywhere in the wiring system.

The lighting and small power layouts furnished by Purchaser will indicate approximate locations of lighting fixtures. The Contractor shall determine, with approval of Purchaser, the exact locations of each fixture in order to avoid interference with other services such as piping, instrumentation, civil, structural, mechanical etc and also with a view to obtain as much uniform illumination as practicable, and to avoid objectionable shadows. Conduits shall be laid out by the Contractor to suit field conditions suitably interfacing with other services and as per directions of the Purchaser.

On walkways, platforms and other outdoor area, lighting fixtures shall be located nearer to landing of stairs or ladders, gauges, flowmeters, panel boards and other equipment to provide proper illumination.

The minimum height of any lighting fixture shall be preferably not less than 2.5 meters above the floor level.

All outdoor cable terminations to outdoor junction boxes, panels, socket outlets etc. shall be

through bottom or from side. Top entries for cables shall be avoided to avoid water entry. All cable glands for outdoor terminations shall be double compression type and the gland shall be covered with PVC or rubber boot shroud. All unused cable entries shall be plugged with suitable blanking plugs.

Mounting height of equipment shall be as under:-

Top of Switch Box : 1200 mm from FFL (Finished floor level) Bottom of

Lighting/Power Panel : 1500mm from FL

5/15Amp. Receptacle : 300mm from FFL unless otherwise specified
(1200 mm for process areas and industrial sheds)

Lighting fixture : As indicated in lay outdrawing

Exhaust fan : In the cutout provided / as indicated in Layout drawings.

Fixtures shall be firmly supported from the structures. Support clamps etc. may be bolted or welded to the existing steel work or metal inserts. In case of concrete structures, where metal inserts are not available, fixtures shall be suspended from concrete surfaces with the help of anchor fasteners. In such cases special care shall be taken to see that anchoring is firm. In places where ceiling fans are provided, lighting fixtures shall be suspended below the level of fan to avoid shadow effect.

Circuit cables in a group shall be cleated to structure by using galvanised strip clamps or cable run in cable trays wherever trays are available. Spacers and cleats shall be of required size to accommodate the cables. All hardware shall be galvanised. Underground lighting cables (in paved areas) shall be taken in suitable G.I. sleeves buried at a minimum depth of 300 mm from FFL. GI pipe sleeves shall be extended to 300 mm above FFL. Exact termination/layout of G.I. pipes (for protection of cables) shall be decided at site as per site convenience in consultation with Purchaser.

Wiring for all outlet sockets shall be done with 3 cores of equal sizes for phase, neutral and earth. The terminals of switch sockets shall be suitable to receive the size of wire specified.

All lighting fixtures shall be provided with terminal block with required terminals suitable for connection of wire upto 2.5sq.mm copper conductor.

The cable shall be straightened after unwinding it from the drum. All cables be clamped/laid in straight run without any sag and kink.

For location where fan points are shown, fan hooks with junction box shall be provided during concreting. Where fan hooks and J.Bs. are provided separately JB shall be located within a distance of 300mm from hook for mounting of ceiling rose.

Industrial type plug sockets with 20A switch or rating as specified shall be provided at a height of 500mm from FFL for window AC units. Socket outlets and plugs for installation in MCC room, DG room, etc. shall be of industrial metal clad type.

Wiring for exhaust fans shall be terminated in receptacles as specified in layout drawing and the connection from receptacle to the exhaust fan shall be by means of a flexible cord equivalent in

size to the main run of wires. Switch for exhaust fan shall be located in a separate switch board along with other switches

Conduit System

Surface or concealed conduit system of wiring shall be adopted, as specified in the drawings. Required number of pull boxes shall be used at intervals to facilitate easy drawing of wires. Separate conduit shall be run for lighting and power circuits. Further, conduits for Normal lighting/Emergency lighting/DC critical lighting shall be separate. Conduit layout shall be decided at site as per site conditions. Drop conduits for switch boards shall be decided by Contractor as per wall locations shown in Architectural drawings. All exposed run of conduits on surface, shall be vertical or horizontal.

Only threaded type conduit fittings shall be used for metallic conduit system. Pin grip type or clamp type fittings are not acceptable. Conduit ends shall be free from sharp edges or burrs. The ends of all conduits shall be reamed and neatly bushed.

Conduit shall be of minimum 25mm dia. Maximum number of wires permissible in a conduit shall be seven for wire size of 2.5 sq mm.

The exposed outer surface of the conduit pipes, including all accessories forming part of the conduit system, shall be adequately protected against rusting. In all cases, bare threaded portion of conduit pipe shall not be exposed unless such bare threaded portion is treated with anti-corrosive preservative or covered with approved plastic compound.

Conduit connection to outlet boxes shall be by means of screwed hubs or check nuts on either side. Where concealed wiring is done, junction boxes (65mm deep) shall be used so as to rest on shuttering properly. All conduit connections shall be properly screwed and Junction box covers shall be properly fitted so as to avoid entry of concrete slurry.

Where concealed wiring is to be adopted, conduits shall be laid in time before concreting of the slab. Pull wire (GI or steel) shall be provided inside conduit for the ease of wire pulling. The Contractor shall coordinate his work with other agencies involved in the civil works in such a way, that the work of the other agencies is not hampered or delayed. Vertical conduit runs shall be made in wall before plastering is done so as to avoid chasing. Where chases are made for conduit run Contractor shall fill these chases or any other openings made by them after completing the work and patch the surface. During installation, care shall be taken to see that proper covers are provided to prevent rusting of conduits. Locations of all point outlets, junction boxes shall be marked with brick powder or sand so that these are easily identified after shuttering removal. As built conduit layout drawing shall be submitted by Contractor after completion of the work.

All junction boxes, bends and other accessories shall be of the same material as that of conduit and shall have the same protective coatings.

After erection, the entire conduit system shall be tested, for mechanical and electrical continuity and shall be permanently connected to earth by means of approved type of earthing clamps.

Hazardous Area Installation

Wiring in hazardous area shall be done by using minimum 2.5mm^2 copper conductor armoured cable. Circuit wiring feeding hazardous areas shall be controlled by two pole switches/MCBs (for phase as well as neutral isolation).

Correct type of lighting equipment (fixtures and JBs) with regard to hazardous protection as specified in the drawing shall be installed for the areas classified as Zone 1, Zone 2etc.

The terminations in the junction boxes and the lighting fittings shall be done avoiding possibility of loose connections due to vibrations. After the terminations are made the cover of the junction boxes and the lighting fittings shall be closed properly with all bolts and hard wares in correct position, retaining its explosion and weather protections. In fixtures having double cable entries, both the entries shall be used for looping in and looping out connection, thus minimising the use of a separate junction box. Wherever separate control gear boxes (C.G. box) are provided looping in and looping out connections shall be through CG box, thus avoiding the use of a additional junction box. All unused cable entries shall be sealed with suitable plugs.

Circuit cables shall be firmly cleated in a group along columns/ beam/ladders/side channels/platform using 1.6mm thick GI saddles on 25x3 mm GI saddle bar at intervals of 400mm to 500mm for straight run and on either side close to bending and at both termination ends as per the directions of Purchaser. Where required, 3 or more of cables may be taken in slotted channel tray after obtaining approval of the Purchaser. Cables shall not be routed along hand rails.

Where fire proofing column/structures are encountered, all cabling shall be taken in GI pipes of required size and both ends shall be sealed, well before fire proofing is done. Similarly, equipment such as lighting fixture, control gear box, lighting/ power panels, field call stations, junction boxes etc. shall be installed on suitable steel mounting frame/distance bracket, thereby avoiding direct contact with the concrete used for fire proofing.

Cable glands for terminating cable on flameproof equipment shall be of double compression FLP type. Any material/equipment specified to be supplied by Contractor for installation in hazardous areas, shall be tested by CMRI and duly approved by PESO Nagpur or DGMS Dhanbad or any other applicable statutory authority. All indigenous FLP equipment shall also have valid BIS license as required by statutory authorities.

High Mast Lighting

The high masts shall be installed on concrete foundations with the base plate bolted on to the anchor bolts. The high mast shall be painted with a coat of primer and two coats of aluminium paint, the second coat to be given just before handing over to the Purchaser. The high masts shall be numbered as per drawings. The high masts shall be connected to the plant earth grid at two points.

Exact orientation of flood lighting fixtures shall be decided at site to achieve optimum utility of these fixtures.

A separate earth pit (lightening) shall be provided near each high mast & shall be connected to lightning Arrestor of High Mast through insulated cable running directly from LA. This pit shall be connected to lightning earth grid.

2.7 EARTHING INSTALLATION

Entire system shall be earthed in accordance with the provisions of the relevant IEC recommendations/ IS code of practice IS 3043-1987 and Indian Electricity Rules, so that the values of the step and contact potentials in case of faults are kept within safe permissible limits.

This consist of main earth conductor (grid conductor) forming a closed ring network with required number of earth electrodes connected to it to provide a common earth for electrical device and

metallic structures. From each earth electrode two distinct connections shall be made of the main earth conductor. The earth plates shall be used for taking multiple earth connections to two or more equipment.

The earth conductors shall be laid in ground, along cable trays / cable trench / pipe rack etc as indicated on the earthing layout drawings. The location shown on the earthing layout drawings are indicative. The exact location of earth conductors in the filed shall be determined by Contractor in consultation with the Purchaser. Earth conductors shall be located avoiding interferences with other services such as piping, instrumentation, civil, structural, mechanical etc.

The ring earthing system around each building shall be laid at a distance of approximately 1.5 m from the building and at a depth of approximately 0.8m. The ring shall be bonded at intervals to the building steel structures, reinforcement of building columns and also to pipes, wherever they are crossing. The earth ring shall further be connected at intervals to deep earthing electrodes to achieve a combined earth resistance of less than **one ohm**.

All exposed metal part such as HT/LT switchgear, DP/FP structure, distribution board, metal clad switchgear enclosure, lamp brackets, lamp holder, plug sockets, lighting poles, junction boxes, high mast etc shall be properly earthed by connecting these to the earth electrode by means of GI wire/Flat or PVC insulated Cu conductor of approved size to pass the fault current safely to earth in case of any fault.

Where lined cable trenches are available, the earth conductor shall be laid in the trenches and shall be firmly cleated to the sidewall of concrete trenches using GI clamps at interval of 400 mm to 500 mm and near to the termination end. The earthing conductor shall run along one of the cable trays along a cable route. The earthing conductor shall be suitably cleated and electrically bonded to all the other cable trays on the same cable route at regular interval of 25 to 30 metre. The earthing for equipment shall be tapped from the main earth conductor and not from cable tray support structure. Earth conductor when laid underground shall be at a depth of 600mm below finished grade level.

Joints and tapping in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and shall be suitably protected by giving two coats of bitumen and covering with Hessian tape. Earth strip laid above ground shall be welded across straight through joints and joints shall be suitably protected by giving two coats of bitumen to avoid oxidation and insulation film formation of the strip surface. When two earth strips are to be joined by means of welding, lap welding with an overlapping of strip equivalent to double the width of the strip and all four sides shall be continuously welded. All joints at tappings above ground shall be means of connector/ lugs. A minimum of two bolts of adequate size shall be used for this purpose. Earthing strip joints at earth plate and equipment shall be through GI bolts, nut etc.

The earthing installation shall be done in accordance with the earthing drawings and the standard drawings of reference attached with this document. The entire earthing system shall fully comply with the Indian Electricity Act and Rules. The contractor shall carry out any changes desired by the Electrical Inspector or the owner, in order to make the installation conform to the Indian Electricity Rules at no extra cost. The exact location on the equipment shall be determined in field, in

consultation with the Engineer-in-Charge or his authorized representative. Any changes in the methods, routing, size of conductors etc shall be subject to approval of the Owner/ Engineer-in-Charge before execution.

In process unit areas, the earthing cable shall be run along cable trays wherever specified in the layout drawings. The earthing cable shall be suitably cleated and electrically bonded to the cable tray at regular intervals

Installation of Earth Electrodes

Earth electrodes shall be installed as shown on earthing layout drawings and installation details. The location shown on the earthing layout drawings are indicative. The exact location of earth electrodes in the filed shall be determined by Contractor in consultation with the Purchaser, depending on the soil strata and resistivity. Earth electrodes shall be located avoiding interferences with other services such as road, building foundation, column, pipelines etc. The civil area drawings shall be referred for this. The distance between two earth electrodes shall not be less than twice the depth of electrode.

Earth electrodes shall preferably be located in a moist soil which has a fine texture, grain size and distribution. Wherever practicable the soil be dug up, all lumps broken and stones removed from the immediate vicinity of the electrodes and soil packed by watering and ramming as tight as possible.

The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.

All earth electrodes shall be tested for earth resistance by means of standard earth test meter. The tests shall take place in dry months, preferably after a protracted dry spell.

The disconnect facility shall be provided for the individual earth electrode to check its earth resistance periodically.

Location of earth electrodes shall be marked by permanent markers for easy identification. All earth Electrodes shall be serial numbered and also marked on ‘As Built’ drawing for future reference.

Individual earth electrodes shall be provided for each lighting arrestor and flood light mast.

Earthing system provided for concrete paved area by other agency where applicable; shall be connected to the plant earthing system below ground by minimum two earth connections.

Connection

The earth system connections shall generally cover the following:
- Equipment earthing for personnel safety
- System neutral earthing
- Static and lighting protection

The following shall be earthed.
- System neutral
- Current and potential transformer secondary neutral
- Metallic non-current carrying parts of all electrical apparatus such as transformers, switchboards, bus duct, motors, neutral earthing resistors, capacitors, UPS, battery charger

panels, welding receptacles, power sockets, lighting / power panels, control stations, lighting fixtures etc.

- Steel structures/ columns, rail loadings platforms etc.
- Cable trays and racks, lighting mast and poles.
- Storage tanks, spheres, vessels, columns and all other process equipment.
- Fence and gate for electrical equipment (e.g. transformer, yard etc.)
- Cable shields and armour
- Flexible earth provision for Wagon, Truck
- Shield wire

Conductor size for branch connection to various equipment shall be as per Installation details unless otherwise stated on earthing layout drawings.

All process pipelines shall be bonded and earthed at the entry and exist points of battery limit of hazardous area. Earth continuity conductors across pipe flanges shall not be provided as per OISD 110.

Steel pipe racks in the process units and offsite area shall be earthed at every 24metres.

Equipment / street light pole etc. located remote from main network may be earthed by means of individual earth electrode and earth conductor unless otherwise stated in specifications.

The main earthing network shall be used for earthing of equipment to protect against static electricity.

All medium and high voltage equipment (above 250V) shall be earthed by two separate and distinct connections with earth.

Plant instrument system clean earthing, UPS system clean / safety earth shall be separate from the electrical earthing system.

All paint, scale and enamel shall be removed from the contact surface before the earthing connections are made.

All earthing connections for equipment earthing shall be preferably from the earth plate mounted above ground wherever provided. Equipment foundation bolts shall not be used for earthing connection.

Earth connections shall be made through compression type cable welded lugs.

All hardware used for earthing installation shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections and all connections adequately locked against loosening.

Lighting fixtures and receptacles shall be earthed through the extra core provided in the lighting circuit/ cable for this purpose.

The reinforcement of sub-station building and the sub-station floor shall be connected to main earth grid.

TESTING OF EARTHING SYSTEM

Earthing systems/connections shall be tested as follows:

Resistance of individual electrodes shall be measured after disconnecting it from the grid.

Earthing resistance of the grid shall be measured after connecting all the electrodes to the grid. The resistance between any point on the metallic earth grid and the general mass of earth shall not exceed 1 ohm.

The resistance to earth shall be measured at the following:

1) At each electrical system earth or system neutral earth.
2) At each earth provided for structure lightning protections.
3) At one point on each earthing system used to earth electrical equipment enclosure.
4) At one point on each earthing system used to earth wiring system enclosures such as metal conduits and cable sheaths or armour.
5) At one point on each fence enclosing electrical equipment.

Measurement shall be made before connection is made between the ground and the object to be grounded.

2.8 LIGHTNING PROTECTION INSTALLATION:

Lightning protection shall be provided for the equipment, structure and buildings as shown on lightning protection layout drawings. Self-conducting structures shall not require separate aerial rod and down conductors. These shall however be connected to the earthing system at two or more points as shown on earthing layout drawing. An independent earthing network shall be provided for lightning protection and this shall be bonded at least at two points with the main earthing network below ground. Lightning down conductor shall be brought to earth electrode in shortest straight path as feasible to minimize surge impedance. Aerial and down conductors shall be located avoiding interferences with other services such as ducts, pipes, equipment, supports etc.

2.9 BATTERIES:

Battery (Lead acid, Nickel Cadmium or VRLA type as specified) shall be erected on stands and insulators supplied by the manufacturer of the batteries. The installation shall be done as per the layout drawings and manufacturer's instructions. Electrolyte if required / as applicable shall be filled as per manufacturer's instructions. Inter row connections shall be made with the leads supplied by the manufacturer.

Neutral Earthing Resistor

The neutral earthing resistor shall be inspected for any damage to the resistor grid and other components. The resistor shall be levelled and installed. All covers etc. shall be checked for tightness to ensure that the enclosure of the resistor is dust, vermin and weatherproof. Earthing conductors shall be taken from the out-end terminal of the resistor, for connection to earth electrodes and to the main grid.

2.10 WELDING RECEPTACLES:

The welding receptacles shall be erected on steel/concrete structures as per the drawings. In isolated places a separate support shall be fabricated and installed.

Push Button/Control Stations

The push buttons / control stations shall be installed near to the motors to be controlled. Individual channel supports shall be installed as per standard. If control stations for hazardous areas are to be supplied by contractor, these shall be of Ex (d) type, tested by CMRI and approved by CCE or other applicable certifying authorities. All outdoor push buttons / control stations shall preferably have integral canopies for additional weather protection. The canopy shall be made of 2 mm thick galvanized sheet steel or FRP where these are not integral with the equipment.

2.11 Miscellaneous Items

Contractor shall provide the following items in substation, as per Indian Electricity Rules.

Fire buckets filled with clean dry sand and ready for immediate use for extinguishing fires and fire extinguisher (carbon dioxide, dry chemical extinguisher etc.) suitable for dealing with electric fires shall be conspicuously marked and kept.

First aid boxes containing ointments and medicines for immediate treatment of injuries (As prescribed by Indian Red Cross Society or equivalent).

Instructions of restoration of persons suffering from electric shock in English, Hindi and local language of the district shall be affixed in a conspicuous place.
Danger boards (H.V., M.V.) shall be provided on transformer gate, switchboards, entrance to switchgear room and at other places as required by Purchaser.

Generators

Contractor shall install main, emergency or standby generators with their gas turbine or diesel engine drivers, and equipment associated with these 'packages', in locations as shown on the AFC contract drawings and in accordance with manufacturer's instructions. Contractor shall install and terminate interconnecting cables in accordance with equipment vendor's drawings and contract drawings.

Contractor shall check the installation and correctness of the various protection devices fitted to medium voltage machines. Anti-condensation heaters where fitted shall be connected up to a temporary supply and left energized as soon as equipment is delivered.

2.12 LIST OF CONSTRUCTION EQUIPMENT

The contractor shall have all necessary construction equipment, tools and tackles and testing instruments to carry out the erection works and to commission the system as specified. These shall include but not be limited to the following, and these shall be brought to site by contractor before the start of work.

Equipment

1. Portable grinder.
2. Portable welding machine.
3. Portable gas cutting / welding set.
4. Pipe threading machine.
5. Pipe bending machine(hydraulic).
6. Portable drill machine suitable to take up drilling for different sizes as per requirement.
7. Dewatering pump sets (diesel driven).
8. Power Hacksaw.
9. Conduit Dyset.
10. Hydraulic crimping Machine

11. Hand crimping tool.
12. Portable electric blowers, vacuum cleaners.
13. Miscellaneous items such as slings, pulleys, tarpaulins, wooden sleepers, ladders, etc. as required.
14. Safety belts, safety goggles, and gloves.
15. Separate tool kit for each Electrician.

Test Instruments

1. Insulation tester 1000V hand driven.
2. Insulation tester 2500V motor/hand driven.
3. Insulation tester 5000V motor/hand driven
4. Phase sequence indicator.
5. Earth Resistance tester.
6. Single phase variac
7. 3 phases variac of adequate capacity.
8. Secondary injection testing kit (By Vendor).
9. Multimeter both analogue and digital
10. Portable Ammeters, Wattmeters, P.F. meters.
11. Portable Voltmeters.
12. Clip on meters of different ranges.
13. Tacho-meter.
14. Kelvins double bridge for measurement of very low resistance.
15. D.C. high -pot test kit.
16. Oil filtration machine of adequate capacity.
17. LUX METER to measure illumination levels.

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SPECIFICATION

FOR

Field Inspection, Testing and Commissioning

SPECIFICATION NO.- MEC/TS/05/E9/15

(ELECTRICAL SECTION)

MECON LIMITED

DELHI 110 092

CONTENTS

PREPARED BY:	CHECKED BY:	APPROVED BY:	ISSUED DATE
CHIROSMITA BANERJEE	SAURABH SINGH	A. BHOWMIC	MARCH 2022

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

1.0 CODES AND STANDARDS

1.1 The equipment shall comply with the requirements of latest revision of following standards issued by BIS (Bureau of Indian Standards), unless otherwise specified:

SP 30 (BIS)	National Electrical Code 2011
IS 1255	Code of practice for installation and maintenance of power cables up to and including 33kV rating
IS 7816	Guide for testing Insulation resistance of rotating machines
IS 10810: Part 43	Method of test for cables: Part 43 - Insulation resistances IS
10810: Part 45	Method of test for cables: Part 45 - High Voltage test
OISD-STD-137	Inspection of Electrical Equipment
OISD-RP-147	Inspection and safe practices during electrical installations

1.2 In addition to the above it shall be ensured that the field inspection, testing and commissioning conforms to the requirements of the following as applicable:

a. Indian Electricity Act and Rules.

b. Regulations laid down by CEA/Electrical Inspectorate.

c. Regulations laid down by PESO / DGMS (as applicable).

d. The petroleum rules (ministry of Industry Government of India).

e. Any other regulations laid down by central/state/local authorities and Insurance agencies.

In case of imported equipment standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.

The equipment shall also confirm to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.

In case of any contradiction between various referred standards/ specifications/ data sheet and statutory regulations the following order of priority shall govern. However, the stringent of the below shall be followed.

- Statutory regulations.
- Schedule of Rate
- Scope of Work/ Job specification.
- Design Basis.
- Data sheets.
- Standard Specification.

- Codes and standards.

2.0 FIELD INSPECTION, TESTING AND COMMISSIONING

Contractor shall carry out complete filed inspection, testing and commissioning of electrical equipment as per Inspection Test Plans.

Before the complete installation or an addition to the existing installation is put into service, inspection/ pre-commissioning checks and tests shall carried out by contractor, In the event of defects being found out, the same shall be rectified and the installation retested as applicable.

The pre-commissioning inspection among the requirements shall include visual inspection, checking the workmanship of the installation, the rating of equipment, safety clearances sizes of cables installed, conformance to the AFC document, soundness of switchgear bus connections, wiring properly dressed and labelled, sealing of unused cable entries, checking of all safety interlocks, control/ interface functions as per requirements etc.

Visual inspection for soundness of bus bar connections of bus ducts, terminal connections of equipment / motor shall be carried out. After the visual inspection, all the covers of equipment manufacturers instructions. It shall be ensure that no foreign materials are present inside bus duct and equipment terminal boxes.

Pre- commissioning tests shall include but not be limited to the following. The works/testing at site shall be done as per the scope matrix between the site installation contractor and respective equipment vendor attached in each tender.

- Continuity test for each winding, power and control circuits.
- Insulation test for each winding, power and control circuit.
- High Voltage test for cables.
- Dielectric strength test on transformer oil.
- Magnetic Current Test and Magnetic Core Balance Test.
- Vector Group
- Voltage Ratio Test
- Short Circuit Test
- Winding Resistance Test for CTs, PTs, Closing coils & trip coil of breakers, Transformers for each tap position.
- WTI, OTI, Buchholz, PRV, MOG, Emergency Stop Simulations
- Checking the correctness of wiring schemes, control circuit interlocks for intended functioning.
- Verification of phase sequence.
- Testing of all types of relays/ releases for required operation.
- Testing of measuring instruments for proper functioning
- Polarity test, ratio test and Knee point voltage test for CT’s and PT’s
- Polarity test and ratio test for PT’s.
- Earth continuity test for all circuits.
- Checking of safety features of correctness of operation etc.
- Checking of all wired interface contacts (analog, digital input/ output contacts) for PLC and ESD interface, at panel and equipment terminal chambers as applicable. (Contractor shall co- ordinate with the other agencies involved for the above and provide support service for checking interfaces of electrical equipments and the intended functioning)
- Earth resistance measurement for each earth electrode and the earthing system as a whole.

- Lighting installation shall be tested for correct illumination levels, with the fittings installed. Fittings shall be operated only With specified type of a lamp or tube.
- Checking of battery float and boost charge voltage at correct levels.
- Battery duty cycle test to meet the load cycle requirement shall be performed at site after installation as part of commissioning.
- Load trials as agreed between Vendor/Contractor and Purchaser.

After the above test and inspection are completed, control circuits shall be tested for correct operation under all operating combinations and proved correct applying power to main circuits.

A close visual inspection of electrical equipment in hazardous area shall be made to ensure that equipment is suitable for the classified zone and gas group and correctly installed , with all covers, bolts, nuts and hardware's intact and there is no physical damage mark seen on the enclosure.

Site Acceptance test procedure for specific equipment shall be furnished by the respective equipment vendor. The contractor shall provide necessary assistance to the equipment vendor to perform site acceptance testing to enable the equipment vendor to perform the same.

All pre-commissioning checks and tests shall be carried out as per the directions of Purchaser. In addition to the equipment manufacturers instructions, pre-commissioning check requirements shall also be complied. All tests shall be carried out by vender/contractor in the presence of Purchaser.

The Vender/contractor shall bring to site required tools, tackles and testing instruments for carrying out filed testing, Vender/Contractor shall use only calibrated measuring and test instrument and shall maintain calibrated records.

The Insulation Resistance test values for various electrical equipment shall be as mentioned below:

2.1 HV, MV and Miscellaneous Switchboards

The insulation resistance test values for switchboards shall be as per following table:

Rated Voltage of the Switchboard	DC Test Voltage in Volts	Minimum Insulation resistance in Mega ohms
33,000V	5,000	200
11,000V	5,000	200
6,600V	1,000	200
3,300V	1,000	200
415V	1,000	100
240V	500	10
110V	500	10

SITE TEST

- IR test
- HV test with 2.5 kV megger for 1 min.
- Functional test for all feeders.
- Testing and calibration of all meters.
- Checking and calibration of overload relays and protective relays by primary injection method.
- Check operation of contactors from local and remote points.
- Checking of interlocking between incomers/ bus couplers and other feeders
- Testing of CTs & PTs installed in panel (Ratio, polarity, winding resistance & class as per datasheet)
- Test of prove inter changeability of similar parts.
- Test to prove correct operation of breakers at minimum and maximum specified control voltages.
- Checking operation of RC circuit (if there) for tripping of circuit breaker after disappearance of control voltage.
- Checking of earthing connection for neutral-earth bus, cable armour, location of E/F CT etc. as per the scheme.
- Checking of tests, service and draw out position of all the breakers and operations of mechanical flag indicator and electrical indication lamps.
- Checking the functioning of various electrical schemes like auto change over, signalling etc.
- Contact resistance test for bus bar & breakers.
- Timing test for ACBs & VCBs.
- Hi Pot test for Breakers (above 1100V).

Pre-Commissioning Check List:

Before commissioning any switchboard, following points shall be checked and ensured for safe energizing of the switchboard:

The installation of equipment to be commissioned is complete in all respects with its auxiliaries and all other mounting including earthing. Openings in floor within and outside panels have been sealed off. All cover and door gaskets are intact to make the enclosure vermin proof.

a) All the metering instruments have been checked and found in working order. Indicating lamps are healthy and are in correct position. All power and control fuses are of proper rating.

b) That the polarity test and ratio test of all the P.T.s and C.T.s is complete and phase sequence of C.T.s conforms to the correct vector group connections. Wiring continuity and correctness are ensured in the protection and measurement circuits. Polarity of D.C. supply for all the circuits is correct.

c) The high voltage tests of incoming and outgoing cables have been conducted and results are satisfactory.

d) All the protective relays including both conventional and microprocessor based numerical relays and thermal overload relays have been tested for secondary injection tests. (Primary injection tests shall be carried out for overload relays, differential protection, Restricted Earth fault protection at full /

reduced current to ensure correctness of complete wiring). Relay settings, status indications, fault annunciations, data logging, display of switchboard SLDs shall be verified from MMI in case the same is provided.

e) The I.R. Value has been recorded for bus bars, circuit breaker, incoming and outgoing cables, control wiring and potential transformers. Where required joint resistance of bus bars have been recorded and found to be satisfactory. All the surroundings and panels have been cleaned and temporary earth leads have been removed.

2.2 DG SET

The Tenderer shall perform the preliminary acceptance test (PAT) and Final acceptance test (FAT) to ensure that the plant and equipment supplied by them meet purchasers' system requirements.
Primary acceptance test for equipment and system covered in the specification shall be conducted unit wise or group wise within a reasonable period after the completion of erection work which will be mutually agreed upon.

The following test shall be performed at site: -

1. Visual and Dimensional check
2. Starting up and interlock checking as per approved scheme.
3. Governor response
4. Voltage regulator response
5. Load test
6. Functional tests on control panel, Sync cum AMF Panel/Only AMF Panel.
7. Power output at 100% Capacity- No Negative Tolerance.
8. Auxiliary power Consumption.
9. Guaranteed fuel oil consumption at 75% PPR of the engine and maximum load on the DG set.
10. Lubricating oil consumption at 50% PPR of the engine.
11. Prime power Rating (PPR) output of the diesel generator set at site at various points of load test.
12. Noise level over maximum load range.
13. Vibration level over maximum load range.
14. HSD shall be the fuel for performance test at the factory and functional test at site.

All tools & test equipment as required for the tests to be conducted at site to be arranged by vendor. CT, PT & relays if any supplied by vendor, same to be tested as per individual equipment test procedure as mentioned elsewhere in MR/ SOR.
Field test report to be prepared & submitted duly signed by vendor & EPMC to the purchaser.

2.3 BUS DUCT

The insulation resistance test values for Transformers shall be as per following table:

Rated Voltage (Highest System Voltage) KV (rms)	Standard Impulse Withstand Voltage KV(Peak)	One Minute Power Frequency Withstand Voltage KV(rms)
3.6	40	10
7.2	60	20
12.0	75	28

17.5	**95**	**38**
24.0	**125**	**50**
36.0	**170**	**70**

TEST

A. Routine Tests

i) One min. power freq. withstand voltage.
ii) Measurement of insulation resistance.
iii) Measurement of resistance and reactance of bus bars.

B. Type Tests

i) Heat run test
ii) Short time rating test (thermal & dynamic)
iii) Impulse withstand test
iv) Tests for degree of protection for enclosures

C. Site Tests

- IR measurement before and after HV test.
- HV test.
- Checking tightness of bolts with torque wrench.
- Checking for phase sequence marking.
- Check for clearances between phase to phase and phase to earth.
- Check for minor damages and cracks in supporting insulators and bushings after cleaning.
- Checking of bus bar cracks and rectification of same.
- Checking for inspection openings and accessibility for replacement of insulator etc.
- Check tightness of earthing connections on enclosure.
- Checking of silica gel breather (if there).
- Checking of working of space heater.
- Contact Resistance Measurement Test

2.4 TRANSFORMERS

The insulation resistance test values for Transformers shall be as per following table:

Rated Voltage of the Transformers	DC Test Voltage in Volts	Minimum Insulation resistance in Mega ohms
Up to 600V	1,000	100
601 to 500V	2,500	1,000
5001 to 15,000V	5,000	5,000
15001 to 35,000V	5,000	10,000

It shall be ensured that during insulation tests, electronic devices and components that are liable to get damaged on applied test voltage shall be disconnected from circuit. The instructions of equipment / panel manufacturer shall be followed strictly in this regard.

For medium voltage (up to 1000V), 1000V Megger and for high voltage 5kV Megger shall be used.

Testing

A. Routine Tests

i) Assembly inspection/ Painting check
ii) Measurement of winding resistance
iii) Measurement of voltage ratio and check of voltage vector relationship
iv) Measurement of impedance voltage (Principal tapping), short circuit impedance and load loss.
v) Measurement of no-load and current.
vi) Measurement of insulation resistance/ polarization index.
vi) Dielectric test:
  a) Induced over voltage withstand test
  b) Applied voltage withstand test
    (H.V. power frequency test)
vii) Certification for off-load tap changer
viii) Final documentation check

B. Type Tests

i) Temperature rise test
ii) Measurement of acoustic sound level
iii) Lightning impulse withstand test (if test certificates are not available)
iv) Short circuit test
v) Measurement of commutating reactance and determination of inductive voltage drops (for thyristor converter transformer only).

Site Tests

The tests to be carried out on the equipment at pre-commissioning stage will include following but not limited to the following:

- IR test on each winding to ground and between winding and check for polarization index.
- Turns ratio test on each tap
- Polarity and vector group test
- Measurement of winding resistance at each tap position for windings by Kelvin bridge.
- Heating and drying and checking with heating and cooling curve.
- Checking of earthing wrt transformer tank (flexible from top cover to tank) other parts,

neutrals and tank to electrodes of LAs (for LAs located near transformer).

- Testing of Buchholz relay for alarm and trip conditions.
- For bushing (SEF & REF) CTs, tests applicable will be as for current transformers.
- Calibration and setting of oil/winding temperature indicators, level gauge. OTI & WTI transducers for 4-20mA output & its integration with DCS System
- Check insulators for cracks.
- Checking for oil leakage and arresting of leakages (if required)
- Checking of operation of all valves.
- Checking of open operation of all valves (except drain and filter set)
- Filtration of oil by using line filter and heater set
- BDV test on Oil samples from top & bottom
- Checking of Oil for acidity, water content and tan delta as per IS 335.
- Measurement of magnetizing current and no-load loss.
- Checking of silica gel breather.
- Checking of noise level at no load and at full load.
- Checking of air circulation conditions for indoor transformers.
- Conducting magnetic balance test.
- Checking of other points given in manufacturer's commissioning manuals.
- IR, wiring and operational tests on all control devices in control cabinet, oil level indicator winding and oil temp. indicators, oil pump, cooling fan etc.

2.5 Generators and Motors

The insulation resistance test values for Generators and Motors shall be as per following table:

Rated Voltage of the Generators and Motors	DC Test Voltage in Volts	Minimum Insulation resistance in Mega ohms
11,000V	5,000	120
6,600V	1,000	80
3,300V	1,000	50
415V	1,000	15

240V	500	12

Testing

A. Routine Tests

The following are the routine tests carried out on each and every motor:

1 Measurement of resistance.
2 Insulation resistance test.
3 Motors are tested at 1/3 times the rated voltage for checking the ability of the motor to run upto full speed, when switched in either direction.
4 No load test.
5 High voltage test.

B. Type Tests

1 Measurement of rotor resistance.
2 No load test
3 Locked rotor test.
4 Full load reading of voltage, current, power input and slip.
5 Temperature rise test.
6 Momentary overload test.
7 Insulation resistance test.
8 High voltage test.
9 Polarization index test (for HT motors)

2.6 CABLES

Before energizing, the insulation resistance of every circuit shall be measured from phase to neutral and from phase/neutral to earth.

Where splices or terminations are required in circuits rated above 650 volts, insulation resistance of each length of cable shall be measured before splicing and /or terminating. After completion of splices and /or terminations measurements shall be repeated.

The insulation resistance of directly buried cable shall be measured before cable trenches are back filled. Measurements shall be repeated after backfilling.

D.C. High Voltage test shall be conducted on cables given below after installation.

a) All 1100 volts grade cables in which straight through joints have been made.

b) All cables above 1100Vgrade.

Cables shall be installed in final positions with all the straight through joints complete.

During the high voltage test, all other electrical equipment related to the cable installation, such as switches, instrument transformers, bus bars, etc., must be earthed and adequate clearance shall be maintained from the other equipment and framework to prevent flash overs. In each test, the metallic sheath/screen/armour shall be connected to earth.

The insulation resistance test values for cables shall be as per following table:

Rated Voltage of the Cable	DC Test Voltage in Volts	Minimum Insulation resistance in Mega ohms
Lighting and power circuit wiring	250	1
650 /1100V grade cables	1,000	10
1,900/3,600V grade cables	1,000	200
3,800/6,600V grade cables	1,000	200
6,350/11,000V grade cables	5,000	200
8,700/15,000V grade cables	5,000	200
12,700/22000V grade cables	5,000	200
19,000/33000V grade cables	5,000	200

For cables up to 1.1KV grade 500V megger and for HV cables 2.5KV/5KV megger shall be used.

Insulation resistance value of the cable shall be taken before & after lying of cables and before energizing the cable. The IR values shall be recorded in the approved inspection test plan formats.

For cables of above 1100V grade, the DC high voltage test shall be performed before energizing the cable. During the DC high voltage test shall be conducted on all 1100 volts & above grade cables in which straight through joints have been made. All other electrical equipment related to the cable installation such as switches, instrument transformers, bus bars etc. must be earthed and adequate clearance shall be maintained from other equipment and framework to prevent flashover. In each test, the metallic sheath/screen/armor shall be also connected to earth.

For record purposes test data shall include the measure values of leakage current versus time.

The D.C. high voltage test data shall be performed as detailed below in the presence of the engineer-in-charge or his authorized representative only. Terminations shall be kept unfinished so that motors, switchgear, transformer etc are not subjected to test voltage.
The test voltage shall be under: -

i) For cables 3.3 KV grade 5.4 KV DC
ii) For cables 6.6 KV grade 10.8 KV DC
iii) For cables 11 KV grade 18 KV DC

Testing

Shop Tests
The cables shall be subject to shop tests in accordance with relevant standards to prove the design and general qualities of the cables as below: -

Routine test on each drum of cables

Acceptance tests

On drum chosen at random for acceptance of the lot

High Voltage withstand test for HT cable (Hi Pot test)

Type tests certificates on each type of cable, inclusive of measurement of armour D.C. resistance of power cables will be furnished by Contractor

PACKING

1. Cables will suit barrel diameter and securely clamped/fixed. The barrels must be sufficiently strong to withstand mechanical shocks and shall effectively protect against transit.
2. Both ends of cable will be metal capped to prevent moisture ingression. Ends shall be kept inside the cable drum in a manner so that these are accessible for testing.
3. Cable drum identification/marking will be as follows:
   a) Maker's name
   b) Consignee's full address
   c) Type size and length of cables
   d) Net and gross weights

Any other marking for shipping Drum Markings

Drum Lengths

1. LT Cables will be delivered at site preferably on standard drums each containing 500 m or 1000 m cables, where total quantity of a particular cable is less than 500 m, the entire length will be supplied in one drum.

2. For 90% cable drum of each item of cable permissible tolerance is in length + 5% For 10% balance cable drums, Contractor shall ensure that each 500 m capacity drum contains at least 250m and each 1000m capacity drum contains at least 500m cable lengths. Overall tolerance for each item of cable is + 1% of total length.

SITE TEST

1. Visual check
2. Checking of continuity and IR values for all the cables before and after HV test.
3. HV test and measurement of leakage current after termination of cable kits.
4. Checking of earth continuity for armour and fourth core (if applicable)
5. Check for mechanical protection of cables.
6. Check for identification (tag number system) distance placement of cable marker, cable joint etc. as per the cable layout drawing.
7. Check earthing of cable structures.
8. Check safe head room in tunnel and basement area.
9. Check clearance from ventilation duct and light fittings for cable structures.
10. Check proper fixing of cable structures.
11. Check for proper drainage and removal of water (if any).
12. Lightning Protection
13. Check continuity of all the earth strips / shield wire.
14. Check tightness of all connections.

15. Measure earth resistance of each electrode and combined system.

2.7 CABLE TRAY

1. All cable trays used are G.I tray type as per specification.
2. Cable trays shall be hot dip galvanized, either ladder type or perforated type
3. The cable trays shall be in standard length sections. Individual sections shall be securely bolted together on 50 X 50 X 5 mm painted iron angles.
4. The cable trays shall be supported on 65 x 65 x 5mm painted iron angle painted as per specification/approved drawing.
5. Vertical support shall be ISMC 100and insertion plates shall be provided in cable trench to support cable trays.
6. All support work shall be completed prior to installation work
7. 10% future space shall be provided for future cables.
8. Supports shall be provided at an interval of 1.0 meters or as per the drawing.

2.8 Lighting Installation

Pre-commissioning checks and tests shall include but not be limited to the following:

a) The insulation resistance of each circuit without the lamps (load) being in place shall be measured and it should not be less than 1000,000 ohms. (Between phases, phases to neutral, phase/neutral to Earth).

b) Current and voltage of all the phases shall be measured at the lighting panel busbars with all the circuits switched on with lamps. If required load shall be balanced on the three phases.

c) The earth continuity for all socket outlets shall be checked. A fixed relative position of the phaseandneutralconnectionsinsidethesocketshallbeestablishedforallsockets.

d) After inserting all the lamps and switching on all the circuits, minimum and maximum illumination level shall be measured in the area and recorded.

e) It shall be ensured that switch provided for ON/OFF control of point (light/fan/socket) is only on LIVE side.

f) Operation of ELCB's shall be checked

g) focusing angle of fixtures shall be changed/ adjusted where required.

h) All the luminaires will be designed, manufactured and tested in accordance with the Indian Standards as far as they are applicable.

i) All the luminaires will be industrial type. Specification for the various types of sodium vapour and fluorescent fittings mentioned in the schedule of quantities will be followed. All the lighting fixtures will be complete with all parts along with lamps/tubes, control gears and accessories for installation and efficient performance whether specifically mentioned in the specification or in the schedule of items or not.

j) Individual light fittings will be provided with suitable gland arrangements for 3x2.5 sq.mm armoured copper cable entry unless otherwise specified. Terminals of all fittings will be suitable

for taking 3x2.5 sq.mm, copper conductor PVC insulated and PVC sheathed cable.

k) All fittings will be supplied with all interconnections made and fully wired upto the terminal block.

l) All live parts will be provided with suitable sleeves to prevent accidental contacts. The earthing terminal in the fitting will effectively earth the body of the entire luminaire.

m) Dust and vapour tight fittings will have the enclosures suitably designed to withstand the heating effect.

n) The fixing arrangement of various components and lamps will be in such a way that the maintenance and replacement jobs can be easily carried out.

o) All flameproof equipment will be provided with flameproof plugs.

p) Flame proof fittings and control gearboxes will be provided as per relevant IS in hazardous area.

Final Test of Materials of lightning system

1. Visual check
2. Dimensional check
3. Accessories fitting check
4. Mechanical and electrical test (where applicable)
5. Final documentation check.

2.9 Conduit and wiring

A) CONDUIT INSTALLATION

I. Embedded Conduit Installation

a. Conduit installation may be embedded in RCC structures or brick work as per the approved drawing.

b. The installation in RCC structures shall be carried out before concrete after the completion of form work and reinforcement work.

c. Conduit size shall be as per the requirement. However minimum size of the conduit shall be 25 sq. mm.

d. Conduits laid in concrete shall have minimum 50mm cover up to the finished surface and shall preferably be laid behind the reinforcement.

e. Conduits shall be securely fixed to prevent their movement during concreting.

f. Proper care shall be taken while installing the conduit near the beam and conduit openings shall be left for the light points as per the direction of the site engineer.

g. Installation in brickwork will require chases to be made in brick work, sufficiently deep to provide adequate cover for the conduits.

h. All embedded accessories such as junction boxes, switchboxes, etc. shall be mounted in such a way that they shall be flushed with the finished surface including plaster.

i. All joints in the installation shall be tight and properly covered to prevent ingress of concrete slurry, water or dust.

j. Conduits for bracket mounted lights shall be provided up to parapet of the wall for their electrical connection.

k. Each fixture shall be connected to Earth Wire.

II. Surface Conduit Installation

a. When conduits are exposed on surface, the complete routing shall be marked on the surface as per approved drawing. Conduit installation shall be carried out neatly with conduits runs truly vertical or horizontal.

b. All screwed connections shall ensure that at least five threads are engaged and electrical continuity shall be maintained.

c. Conduits &flexible PVC conduits shall be used for wiring in false ceiling.

d. Conduits &flexible PVC conduits shall be used for wiring above the surface wherever required.

e. Conduits shall be supported with saddles at a spacing of 1200mm maximum for conduits up to 25mm size and 1800mm for larger sizes. Saddles shall also be provided at both the fittings, Equipment, devices, junction boxes, bends and offset within 200mm maximum. However, this method shall be implemented only for open conduiting and not for concealed one.

f. Minimum clearance between conduits and surface shall be 6mm. Saddles shall be cast /malleable iron, cast aluminium or any other approved materials and galvanized painted.

g. Each electrical point, provisions to be provided to connect it by two ways/paths. Conduits shall be provided accordingly

h. All the conduits from SSB/Power points/Fixture terminated below LDB shall be identical & have good aesthetic appearance.

i. Conduit terminated below LDB shall be identical & the aesthetic appearance shall be good.

III. Conduit wiring (Supply & Point wiring) :-

a. Conduit wiring shall generally be carried out with single core PVC insulated cables / wires.

b. The conduit installation shall be complete in all respects before the cables drawn in conduits.

c. The cables shall be neatly bunched together to prevent kinks or twisting.

d. Each point wiring shall comprise the following:

* Insulated copper single core wires of 600/1100v grade (HR PVC) and including one

number for earthing. For suspending of fluorescent light fitting dome cover junction box shall be used. All wiring shall be done by using 2 Nos. of 1.5 Sq mm wires (one each for Phase& Neutral) plus 1 No. 1.5 sq.mm. wire for Earthing). Wiring for industrial socket for AC and power points shall be done by using 2 Nos. of 4 sq mm wire plus 1 No. of 2.5 sq mm wire as earthing.

* Color Code:-Phase- Red, Yellow, Blue. Neutral- Black. Earthing- Green.
* Wiring for exhaust fans shall be terminated in ceiling roses/receptacles and the connection from ceiling roses/receptacles to the exhaust fan shall be by means of a flexible cord equivalent in size to the main run of wires. For exhaust fan of battery room no plug shall be provided near to exhaust fan.
* Fabrication and fixing of hardware such as clamp, saddles, bolts, nuts, frame work etc as required. PVC insulated 1 Sq mm wire for copper earthing shall be run within conduits for earthing of fittings, junction boxes, switch/single phase socket outlet / enclosures.
* Each wire shall be traced for continuity, insulation testing and connection to be made at both ends
* Earthing shall be done at single point only.
* After erection, the entire conduit system shall be tested through-out, for mechanical & electrical continuity & shall be permanently connected to earth by means of earthing clamps, in accordance with Indian Electricity Rules.
* All conduits shall be IS certified & tested.
* For guard room, 3 Nos. of cable shall be used and junction boxes shall be provided for termination of these cables for normal power, emergency power and bore well starter.
* Battery room SSB shall be located outside the room and exhaust fan of the battery room shall be directly connected to wiring (no plug socket required)
* Each Fixture shall be connected to earth wire.

2.10 Earthing Installation

Earthing systems/ connections shall be tested as follows:

a) Resistance of individual earth electrodes shall be measured after disconnecting it from the grid by using standard earth test megger.

b) Earthing resistance of the grid shall be measured after connecting all the earth electrodes to the grid. The resistance value of an earth grid to the general mass of earth shall be as follows:

- For the electrical system and equipment, a value that ensures the operation of the protection device in the electrical circuit but not in excess of 1ohm.
- For lighting protection, the value of 5 ohms as earth resistance shall be desirable, but in no case it shall be more than 10ohms.

c) The resistance to earth shall be measured typically at the following points:

- At each electrical system earth or system neutral earth.
- At each earth provided for structure lighting protections.
- At one point on earthing system used to earth electrical equipment enclosures.
- At one point on earthing system used to earth wiring system, enclosures, such as metal

conduits and cable sheaths or armour.

– At one point on fence enclosing electrical equipment.

SITE TEST

- Check tightness of all earth connections.
- Check earthing of all metallic equipment, cable trays, busbar supporting structures, building column (if steel) all electrical equipment, pipe lines etc. as per the drawing / specification
- Measurement of earth resistance for each electrode.
- Measurement of total earth resistance.
- Measurement of earth loop resistance for E/F path of biggest LT drive.

Final Test of Materials of earthing system

i) Visual check

ii) Dimensional check

iii) Accessories fitting check

iv) Mechanical and electrical test (where applicable)

v) Final documentation check

2.11 Lightning protection Installation

All buildings and plant structures vulnerable to lightning strokes owing to their height or exposed situation shall be protected against atmospheric flash over and lightning strokes in such a manner as to eliminate any danger to the personnel employed therein. Stipulations of IS : 2309 - 1969 shall be followed.

A 'Faraday Cage' made of hot galvanised strip steel connected to all buried pipes and steel structures crossing this cage ring shall be laid around each main building or plant unit as earthing device. This shall be separate from the electrical equipment earthing ring main.

All lightning arrestor earth leads of the buildings and plant units shall be connected to this cage ring.

Air termination network should cover all salient points of the structure. All metallic chimneys, ducts and the like above the roof of the structure shall be bonded to and form part of the air termination network. Vertical air termination points shall project at least 30 cm above the object on which it is fixed.

Down conductors shall follow the most direct path possible between air termination and earth termination avoiding sharp bends. Down conductor shall have a testing point adjacent to the earth electrode. Each conductor shall have an independent earth termination. All earth terminations shall be interconnected.

Earthing electrodes and grid for lightning protection will be distinct separate from the earthing

system for earthing of electrical equipment and at no place will be connected to other earthing system.

Earthing connection to equipment subject to movement, vibration and shocks, shall be through flexible stranded conductors.

The termination of strips to the equipment shall be done by bolting and the wires shall be terminated by compression lugs. Jointing of strips shall be done by welding for proper continuity. All contact surfaces shall be thoroughly cleaned of dust and oil and after jointing, the joints shall be given bitumen paint.

Guidelines for installation of Earthing Conductor

- Earthing conductors laid directly in ground for **Lightning protection**, shall be coated with one coat of bituminised paints, be wrapped with one layer of bitumastic tape laid on half lapped and shall have a final coat of bituminised paint to prevent corrosion.
- Earthing conductors run on walls/floors/cable and equipment structures etc. shall be supported at suitable intervals and painted with black oxide paint.
- All joints in all kind of Earthing conductors except at earthing electrode shall be welded and painted black with bitumen paint.
- At road /rail crossings earthing strips shall be laid through conduits /concrete ducts.
- Special earthing shall be provided for all electronic equipment as per manufacturer's recommendations / practice.

2.12 BATTERY, BATTERY CHARGER & UPS SYSTEM

Pre-Commissioning Checks

- All Pre-Commissioning checks to be carried out shall be in full compliance with the Inspection Test Plan.
- All the test instruments used shall be calibrated before use and shall have a valid calibration certificate.
- All the tests on live circuits shall be carried out under permit control applying lock out tag procedures.
- The testing engineer shall carry out the pre-commissioning checks after obtaining the permit to work.
- All the incoming & outgoing control & power cables to be connected.
- Tightness of all the connections shall be checked and panel to panel inter panel wiring to be completed.
- The IR value of main bus bars, distribution bus bars and neutral bus bars is to be checked as per vendors manual and recorded.
- Mechanical operation of breakers shall be checked.

- Schemes shall be checked as per the schematic diagram.
- Electrical operation of breakers, Simulation and interlocks shall be checked before the energization of panels / boards.
- Battery to be filled with electrolyte and cleaned & hold to settle.
- The batteries shall be charged as per the vendors Manual.
- Specific gravity, temperature & Voltage of individual cells shall be checked and recorded as per the Inspection test Plan.
- All the safety requirements of testing are covered under the risk assessment for Electrical work. All testing shall be carried out on dead circuits prior to Energization.
- All the tests on live circuits shall be carried out under permit control applying lock out tag out procedures.
- Measure the earth path resistance at the main earthing terminal.
- Measure the voltage and specific gravity of each cell and compare with the recommended values.
- When all the inspection and tests have been carried out, the batteries may be given their initial charge. This may be carried out under the supervision of vendor's representative on site. The boost and float charge voltage settings should be noted and confirm the current limit settings.
- Check the operation of the battery earth fault alarm and measure the earth current flowing for a zero-impedance earth fault.
- Check the operation of all alarms and trips including the main supply and charge failure alarms.
- Check the operation of the DC over and under voltage alarms and trips.
- After reaching required voltage and specific gravity levels stop the battery bank charging and put under standby as per vendor's manual recommendation.
- Functional check shall be carried out on each charger and UPS.
- If number of battery bank is two then parallel operation for charging to be checked with battery charger and UPS.
- Carry out a battery discharge test using the vendor procedure and record the results including decay graphs.
- Recharge the battery at completion of discharge test, record the specific gravity of the electrolyte and cell volts.

Commissioning

- The UPS/Battery Charger shall be commissioned only after successful completion of pre-commissioning tests/checks. The commissioning program shall be communicated to all

concerned persons in advance.

- All the tests on live circuits shall be carried out under permit control applying lock out tag out procedures.
- The setting of all the relays shall be done as per relay coordination charts.
- All the commissioning activities shall be carried out under the direct supervision of the vendor / Company representative.

2.13 High Voltage Testing

D.C. high voltage test shall be conducted as per following table on all H. V. feeder cables and also on 1100V grade cables where straight through joints have been made.

Rated Voltage of Cable (kV)	TEST VOLTAGE (kV) BETWEEN		Duration (Minutes)
Uo / U *	Any Conductor and Metallic Sheath / Screen / Armour	Conductor to Conductor (For Unscreened Cables)	
0.65/1.1	3	3	5
1.9/3.3	5	9	5
3.3/3.3	9	9	5
3.8/6.6	10.5	18	5
6.6/6.6	18	18	5
6.35/11	18	30	5
11/11	30	30	5
12.7/22	37.5	-	5
19/33	60	-	5

* U**O :** Phase Voltage
U : Line Voltage

The cable cores must be discharged on completion of DC high voltage test and cable shall be kept earthed until it is put into service.

DC test voltage for old cables shall be 1.5 times rated voltage or less depending on the age of cables, repair work or nature of joining work carried out, etc. In any case, the test voltage shall not be less than the rated voltage.

All protective relays including thermal overload relays shall be tested by secondary injection current. Primary injection tests shall be carried out for differential protection, restricted earth fault protection at full/ reduced current to ensure correctness of complete wiring.

Before energizing any equipment, 'COMMISSIONING CLEARANCE FORM' as per standard format shall be duly filled in by contractor and submitted to MECON/ Owner. It shall be ensured that the electrical inspectorate approval is available before energizing the equipment.

3.0 LIST OF CONSTRUCTION EQUIPMENT

The contractor shall have all necessary construction equipment, tools and tackles and testing instruments to carry out the erection works and to commission the system as specified. These shall include but not be limited to the following, and these shall be brought to site by contractor before the start of work.

Equipment

1. Portable grinder.
2. Portable welding machine.
3. Portable gas cutting / welding set.
4. Pipe threading machine.
5. Pipe bending machine(hydraulic).
6. Portable drill machine suitable to take up drilling for different sizes as per requirement.
7. Dewatering pump sets (diesel driven).
8. Power Hacksaw.
9. Conduit Dyset.
10. Hydraulic crimping Machine
11. Hand crimping tool.
12. Portable electric blowers, vacuum cleaners.
13. Miscellaneous items such as slings, pulleys, tarpaulins, wooden sleepers, ladders, etc. as required.
14. Safety belts, safety goggles, and gloves.
15. Separate tool kit for each Electrician.

Test Instruments

1. Insulation tester 1000V hand driven.
2. Insulation tester 2500V motor/hand driven.
3. Insulation tester 5000V motor/hand driven
4. Phase sequence indicator.
5. Earth Resistance tester.
6. Single phase variac
7. 3 phases variac of adequate capacity.
8. Secondary injection testing kit (By Vendor).
9. Multimeter both analogue and digital
10. Portable Ammeters, Wattmeters, P.F. meters.
11. Portable Voltmeters.
12. Clip on meters of different ranges.
13. Tacho-meter.
14. Kelvins double bridge for measurement of very low resistance.
15. D.C. high-pot test kit.
16. Oil filtration machine of adequate capacity.
17. LUX METER to measure illumination levels.

Client and EPMC LOGO	INSPECTION REPORT FOR PANELS / DISTRIBUTION BORAD		
Contractor LOGO	**PROJECT:**	**JOB ID**	
	CLIENT:	**DOC ID**	
	EPMC:		
	CONTRACTOR:	**REV**	
LOCATION/ AREA:		**REPORT NO**	
		DATE	

PRELIMINARY CHECKOUT

SL NO	ACTIVITY	INSPECTION STATUS	REMARKS
1	Permanent Installation/ alignment, Checking of base channel, correct provision of grouting.		
2	Input supply available and termination complete.		
3	Panel interconnection correct		
4	Check the cleanliness inside the panel.		
5	All bolted connection inspected for tightness		
6	Proper termination of cable and wiring continuity		
7	Check all connection are tightened & ferruled		
8	Proper earthing of panel (doubly earthed)		
9	IR check of incoming and outgoing cables		
10	All cable check for proper cable tag		
11	Check function and operation		
12	Proper glanding termination		
13	Check name plate of panel		
14	Sealing of dummy hole in gland plate		

Remarks

For(contractor Name)	For (EPMC/Client)
Name	Name

Sign	Sign
Date	Date

Client and EPMC LOGO	INSPECTION REPORT FOR DIESEL GENERATOR		
Contractor LOGO	PROJECT:	**JOB ID**	
	CLIENT:	**DOC ID**	
	EPMC:		
	CONTRACTOR:	**REV**	
LOCATION/ AREA:		**REPORT NO**	
		DATE	
Test Equipment type /Brand		**Calibration date**	

SL NO	Activity	Inspection Status	Remarks		Activity	Inspection Status	Remarks
1	EXTERIOR OF EQUIPMENT			14	EQUIPMENT IDENTIFICATION		
2	COMPLETENESS OF ASSEMBLY			15	BRACING		
3	EQUIPMENT ROTATION			16	PROPER PHASE CONNECTIONS		
4	CHECK OIL LEVEL			17	REFERENCE DRAWINGS		
5	CHECK FUEL LEVEL			18	WORKING CLEARANCE		
6	PROPER EQUIPMENT GROUNDING			19	ANCHORAGE		
7	CHECK METERS/GAUGES			20	ALL FILTERS AND VENTS CLEAR		
8	CHECK TIGHTNESS OF BOLTED CONNECTIONS			21	CHECK EQUIPMENT ENVIRONMENTAL CLASSIFICATION		
9	VERIFY GOVERNOR AND REGULATOR			22	CHECK FOR PROVISIONS OF SPILL CONTAINER		
10	CHECK VIBRATION			23	CONTROL SYSTEM		

11	CHECK BATTERIES			24	CHECK FUEL FILTER		
12	CHECK RADIATOR FLUID			25	CHECK ALARM INDICATORS: PROPER COLOR FOR EACH FUNCTION		
13	PROPER SYSTEM GROUND			26			

VOLTAGE	R-N	Y-N	B-N	R-B	Y-B	R-Y
CURRENT	R	Y	B	N	G	
INSULATION RESISTANCE @V	R-GRID	Y-GRID	B-GRID	R-B	Y-B	R-Y
POLARIZATION INDEX RATIO = 10 MINUTE/1 MINUTE						
DC OVER POTENTIAL TEST @V						

LOAD TESTS AS A PERCENTAGE OF GENERATOR RATING

	NO LOAD	25%	50%	75%	100%	110% (Prime Engine Only)
R-N						
Y-N						
B-N						
R-B						
Y-B						
R-Y						
R						
Y						
B						
N						
G						

Remarks

For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

NOTES:

1. PERFORM 5 MEASUREMENTS AT ONE MINUTE INTERVALS.
2. DC HIPOT MEASUREMENTS SHOULD BEGIN AT 20% OF MAXIMUM TEST VOLTAGE AND INCREASE IN EQUAL INTERVALS.
   MAX DC TEST VOLTAGE = R (2 x NAME PLATE RATING) x 1.6
   WHERE R = .8 FOR DC TEST ON INSTALLATION
   R = .6 FOR DC TEST AFTER SERVICE
   (TEST MEASUREMENTS SHOULD NOT EXCEED MANUFACTURER'S RECOMMENDATION)
3. VOLTAGE MEASUREMENT TO BE MADE AFTER GENERATOR IS STARTED AND CONNECTED TO LOAD (CAN USE LOAD BANK).
4. DURING COMMISSIONING OF GENERATOR SETS OR ANY EQUIPMENT, A REPRESENTATIVE OF THE MANUFACTURING COMPANY OR SUPPLIER MUST BE PRESENT TO WITNESS AND/OR PERFORM THE TESTS.
5. ENGINE GENERATOR TESTING IS A VERY INTENSIVE PROCESS AND REQUIRES A 10 TO 14 HOUR DAY DEPENDING ON THE EQUIPMENT BEING COMMISSIONED. SUPPLIER/MANUFACTURER NORMALLY SUPPLY GENERATOR TESTING LOAD REQUIREMENTS.
6. VERIFY ALL SYSTEM CHECK POINTS DURING LOAD CHANGES AND RECORD PER SPECIFIED REQUIREMENTS AND/OR EQUIPMENT MANUFACTURER.
7. PERFORM AND RECORD ENGINE MANUFACTURER'S RECOMMENDED CHECKS AND INSPECTIONS.

Client and EPMC LOGO	INSPECTION REPORT FOR BUSDUCT		
Contractor LOGO	PROJECT:	**JOB ID**	
	CLIENT:	**DOC ID**	
	EPMC:		
	CONTRACTOR:	**REV**	
LOCATION/ AREA:		**REPORT NO**	
		DATE	
SL NO	**ACTIVITY**	**INSPECTION STATUS**	**REMARKS**
1	Ensure that the switch board terminal box & the transformer terminal boxes are inspected & cleard before proceeding to the busduct installation.		
2	Check the equipment no. And rating as per drawings, no physical damage etc.		
3	Check availability of all accessories		
4	Inspect the bus duct insulators for any physical damage occured during the transit.		
5	Check bushing cracks,chips or presence of dirt. Bushing cleaned as per vendor's instruction		
6	Ensure various section of bust duct enclosures are coupled togetherby using proper gaskets & bellow as specified.		
7	Ensure the busbar are properly fixed & coupled on the Insulator and correct phase are connected at both ends.		
8	Ensure bus bar joints are insulated using maunfacturers recommanded materials,wherever required.		
9	Prior to closing of the bus duct cover, ensure that the bus duct enclosure are cleared of tool/ loose materials and debris.		
10	Ensure enclosure of bus duct & support structures earthed(to the earthing grid) as per drawing.		
Remarks			
For(contractor Name)		**For (EPMC/Client)**	

Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSULATION RESISTANCE & TEST OF BUSDUCT													
Contractor LOGO	PROJECT:										JOB ID			
	CLIENT:										DOC ID			
	EPMC:													
	CONTRACTOR:										REV			
LOCATION/ AREA:											REPORT NO			
											DATE			
Megger detail	Make		serial no.			Model					Calibration due date			
Bus Bar	Insulation Resistance in M.OHMS										Applied Voltage	Continuity	Remark	
	R-E	Y-E	B-E	R-Y	Y-B	B-R	R-N	Y-N	B-N	N-E				
Section														

2. TORQUE TEST

Joints has been tightened and Torqued at .....Nm

Ensure the bus bar are properly fixed and coupled on the insulators and correct phases are connected at both ends.

3. SPACE HEATER

Temperature setting of Thermostat

Load current of SH

.....

Functional Check Ok/ Not Ok

Remarks

For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSPECTION REPORT FOR DISTRIBUTION TRANSFORMER		
Contractor LOGO	PROJECT:	**JOB ID**	
	CLIENT:	**DOC ID**	
	EPMC:		
	CONTRACTOR:	**REV**	
LOCATION/ AREA:		**REPORT NO**	
		DATE	

PRELIMINARY CHECKOUT

SL NO	ACTIVITY	INSPECTION STATUS	REMARKS
1	Proper installation and alignment of 2 Pole structure		
2	Proper installation and alignment of Transformer and its accessories		
3	Checking the proper connection and wiring.		
4	Proper cleanliness of the transformer		
5	Check the proper earthing of the structure (doubly Earthed)		
6	IR check of incoming and outgoing cables.		
7	Check the proper tightness		
8	BVD Test		
9	Check the operation and function		
10	check for the proper cable Tags		
Remarks			

For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSPECTION REPORT FOR MOTORS							
Contractor LOGO	PROJECT:					**JOB ID**		
	CLIENT:					**DOC ID**		
	EPMC:							
	CONTRACTOR:					**REV**		
LOCATION/ AREA:						**REPORT NO**		
						DATE		
Megger Used for HT	Make		serial no.		Model		**Calibration due date**	
Megger Used for LT	Make		serial no.		Model		**Calibration due date**	

Sl No.	**Terminal Under Test**	**IR Value(In M.OHMS)**	**Remarks**
1	R-E,YB Earthed		
2	Y-E,RB Earthed		
3	B-E,YR Earthed		
4	R-Y		
5	Y-B		
6	B-R		

Sl No.	**P.I FOR HT MOTORS**	**IR Value after 1 Minutes(in M OHMS)**	**IR Value after 10 Minutes(in M OHMS)**	**PI Value (for HT Motors)**

Winding resistance for Motor

Sl No.	**Motor Tag No.**	**Terminal of Equipment**	**Motor winding resistance**	

		U1-V1		
		V1-Y1		
		Y1-U1		

Pre Commissioning & Operation check:

a) Direction of rotation (If incorrect reverse the lead and correct terminal coding)	**.....**
b) Starting Current (Kick)	**.** **.....**
c) Operation of control & signalling circuit	**.....**

AT NO LOAD RUN

Time	**Motor Volatge**			**Motor Current**			**RPM**	**Bearing Temp.**	**Body/Winding temp.**	**Any abnormal Noise**	**Vibrations**		
	R-Y	**Y-B**	**B-R**	**R**	**Y**	**B**					**Horizontal**	**Vertical**	**Axial**

AT ON LOAD RUN

Time	**Motor Volatge**			**Motor Current**			**RPM**	**Bearing Temp.**	**Body/Winding temp.**	**Any abnormal Noise**	**Vibrations**		
	R-Y	**Y-B**	**B-R**	**R**	**Y**	**B**					**Horizontal**	**Vertical**	**Axial**

Remarks

For(contractor Name)	**For (EPMC/Client)**
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSPECTION REPORT FOR BURRIED CABLE TRENCH										
Contractor LOGO	PROJECT:							JOB ID			
	CLIENT:							DOC ID			
	EPMC:										
	CONTRACTOR:							REV			
LOCATION/ AREA:								REPORT NO			
								DATE			
SL NO	CABLE ROUTE		CABLE Tag No.	Buried Trench Dimension in mm			Dressing / Sand bedding	Route mark/ Cable tag	Brick Covering	Remark	
	FROM	TO		Length	Width	Depth					
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
Remarks											

For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSULATION RESISTANCE & CONTINUITY TEST (PRE LAYING / POST LAYING OF CABLE)		
Contractor LOGO	PROJECT:	JOB ID	
	CLIENT:	DOC ID	
	EPMC:		
	CONTRACTOR:	REV	
LOCATION / AREA:		REPORT NO	
		DATE	
Megger detail	Make serial no. Model	Calibration due date	

SL NO	CABLE Tag	Type	Size	Voltage Grade	Insulation Resistance in M.OHMS								Continuity	Remark
					R -E	Y - E	B -E	R -Y	Y - B	B - R	RYB -N	N-E		
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														

Remarks

For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSPECTION REPORT FOR CABLE LAYING					
Contractor LOGO	PROJECT:			JOB ID		
	CLIENT:			DOC ID		
	EPMC:					
	CONTRACTOR:			REV		
LOCATION/ AREA:				REPORT NO		
				DATE		
SL NO	**CABLE TAG**	**SIZE OF CABLE**	**FROM**	**TO**	**LAID LENGTH Mtr's**	**REMARKS**
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
Remarks						

For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSPECTION REPORT FOR INSTALLATION CABLE TRAY SUPPORT			
Contractor LOGO	PROJECT:		JOB ID	
	CLIENT: EPMC:		DOC ID	
	CONTRACTOR:		REV	
LOCATION/ AREA:			REPORT NO	
			DATE	
SL NO	ACTIVITY		INSPECTION STATUS	REMARKS
1	Check proper installation of Cable tray			
2	Check proper painting of cable tray support before and after installation.			
3	Check proper installation of cable tray.			
4	Check routing of tray as per layout.			
5	IR check			
6	Check function and operation			
SLNO	Size of tray/ Structural Steel	Lengths (Mtrs)	Area	Remarks
Remarks				

For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSPECTION REPORT FOR INSTALLATION OF INTERNAL LIGHTING			
Contractor LOGO	PROJECT:	JOB ID		
	CLIENT: EPMC:	DOC ID		
	CONTRACTOR:	REV		
LOCATION/ AREA:		REPORT NO		
		DATE		

S. No	Inspection Item	Inspection status	Remarks
1	Check proper installation of light fixtures, type, model & mounting.		
2	Check proper installation of Switches/Sockets.		
3	Check proper installation & Cable Dressing of fixture & LDB etc.		
4	Check proper earthing with light fixtures & DBs.		
5	Check the operation of light fixture with lighting DB.		
6	Check proper installation of exhaust fan & ceiling fans.		
7	Check emergency light and its operation as per drawing		
8	Check Lux level		
9	No. of Fixtures and switchgears		

S. No.	Area/Location	Type of Fixture	Qty.	Remarks

Remarks	
For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSPECTION REPORT FOR INSTALLATION OF EXTERNAL LIGHTING		
Contractor LOGO	PROJECT:	**JOB ID**	
	CLIENT:	**DOC ID**	
	EPMC:		
	CONTRACTOR:	**REV**	
LOCATION/ AREA:		**REPORT NO**	
		DATE	

S. No	Inspection Item	Inspection status	Remarks
1	Check type, model, and area classification of fixture.		
2	Check proper installation of light pole.		
3	Check proper installation of light fixtures & JB		
4	Check proper installation of FLP Junction Box.		
5	Check proper earthing with pole, light fixture & JB		
6	Check glanding of cables, tightness, size, type, etc.		
7	Measurement of circuit current at OLDB		
8	Check cable IR drop at LDB before charging		
9	Check proper installation of cable gland		
10	Check proper termination of cable in junction box		

S. No.	Area/Location	Type of Fixture	Qty.	Remarks

Remarks

For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSPECTION REPORT FOR INSTALLATION OF HIGH MAST		
Contractor LOGO	PROJECT:	JOB ID	
	CLIENT: EPMC:	DOC ID	
	CONTRACTOR:	REV	
LOCATION/ AREA:		REPORT NO	
		DATE	

S. No	Inspection Item	Inspection status	Remarks
1	Check proper installation of High Mast		
2	Check proper installation of light fixtures		
3	Check proper installation of Feeder Panel.		
4	Check proper earthing of High Mast, Feeder Panel		
5	Check operation of High Mast in Auto/ manual mode Including the operation of carriage		
6	Check lightning protection system of High Mast		

S. No.	Area/Location	Type of Fixture	Qty.	Remarks

Remarks	
For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSPECTION REPORT FOR INSTALLATION OF SWITCH/SOCKET/FAN			
Contractor LOGO	PROJECT:	JOB ID		
	CLIENT:	DOC ID		
	EPMC:			
	CONTRACTOR:	REV		
LOCATION/ AREA:		REPORT NO		
		DATE		

S. No	Inspection Item	Inspection status	Remarks
1	Check proper installation of exhaust fan & ceiling fans.		
2	Check proper installation of Switches / Sockets, modular boxes, Switch boards.		
3	Check proper installation & Cable Dressing of LDB, wiring etc.		
4	Check proper earthing with light fixtures & DBs, sockets & Fans		
5	Check operation of Switch, Sockets& Fans		
6	Check proper operation of emergency lights		

S. No.	Area/Location	Type of Fixture	Qty.	Remarks

Remarks	
For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSPECTION REPORT FOR CONDUITING IN SLAB/ WALL & WIRING		
Contractor LOGO	PROJECT:	**JOB ID**	
	CLIENT: EPMC:	**DOC ID**	
	CONTRACTOR:	**REV**	
LOCATION/ AREA:		**REPORT NO**	
		DATE	

PRELIMINARY CHECKOUT

SL NO	ACTIVITY	INSPECTION STATUS	REMARKS
1	**CONDUITING**		
1.1	Virtual check of material (IS- Certified)		
1.2	Routing of conduit and location of junction box		
1.3	Proper binding of conduit with steel bar and burr removed from conduit and putting small pieces of bag inside junction box.		
2	**WIRING**		
2.1	Identification of circuit check		
2.2	Check the size of wire and colour code		
2.3	Check earthing Continuity		
2.4	Insulation Test		
2.5	Check continuity of wire		
2.6	Earthing of switch box		

Remarks

For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSPECTION REPORT FOR EARTHING		
Contractor LOGO	PROJECT:	**JOB ID**	
	CLIENT: EPMC:	**DOC ID**	
	CONTRACTOR:	**REV**	
LOCATION/ AREA:		**REPORT NO**	
		DATE	

PRELIMINARY CHECKOUT

SL NO	ACTIVITY	INSPECTION STATUS	REMARKS
1a	Earth electrode , Pit & their connection are to be checked for proper installation		
1b	Earth electrode resistance test		
2	Check all connection for proper tightness.		
3	Check the test facility shall be provided with test links for earthing system		
4	Check the dimension of earth strip & bitumen application.		
5	Check the welding and cleanliness of earth strip		
6	Earth resistance of earth electrode and grid		
7	Continuity test for earthing conductor		
8	Paint of epoxy on earthing joints.		
9	check no earth pit, marking of measured value		

Remarks

For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSPECTION REPORT FOR EARTH RESISTANCE TEST				
Contractor LOGO	PROJECT:		**JOB ID**		
	CLIENT:		**DOC ID**		
	EPMC:				
	CONTRACTOR:		**REV**		
LOCATION/ AREA:			**REPORT NO**		
			DATE		

SL NO	**AREA/LOCATION**	**EARTH PIT NO.**	**EARTH RESISTANCE**		**REMARKS**
			WITH GRID	**WITHOUT GRID**	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
Remarks					

For(contractor Name)	**For (EPMC/Client)**
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSPECTION REPORT FOR LIGHTNING PROTECTION		
Contractor LOGO	PROJECT:	**JOB ID**	
	CLIENT: EPMC:	**DOC ID**	
	CONTRACTOR:	**REV**	
LOCATION / AREA:		**REPORT NO**	
		DATE	

PRELIMINARY CHECKOUT

SL NO	ACTIVITY	INSPECTION STATUS	REMARKS
1	Check all materials are as per approved IC or IWC report/ Specified Tender standards.		
2	Check the routing of down conductor should be straight as possible, Following the shortest path,aviding the sharp bents or upward sections.		
3	Check bending radii should not less than 20 cm or 90 degree.		
4	Check Lighting rod at least connected with two down Conductors.		
5	Check all the receiving antennas (TV , Radio, Telephone) should be connected with Lighting protection system with proper conductors.		
6a	Earth electrode , Pit & their connection are to be checked for proper installaion		
6b	Earth electrode resistance test		
7	Check all connection for proper tightness.		
8	Check the test facility shall be provided with test links for earthing system and for preiodic inspection.		
9	Check the dimension of earth strip & bitumen application.		
10	Check the welding and cleanliness of earth strip		
11	Earth resistance of earth electrode and grid		
12	Paint of epoxy on earthing joints.		
13	check no earth pit, marking of measured value		

Remarks

For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSPECTION REPORT FOR LIGHTING RESISTANCE TEST				
Contractor LOGO	PROJECT:		JOB ID		
	CLIENT:		DOC ID		
	EPMC:				
	CONTRACTOR:		REV		
LOCATION/ AREA:			REPORT NO		
			DATE		
SL NO	AREA/LOCATION	EARTH PIT NO.	EARTH RESISTANCE		REMARKS
			WITH GRID	WITHOUT GRID	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
Remarks					

For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSPECTION REPORT FOR BATTERY AND BATTERY CHARGER		
Contractor LOGO	**PROJECT:**	**JOB ID**	
	CLIENT:	**DOC ID**	
	EPMC:		
	CONTRACTOR:	**REV**	
LOCATION/ AREA:		**REPORT NO**	
		DATE	

PRELIMINARY CHECKOUT

SL NO	ACTIVITY	INSPECTION STATUS	REMARKS
1	Proper alignment of Battery Charger		
2	Checking the proper connection/wiring		
3	Check the cleanliness inside the Battery Charger.		
4	Check for proper earthing		
5	IR check		
6	Check function and operation		

Remarks

For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INSPECTION REPORT FOR UPS		
Contractor LOGO	**PROJECT:**	**JOB ID**	
	CLIENT:	**DOC ID**	
	EPMC:		
	CONTRACTOR:	**REV**	
LOCATION/ AREA:		**REPORT NO**	
		DATE	

PRELIMINARY CHECKOUT

SL NO	ACTIVITY	INSPECTION STATUS	REMARKS
1	Proper alignment of UPS		
2	Checking the proper connection/wiring		
3	Check the cleanliness inside the panel.		
4	Proper earthing of panel (doubly earthed)		
5	IR check and HV		
6	Check function and operation		
7	Voltage Measurement Between P-N/P-E/N-E		

Remarks

For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

Client and EPMC LOGO	INCOMING MATERIAL INSPECTION REPORT		
Contractor LOGO	PROJECT:	JOB ID	
	CLIENT:	DOC ID	
	EPMC:		
	CONTRACTOR:	REV	
LOCATION/ AREA:		REPORT NO	
		DATE	

Sr. No.	SOR No.	Description of Material	Size	Batch No.	Quantity	Manufacturer Name	Date of Receipt	IRN/TC	Remarks
1									
2									
3									
4									
5									

The above material inspected and found satisfactory for execution.

For(contractor Name)	For (EPMC/Client)
Name	Name
Sign	Sign
Date	Date

	CONTRACTOR		**QUALITY ASSURANCE PLAN FOR ELECTRICAL EQUIPMENT**	CLIENT:	**M/s IGGL**
				PROJECT:	**NORTH EAST GAS GRID PIPELINE PROJECT (Section-1 & 2)**
	ORDER NO. & DATE			PACKAGE NO.	**23UU**
	SUB-CONTRACTOR			PACKAGE NAME	**Electrical System/ RT NRL Incoming power cable**
	ORDER NO. & DATE				

INSTRUCTIONS FOR FILLING UP :

1. QAP shall be submitted for each of the equipment separately with break up of assembly/sub-assembly & part/component or for group of equipment having same specification.
2. Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for extent of inspection & tests may be added as applicable for the plant and equipment
3. Separate identification number with quantity for equipment shall be indicated wherever equipment having same specifications belonging to different facilities are grouped together.
4. Weight in tonnes (T) must be indicated under column 5 for each item. Estimated weights may be indicated wherever actual weights are not available.

ABBREVIATIONS USED :

CONTR : CONTRACTOR

MFR : MANUFACTURER

CODES FOR EXTENT OF INSPECTION, TESTS, TEST CERTIFICATES & DOCUMENTS:

Code	Description	Code	Description	Code	Description	DOCUMENTS:
1.	Visual	12.	Routine test as per relevant IS other standard	23.	Short time rating	D1. Approved GA drawings
2.	Dimensional	13.	Type test as per relevant IS/ other standard	24.	Operational & functional check	D2. Approved single line/ schematic diagram
3.	Fitment & Alignment	14.	Impulse Test	25.	Over Speed Test	D3. Approved data sheet
4.	Physical Test (Sample)	15.	Partial Discharge Test	26.	Flame Proof Test	D4. Approved bill of materials
5.	Chemical Test (Sample)	16.	Heat run risc test\tempr.	27.	Clearance and creepage Distance	D5. Unpriced P.O. copy
6.	Ultrasonic Test	17.	Enclosure Protection Test	28.	Acceptance Test	D6. Calibration Certificate of all measuring instruments and gauges
7.	Magnetic Particle Test (MPT)	18.	Calibration	29.	Harmonics measurement .	
8.	Radiography Test	19.	Noise & Vibration			
9.	Dye Penetration Test	20.	Test certificates for bought out components			
10.	Measurement of IR Value a) Before HV Test b) After HV Test	21.	Tank Pressure Test			
11.	High Voltage test/Dielectric test	22.	Paint shade verification & Thickness			

EQUIPMENT DETAILS							INSPECTION AND TESTS						Test Certificates & documents to be submitted to MECON	Acceptance Criteria Standards /IS/ BS/ASME/ Norms and Documents	REMARKS / SAMPLING PLAN
Sl. No.	Description (With equipment heading, place of use, and Breif Specifications)	Indentificatuin No.	Quantity		Manufacturer's Name and Address	Expected schedule of Final Inspection	Raw Material and inprocess stage inspection			Final Inspection/Test by					
			No/M	T			MFR	CONTR	MECON	MFR	CONTR/ TPI	MECON/ Owner			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	**LT Power and Control Cable**		**Mt.**				-	-	-	**1,10,11, 12,13, 28**	**1,2,10,11, 12, 28**	**1,2,10,11, 12, 28**	**12,13,28 D3, D5, D6,**	**I.S., Data Sheet, Specifications & Test Certificate**	**13* for similar rating, Inspection to be done by TPI**
3	**GI Cable tray**		**No.**				**1,2,3,4, 21,27**	-	-	**1,2,10,11, 12**	**1,2,3,12, 22**	**IWC ***	**12,13,20 D3, D5, D6**	**I.S., Data Sheet, Specifications & Test Certificate**	**13* for similar rating, Inspection to be done by TPI**
3.	**Power & Lighting Distribution Board/MCCB Enclosure**		**Set**				**1,2,3,4, 24, 27**	-	-	**1,2,3,12, 22, 24,27**	**1,2,3,12, 22, 24,27**	**IWC ***	**D1, D2, D3, D4, D5, D6, 20, 12,13*,16**	**I.S.,Data Sheet, Specification, Approved Drawings**	**13* for similar rating**

For Manufacturer (Stamp & Signature)

For CONTR (Stamp & Signature)

For MECON (Stamp & Signature)

Q.A.P. NO. MEC/05/E9/23UU/QAP/02

SHEET 1 OF 1 R-0

*IWC- Inspection waiver based on TPI witness report at OEM works.

ELECTRICAL

LIST OF SUPPLIERS OF MAJOR BOUGHT-OUT ITEMS

Air Conditioner

1. O General
2. Daikin
3. Hitachi

Batteries (Lead Acid)

1. Amco Batteries Ltd.
2. Exide Industries Ltd.
3. HBLNIFE Power System Ltd.
4. Amara Raja Batteries Ltd.

Batteries (Nickel Cadmium)

1. Amco Batteries Ltd.
2. HBLNIFE Power Systems Ltd.

Batteries Charger/DC-DC Converter

1. Amara Raja Power System(P)Ltd.
2. BCH.
3. Chhabi Electricals Pvt. Ltd.
4. Caldyne Automatics Limited
5. Dubas
6. HBL Nife Power Systems Ltd.
7. Universal Industries Products
8. Universal Instrument Mfg Co Pvt Ltd

Cable – Fire Alarm & Communication Cables

1. Cords Cable Industries Ltd.
2. CMI
3. Delton cables Ltd.
4. ELKAY Telelinks
5. KEI Industries Ltd.
6. Reliance Engineers Ltd.

Cable – HT(XLPE)

1. Universal Cable Ltd.
2. KEI Industries Ltd.
3. Industrial Cables
4. NICCO Corporation Ltd.
5. Uniflex

6. Polycab.
7. Torrent cables Ltd.
8. Gloster cables limited Secunderabad (upto 11kv)
9. Gemscab industries ltd Delhi (upto 11kv)
10. CMI LIMITED New Delhi- (upto 11kv)
11. Apar Industries Ltd (Unit: Uniflex Cables) MUMBAI-(upto 11kv)

Cable – LT Power and Control

1. Cords Cable Industries Ltd.
2. Universal Cable Ltd.
3. KEI Industries Ltd.
4. Havells.
5. Delton
6. Elkay Telelinks
7. Evershine Electricals
8. Ecko Cable Pvt Ltd, Delhi
9. Allied Engineering works Pvt Ltd, Delhi
10. Ravin
11. Rallison
12. Suyog
13. Suraj Cable
14. Netco
15. Uniflex
16. Paramount
17. Gloster
18. Associated cables Pvt Ltd.
19. CMI
20. Gemscab
21. Industrial cables
22. NICCO Eastern Pvt Ltd, Kolkata
23. Polycab
24. RR Kabel Ltd,Vadodara
25. Torrent
26. Ultracab India Ltd, Rajkot
27. Ocean Cables Pvt Ltd
28. Gupta Power infrastructure ltd, Bhubneshwar
29. Ravi Industries, Sonipat
30. Nangalwala Industries Pvt Ltd, Alwar
31. Insucon Cables & Conductors Pvt Ltd, Jaipur
32. Dynamic Cables Pvt Ltd, Jaipur

33. Rajasthan Cables & Conductors Pvt ltd, Jaipur
34. Svarn Infratel Pvt Ltd, Faridabad
35. Chandresh Cables Ltd, Ahmedabad
36. RR Kabel Ltd,Vadodara

Cable – Gland

1. Baliga
2. Commet
3. Flexpro
4. Flameproof
5. FCG
6. Electro Werke
7. Dowells
8. CCI
9. Lapp
10. Hansel
11. HMI
12. Phoenix

Cable – Lugs

1. Dowells
2. Hubble
3. Jainson
4. Ismal
5. Commet
6. Connectwell
7. Phoenix

Cable – Tray

1. Rukmani Electricals & Components Pvt Ltd Hooghly
2. Advance Power Product Kolkata
3. Ercon Composites
4. Yamuna Power & Infrastructure Ltd.
5. Aditya Steel Industries
6. Eros Metal Works (P) Ltd Nagpur
7. Pentax Ferro Incorporate Mumbai
8. Vatco Electric power pvt ltd
9. Patni System Pvt Ltd
10. Satyam composites pvt. Ltd, Vadodara (FRP Cable Tray)
11. Sumip Composites Pvt Ltd, Ahmedabad (FRP Cable Tray)

Cable Termination and Jointing Kit

1. CCI
2. Raychem
3. M-Seal
4. 3M

Ceiling/Exhaust/Pedestal Fans & Circulators

1. Bajaj Electricals Ltd.
2. Crompton Greaves Ltd.
3. Khaitan Electricals Ltd.
4. Havell's

Contactors – AC Power & Control

1 Andrew Yule
2 ABB
3 BHEL
4 C&S
5 Havell's
6 L&T
7 Schneider
8 Siemens Ltd.
9 Telemechanique

Control Transformer

1. AE
2. Indushree
3. Intra Vidyut
4. Kalpa Electrikals
5. Transpower Industries Ltd.
6. Siemens

DG Set

1. Sterling and Wilson.
2. GD Ankalesaria.
3. Deev Genset.
4. Jackson
5. Sudheer Gensets.
6. Power Engineering (India) Pvt Ltd.

Earthing Materials

1. Rukmani Electrical & Components Pvt Ltd.
2. Indiana Grating Pvt Ltd.
3. Jef Techno Solutions Pvt Ltd
4. Brass copper & alloy (i) ltd Mumbai
5. Reliable sponge pvt.ltd Rourkela

Flame proof LDB's/ JB,s/Control Station/ switches/ Flame Proof Feeder Pillar

1. FCG
2. Sudhir
3. Prompt Engineering Works
4. Flame Proof equipments pvt. Ltd.
5. Baliga Lighting Equipments Pvt. Ltd.
6. Flexpro Electricals Pvt. Ltd.

High Mast

1. Bajaj Electricals Limited
2. Crompton Greaves Limited.
3. Philips India Limited
4. Surya Roshani

High Voltage PCC/ MCC panels

1. BHEL
2. Control and Switchgear
3. Siemens
4. Tricolite Electrical Industries
5. Schneider
6. CGL
7. L&T

Indicating Lamps

1. Alstom Ltd.
2. BCH
3. L&T Ltd.
4. Siemens Ltd.
5. Vaishno Electricals

Indicating Meters

1. ABB
2. AMCO
3. AE
4. Alstom Ltd. (EE)
5. Conzerv/Schneider
6. Elecon Measurement Pvt. Ltd.
7. HPL Electric & Power Pvt. Ltd.
8. MECO Instruments Ltd.
9. Minilec
10. Rishabh Instruments Pvt. Ltd.
11. Trinity energy system
12. kaycee
13. Salzer

Lighting Fixtures

1. GE Lighting Pvt. Ltd.
2. Bajaj Electricals Ltd.
3. Crompton Greaves Ltd.
4. Philips India Ltd.

Lighting Fixtures – Flameproof

1. Bajaj Electricals Ltd.
2. Baliga Lighting Equipment Pvt. Ltd.
3. Crompton Greaves Ltd.
4. CEAG Flameproof Controlgear Pvt. Ltd.
5. Flexpro Electricals Pvt. Ltd.
6. Philips India Ltd.
7. Sudhir Switchgears Pvt. Ltd.
8. FCG.

Miniature Circuit Breakers (MCBs) and Lighting DB

1. ABB
2. Hagger
3. Havell's India Ltd.
4. Indo Asian Fusegear Ltd.
5. Legrand

6. MDS Switchgear Ltd.
7. Schneider
8. Siemens Ltd.
9. HPL

Molded Case Circuit Breaker (MCCBs)

1. ABB
2. Andrew yule
3. Larsen & Toubro
4. Schneider
5. Siemens
6. Control and Switchgear

Protection Relays – Thermal

1. BCH
2. L&T Ltd.
3. Siemens Ltd.
4. Scheinder
5. Telemenchanique & Controls (India) Ltd.

Low Voltage Power Control Center (PCC)/ MCC/ PDB/ MLDB/ LDB

1. Pyrotech Electronics Pvt. Ltd.
2. Risha control Engineers Pvt. Ltd.
3. ABB
4. BCH
5. C & S
6. Elecmech Switchgear & Instrumentation
7. KMG ATOZ
8. L&T
9. Siemens
10. Tricolite Electrical Industries
11. Unilec Engineers ltd.
12. Vidyut Control India Pvt. Ltd.
13. Control and Schematic
14. Zenith Engineering

Push Buttons

1. BCH
2. Alstom Ltd.
3. L&T
4. Siemens Ltd.
5. Telemenchanique & Controls (India) Ltd.
6. Vaishno Electricals

Switches-Control

1. BCH
2. Easum Reyrolle Relays & Devices Ltd.
3. Alstom
4. Kaycee Industries Ltd.
5. L&T
6. Siemens Ltd.

Switches – 5/15A Piano/ Plate, Switch Socket

1. Anchor Electronics & Electricals Pvt. Ltd.
2. Kingal Electricals Pvt. Ltd.
3. North-West Switchgear Ltd.

Switch Socket Outlets (Industrial)

1. Alstom Ltd.
2. Best & Cromption Engineering Ltd.
3. BCH
4. Crompton Greaves Ltd.
5. Essen Engineering Company Pvt. Ltd.

Solar Modules

1. Tata BP Solar (I) Ltd.
2. REIL, Jaipur.
3. CEIL, Sahibabad.
4. HBL Power

Solar Street Lighting

1. Tata BP Solar (I) Ltd.
2. REIL, Jaipur.

3. CEIL, Sahibabad.
4. HBL, Hyderabad

Terminals Blocks

1. Connectwell
2. Controls & Switchgear Co. Ltd.
3. Elmex Controls Pvt. Ltd.
4. Essen Engineering Co. Pvt. Ltd.

Transformers

1. ABB
2. Andrew Yule
3. Areva
4. BHEL
5. Bharat Bijlee
6. Crompton Greaves
7. EMCO Ltd.
8. Intra Vidyut
9. Indushree (Upto 200 KVA)
10. Indcoil
11. Kirloskar
12. Skippers Electricals
13. Transformers & Rectifiers (I) Ltd.
14. Voltamp
15. Telawne Power Equipments Private Limited Navi Mumbai

UPS System and Inverter

1. DB POWER/EMERSON/VERTIVE
2. APLAB
3. KELTRON
4. HI-REL
5. DUBAS
6. Toshiba Corporation
7. Fuzi Electric Co Ltd

GI-Octogonal Pole

1. Bajaj
2. Transrail
3. Wipro

Note-1: -

1) For any other item(s) for which the vendor list is not provided, bidders can supply those item(s) from vendors/ suppliers who have earlier supplied same item(s) for the intended services in earlier projects and the item(s) offered is in their regular manufacturing/ supply range.

The bidder is not required to enclose documentary evidences (PO copies, Inspection Certificate etc.) along with their offer, however in case of successful bidder, these documents shall required to be submitted by them within 30 days from date of Placement of Order for approval to IGGL / MECON.

2) The details of vendors indicated in this list are based on the information available with MECON. Contractor shall verify capabilities of each vendor for producing the required quantity. PMC does not guarantee any responsibility on the performance of the vendor. It is the contractor's responsibility to verify the correct status of vendor and quality control of each parties and also to expedite the material in time.

Note-2 - Item/Vendor, which are not listed above, shall be subject to prior approval from Client/Consultant.

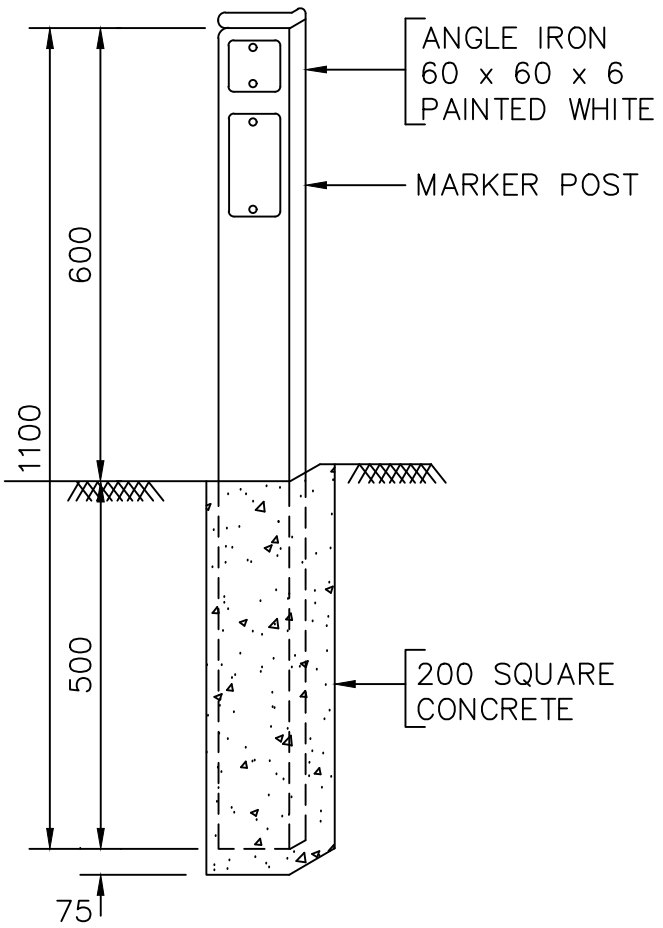
For procuring bought out items from vendors other than those listed above, the same may be acceptable subject to the following: -

a) The vendor/ supplier of bought out item(s) is a manufacturer/ supplier of said item(s) for intended services and the sizes being offered is in their regular manufacturing/ supply range.

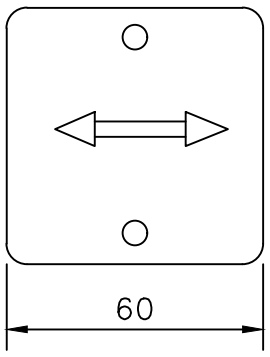
b) The vendor / supplier should not be in the Holiday list of IGGL / MECON / other PSU.

The bidder should enclose documentary evidences i.e. PO copies, Inspection Certificate etc. for the above, along with their bids.

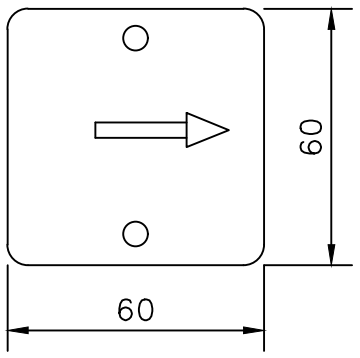
-x-x-x-



SIGN 'B'



SIGN 'C'



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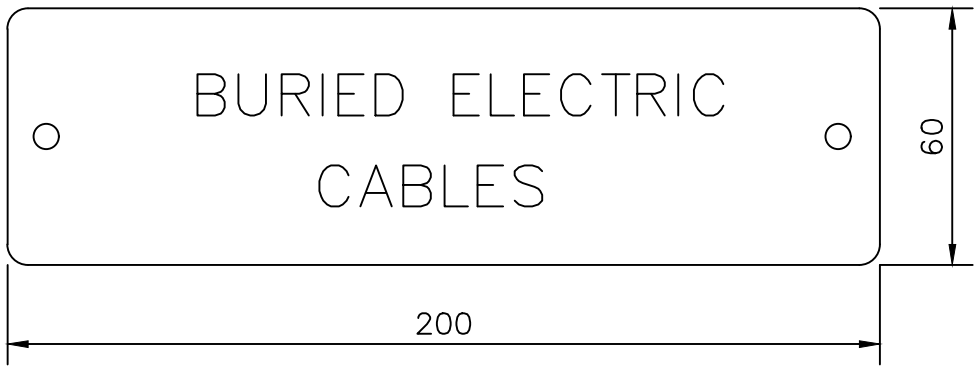
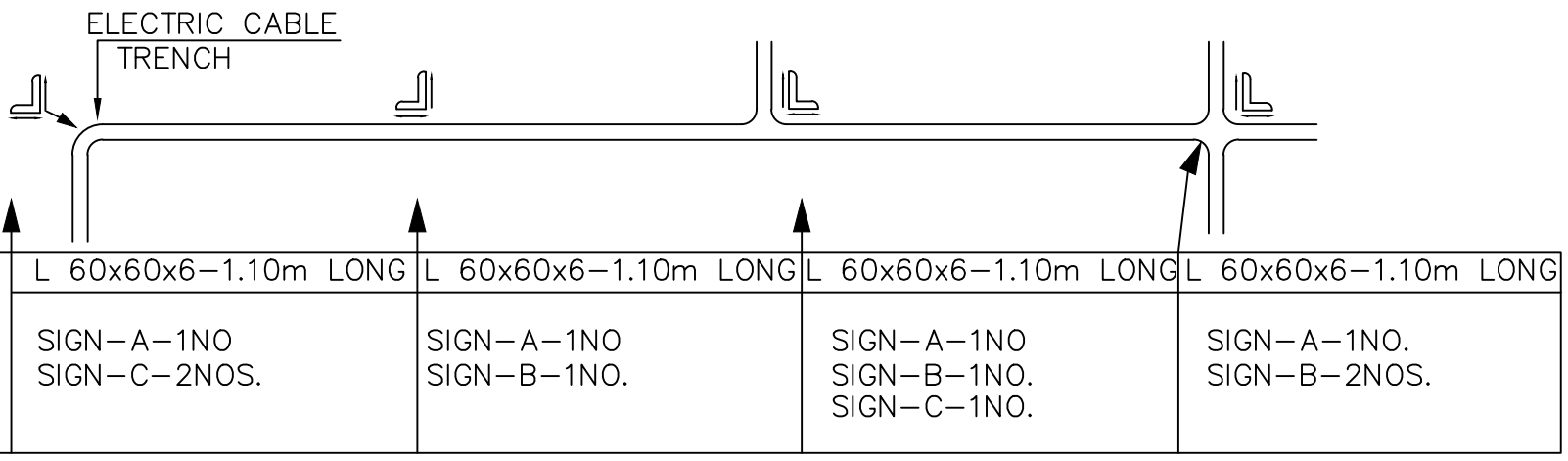


TYPICAL ARRANGEMENT OF MARKER



	L 60x60x6–1.10m LONG	L 60x60x6–1.10m LONG	L 60x60x6–1.10m LONG	L 60x60x6–1.10m LONG
ASSEMBLY CONSISTING	SIGN–A–1NO SIGN–C–2NOS.	SIGN–A–1NO SIGN–B–1NO.	SIGN–A–1NO SIGN–B–1NO. SIGN–C–1NO.	SIGN–A–1NO. SIGN–B–2NOS.

NOET:– 1. TRENCHES SHALL BE MARKED AT ALL DIRECTION CHANGES, INTERSECTIONS AND STRAIGHT RUNS.
2. SIGN MADE OF 14 ENAMELLED SHEET PLATE WHITE LETTRING MADE ON GREEN BACKGROUND.

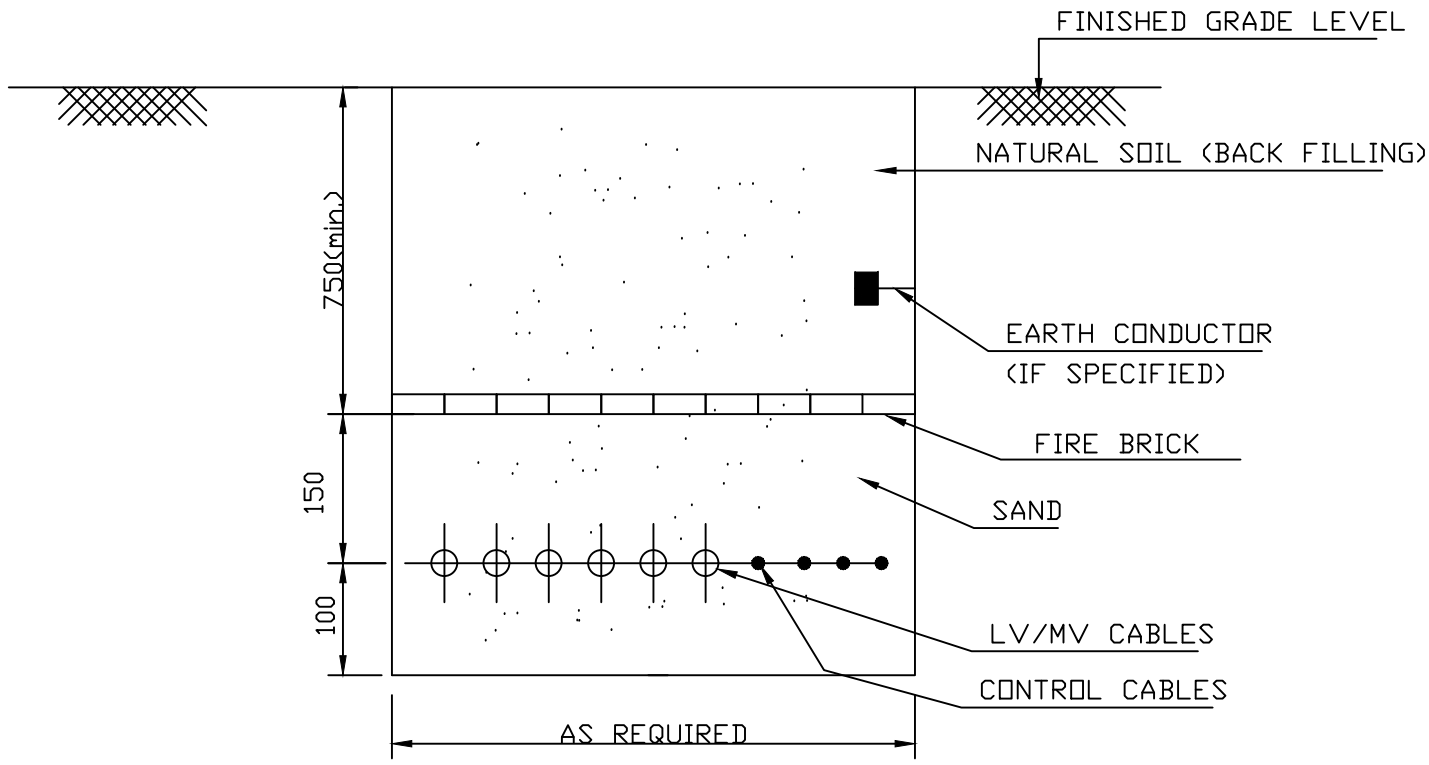
REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
			REVISIONS				

SECTION: ELECTRICAL				
	NAME	DATE	CHKD	DATE
DSGN	S.J.	31.05.23	A.M.	
DRWN	B.G.			
APPROVED P.SRIVASTAVA				

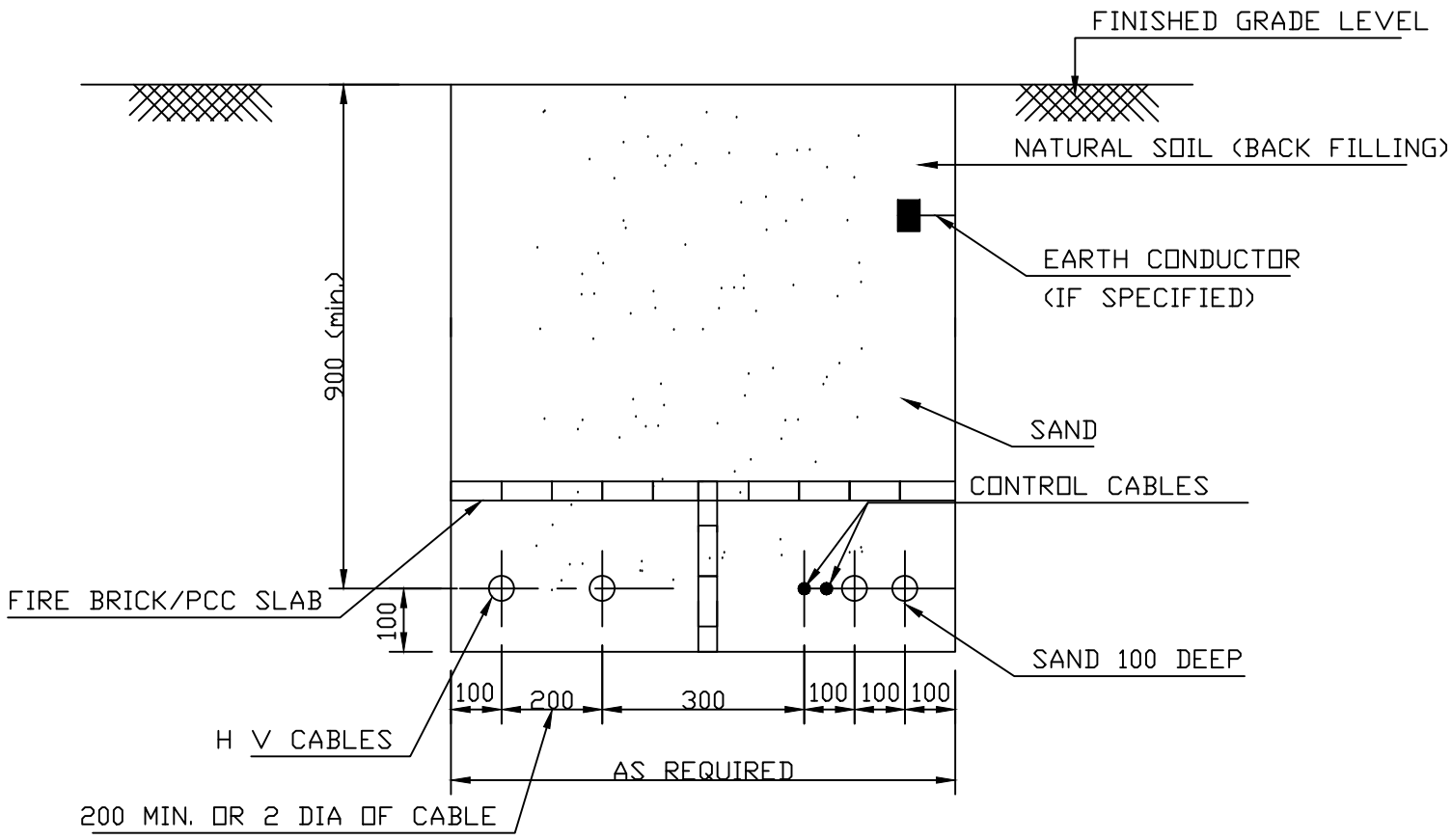
MARKING OF BURIED TRENCH FOR ELECTRIC CABLES

मेकॉन लिमिटेड
MECON LIMITED

SCALE : N.T.S.	EDITION	REV
DRG.NO MEC/05/E9/TS–14/SD/01/01	1	0



TYPICAL SECTION WITH LV/MV CABLES ONLY



TYPICAL SECTION WITH HV CABLES ONLY

NOTES:-

1. LEAVE SPACE FOR LATER ADDITION OF AT LEAST 2 CABLES OR 15% AVERAGE SPARE SPACE REGARDLESS OF FUTURE EXPANSION.
2. IF TELEPHONE CABLES ARE LAID IN THE SAME TRENCH A CLEARANCE OF 300mm SHALL BE BE PROVIDED BETWEEN POWER AND TELEPHONE CABLES .

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
REVISIONS							

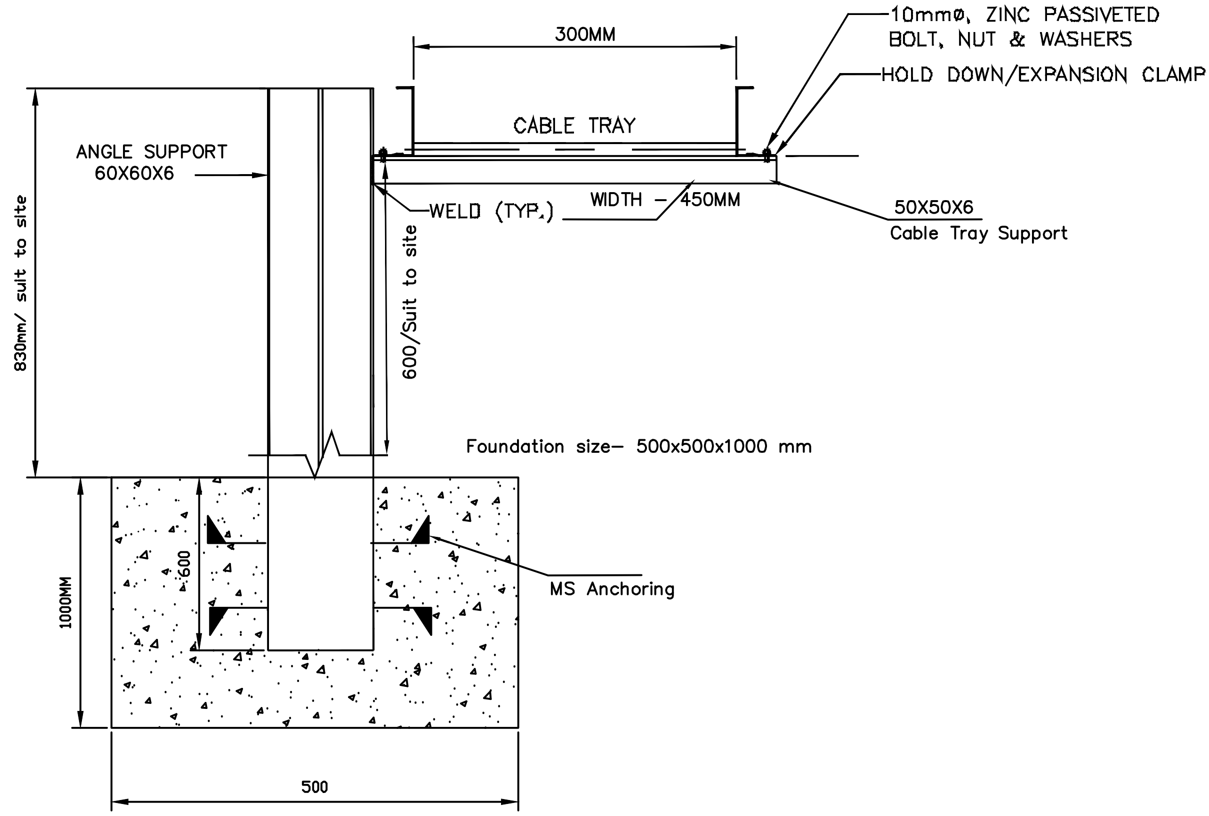
SECTION: ELECTRICAL				
	NAME	DATE	CHKD	DATE
DSGN	S.J.	31.05.23	S.S.	
DRWN				
APPROVED P.SRIVASTAVA				

TYPICAL SECTION OF CABLE TRENCH IN UNPAVED AREA

मेकॉन लिमिटेड

MECON LIMITED

SCALE : N.T.S.	EDITION	REV
DRG.NO MEC/05/E9/TS-14/SD/01/02	1	0



HORIZONTAL CABLE TRAY (LADDER TYPE) ON STEEL COLUMNS

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD

REVISIONS

REFERENCES

DRG. NO.

SECTION: ELECTRICAL

	NAME	DATE	CHKD	DATE
DSGN	V.N.	31.05.23	S.S.	
DRWN				

APPROVED P.SRIVASTAVA

TYPICAL CABLE TRAY SUPPORT

मेकॉन लिमिटेड

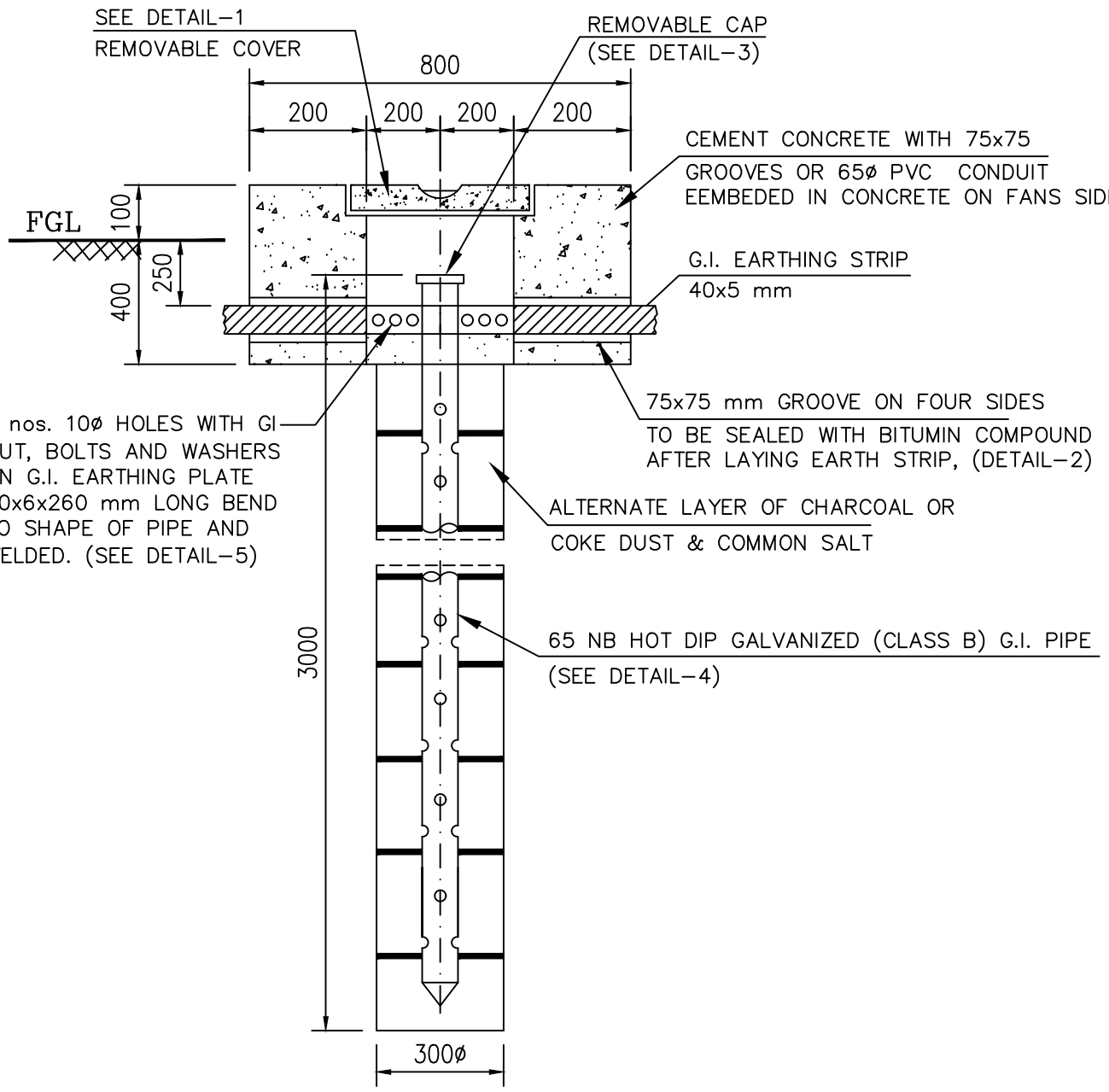
MECON LIMITED

SCALE : N.T.S.

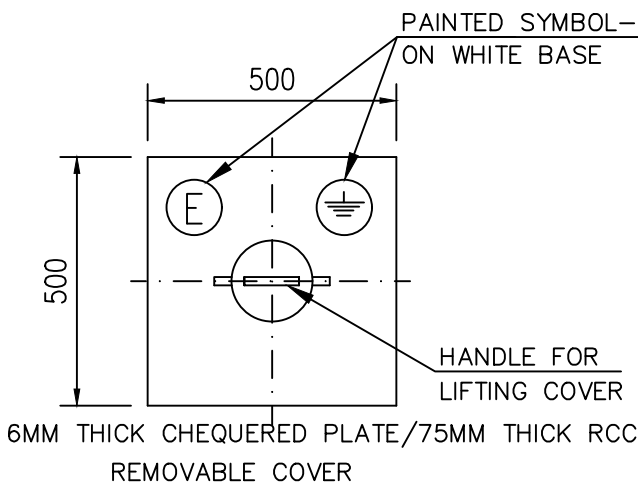
DRG.NO MEC/05/E9/TS-14/E9/01/93

EDITION 1

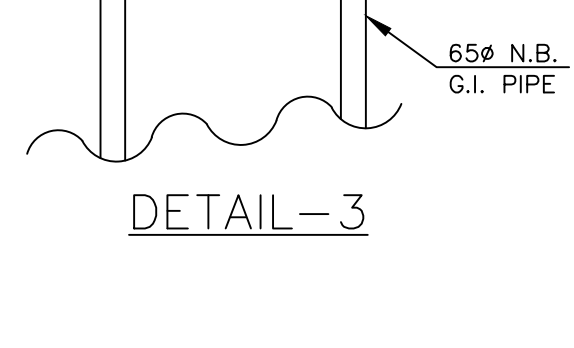
REV 0



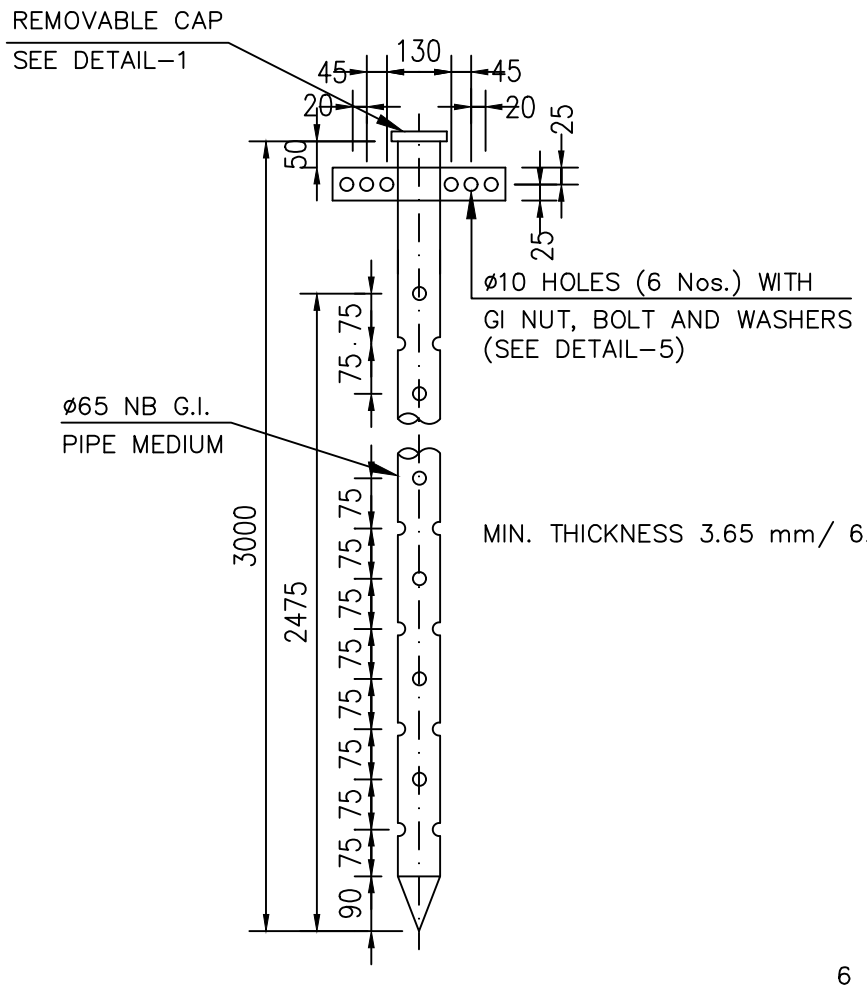
DETAIL–4



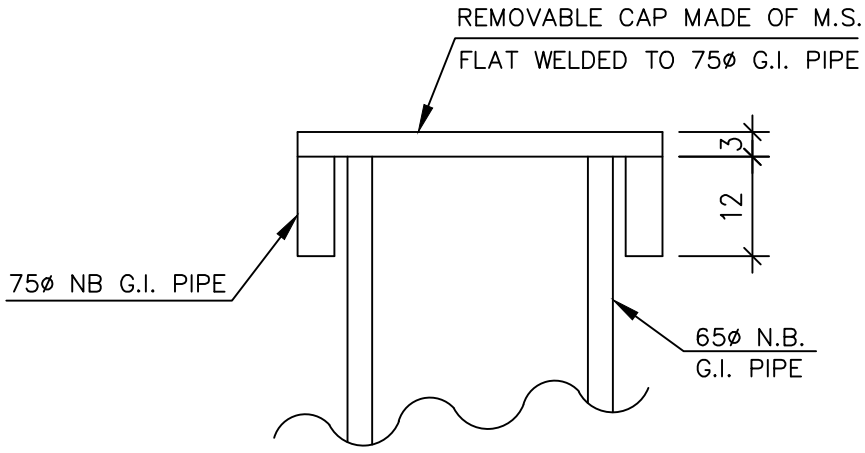
DETAIL–1



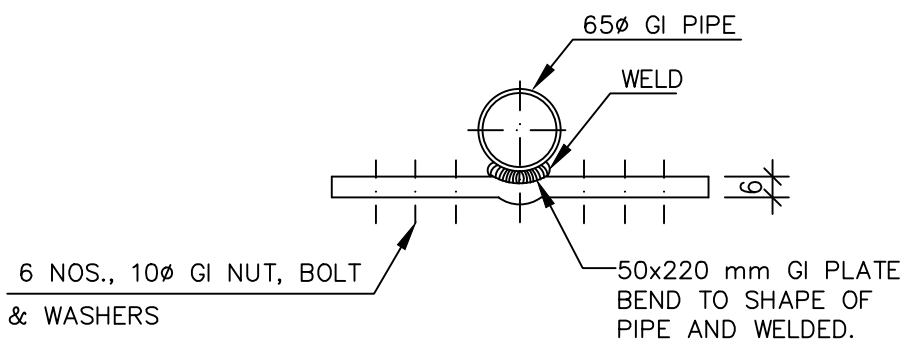
DETAIL–2



DETAIL–3



DETAIL–4



DETAIL–5

NOTE: –

1.) THE PIPE SHALL BE HOT DIP GALVANISED AFTER FABRICATION.

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.

REVISIONS

SECTION: ELECTRICAL

	NAME	DATE	CHKD	DATE
DSGN	S.S.	31.05.23	Q.A.	
DRWN	B.G.			

APPROVED P.SRIVASTAVA

G.I. PIPE EARTH PIT DETAILS

मेकॉन लिमिटेड

MECON LIMITED

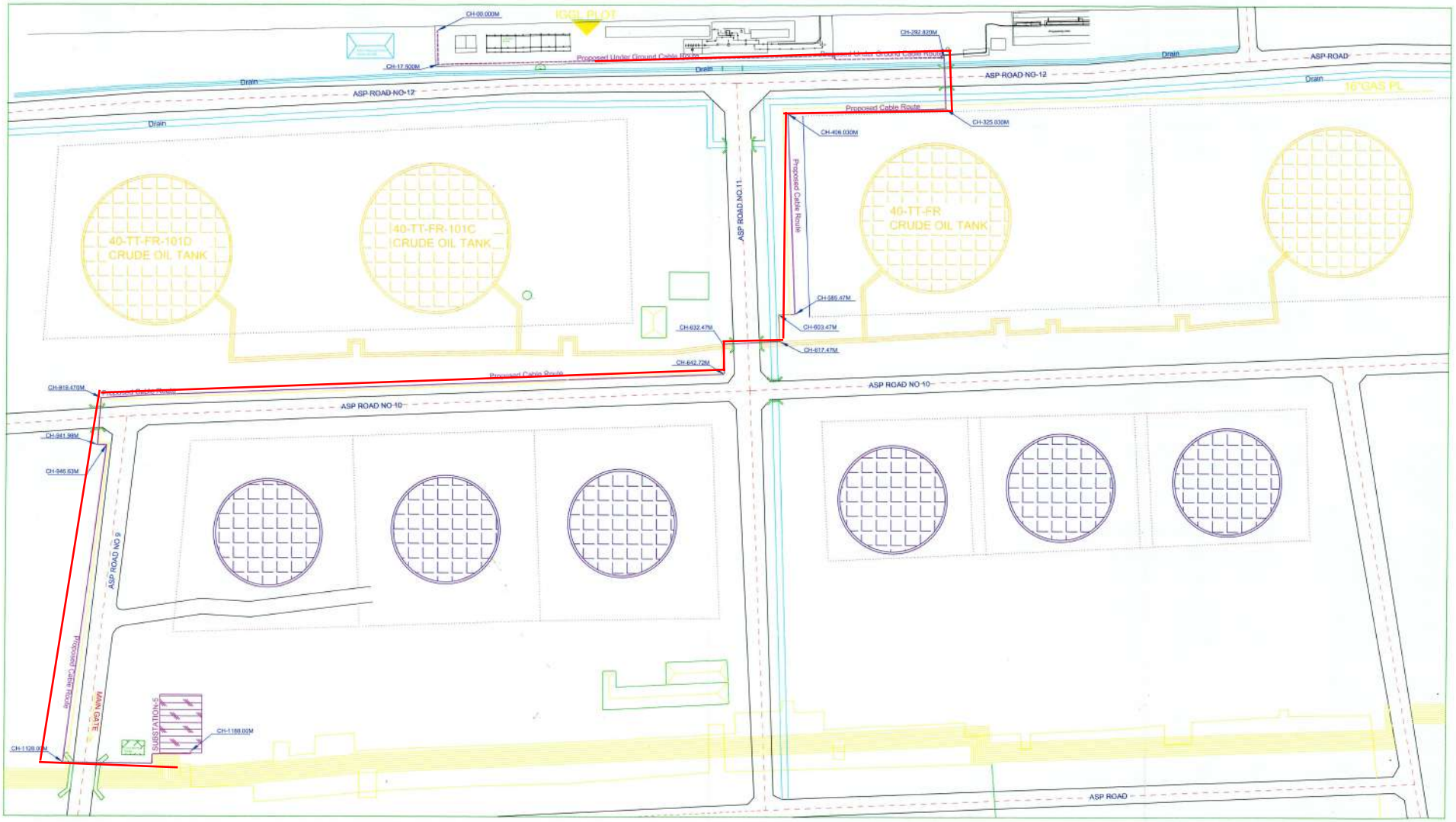
SCALE : N.T.S.

EDITION 1

REV 0

DRG.NO MEC/05/E9/TS–14/SD/03/01

TOPOGRAPHY SURVEY DRAWING FOR ELECTRICAL CABLE LINE -RT NRL



For ACE	For MECON/IGGL
Sign:	Sign:
Name: Sanjeev Kumar	Name: Arbind Mahto
Date:	Date:

NOTE'S

1. ALL DIMENSION ARE IN Meter Not Chainage. UNLESS NOTED OTHERWISE.
2. THIS DRAWING ARE ISSUE FOR ELECTRICAL CABLE ROUTE.
3. CH-00.000M TO CH-292.820M ARE PROPOSED FOR UNDER GROUND ROUTE.
4. TOTAL LENGTH=1188.00M(Asper Site Condition).

INDRADHANUSH GAS GRID LIMITED
MECON LIMITED
ACE PIPE LINE CONTRACTS PVT. LTD.

Laying & construction of steel gas Pipe Line and Terminals Along with Associted Facilities for North East Gas Grid (NEGGL) Pipeline Section -I & Section -2 Part D

TOPOGRAPHY SURVEY FOR ELECTRICAL CABLE LINE

SCALE	PAPER SIZE	DRAWING NUMBER	RHT. No.	REV
		MECON/ACE/RT-002	1	00