



OGDCL PAKISTAN:
OIL & GAS DEVELOPMENT
COMPANY LIMITED

NASHPA COMPRESSION PROJECT (PHASE-II)

ISSUED FOR TENDER

REV	DATE	DESCRIPTION	ORIG	CHKD	LE	QA	PM	LOCAL REPR.	PROJ. MAN
0	Mar 09, 2018	Issued for Tender	JAB	ZHW	AIB	MHQ	MAS		
A	Jan 08, 2018	Issued for Review & Approval	JAB	ZHW	AIB	MHQ	AHB		
REVISIONS			APPROVAL				CLIENT APPROVAL		



ENAR Petrotech Services (Pvt.) Limited ,
7-B , Sector 7-A , Korangi Industrial Area ,
Karachi Pakistan

TITLE:

SPECIFICATION FOR ELECTRICAL INSTALLATION WORKMANSHIP

CONTRACT NO.
14-0193

DOCUMENT NO:

0193 – ELA – 6503 – 0



CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.
(OGDCL)

PROJECT: NASHPA COMPRESSION PROJECT (PHASE-II)

SPECIFICATION FOR ELECTRICAL INSTALLATION WORKMANSHIP



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1. SCOPE

This Specification covers the minimum acceptable standards of workmanship, materials and construction methods required in the execution of electrical works for **NASHPA Compression Facility**.

The electrical works will comprise but not be limited to the following: -

- a) Laying, termination, glanding and testing of cables (complete for on-skid & off skid) including but not limited to following major runs;
 - From Switchgear/MCC Panel (MDB) to packages / field equipment.
 - From UPS Distribution Board Panel to packages / field equipment.
 - From UPS Distribution Board Panel to Control Room
- b) Installation, cabling, testing etc. of complete Lighting system including pole mounted flood lights & structure lights etc. in new front end compressors area & instrument air compressor.
- c) Installation, cabling, testing etc. of complete earthing system including earth electrodes, bare conductor, interconnectivity with existing earthing network, etc. in new front end compressors area & instrument air compressor.
- d) Installation, cabling, testing etc. of cathodic protection system including of transformer rectifiers etc. for new front end compressors area.
- e) Installation, cabling, testing etc. of heat tracing system including of including of Distribution Box / or Junction Box etc. for new front end compressors area & instrument air compressor.
- f) Installation, cabling, testing etc. of lightning protection system including of lightning rods, fixing, etc. for new front end compressors & instrument air compressor.
- g) Installation of Welding Outlet along with mounting stand and other accessories for new front end compressors area.
- h) Installation of cable tray (ladder-type) along with, horizontal / vertical elbows, horizontal tees, fixing clips, joining/coupling plates etc.
- i) This specification, related drawings, and referenced documents are intended to produce a complete and fully operable electrical system, equipment package, or facility in full compliance with applicable industry codes and standards, government regulations, and OGDCL's / Consultant's technical requirements.

In case discrepancies are found among this specification and other documents, OGDCL/Consultant representative shall be referred for correct interpretation.

2. REFERENCES

- a) The following documents are referenced herein and are considered part of this specification.
- b) Unless otherwise specified in Section 2.1 or Section 2.2, use the latest edition of the referenced documents.



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2.1. OGDCL / Consultant Reference Document

- 0193-ELA-6500 Basis of Design
- 0193-ELA-6501 Electrical Load List
- 0193-ELA-6502 Specification for Power & Control Cables
- 0193-ELA-6504 Specification for LV A.C Induction Motor
- 0193-ELA-6505 Data Sheet for Instrument Air Compressor Motor
- NGP-010-ELE-15 01-0002-13 Single Line Diagram for Main Distribution Board
- NGP-010-ELE-15.01-0004-13 Single Line Diagram for UPS
- NGP-000-ELE-15.01-0002-24- Cable Routing Layout for General Area
- NGP-001-ELE-15.01-5002-17 Cable Layout for Instrument & Utility Air System
- NGP-000-ELE-15.01-0001-00 Hazardous Area Classification Layout
- 010193-ELF-6800 Typical Installation Detail Drawings

2.2. Industry Codes and Standards

American Petroleum Institute (API)

- RP 505 Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2
- RP 540 Electrical Installations in Petroleum Processing Plants
- RP 2003 Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents

Institute of Electrical and Electronics Engineers (IEEE)

- 841 IEEE Standard for Petroleum and Chemical Industry—Premium- Efficiency, Severe-Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—Up to and Including 370 kW (500 hp)

International Electrotechnical Commission (IEC)

- 60034 Rotating electric machines
- 60074 Method for assessing the oxidation stability of insulating oils
- 60079-14 Explosive atmospheres - Part 14: Electrical installations design, selection and erection
- 60156 Insulating liquids - Determination of the breakdown voltage at power frequency - Test method
- 60364-5-52 Low-voltage electrical installations - Part 5-52: Selection and erection of electrical equipment - Wiring systems



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- 3.3. Personnel engaged on the construction of electrical installations shall be fully qualified and competent tradesmen skilled in the particular activity in which they are engaged. The EPCC Contractor shall be prepared to give written proof or demonstrations of this requirement to the satisfaction of OGDCL / Consultant.
- 3.4. Material and equipment supplied under this contract shall be new, comply with specifications, and where appropriate shall be provided with certificates issued by the National Certifying Authority for equipment in Hazardous Areas. All materials and equipment shall be subject to inspection and approval by OGDCL / Consultant.
- 3.5. Work in Classified Areas shall be carried out strictly in accordance with API RP 505 / IEC 60079 and with the site construction safety instructions. Particular attention shall be paid to the location and weather protection of EExd equipment.
- 3.6. Care shall be taken at all times to ensure that the finished work has a good appearance, and that ready access is available to components. Particular attention shall be paid to the following:
 - 3.6.1. Thermal insulation and fire proofing materials, forming part of or applied to process lines, structures, etc. shall be left undisturbed. Damage, however caused, must be reported immediately.
 - 3.6.2. Work carried out prior to the application of thermal insulation and fire proofing materials, shall allow adequate clearances, and the work must be fully protected against possible damage during the application of thermal insulation and fire proofing materials.
 - 3.6.3. All electrical equipment and installations shall be located and / or protected against the effects of heat. A minimum clearance of 250mm shall be maintained between cable or conduits and the surface of the thermal insulation of any hot surfaces. For un-insulated hot surfaces the clearance shall be 500mm. Hot surface shall mean any surface, which would exceed the maximum ambient temperature that has been used for installation design.
 - 3.6.4. Acid resistant tiled surfaces shall not be cut, drilled or used for any fixing.
 - 3.6.5. The drilling, cutting or welding of pipe work, steelwork or building structures shall not be carried out without the prior approval of OGDCL / Consultant.
 - 3.6.6. The EPCC Contractor shall make good any damage caused to building and paint finishes by his operations to the satisfaction of OGDCL / Consultant.
 - 3.6.7. Equipment shall be protected from the hazards of general site construction and the elements.
- 3.7. Correct, well-maintained modern tools and aids shall be used, as they are essential for a proper installation. Where special tools are available from equipment manufacturers, they shall be obtained in sufficient quantity so as not to delay the works.
- 3.8. The IEE Regulations for Electrical Installations (Wiring Regulations), BS Codes of Practice, IEC Publications and manufacturer's instructions shall be observed and are not necessarily repeated in this specification except to emphasize or qualify a point.



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- 3.9. The EPCC Contractor shall be responsible to take the approval from electric inspector of all electrical installations like, distribution and earthing systems etc.
- 3.10. Prior to any Equipment being installed, it shall be the EPCC Contractor's responsibility to ensure that prepared foundations, supports, fixing arrangements, steel guide plates / runners are properly installed to suit the Equipment for which they are intended and to ensure that the finished Work has a good appearance and that ready access is available to all components. All dimensions associated with bolting down shall be checked to ensure that they comply with the manufacturer's arrangement drawings.

4. CABLE INSTALLATION

4.1. General Requirements

- 4.1.1. Cable routes detailed in the project reference drawings and specifications will have been selected to avoid areas likely to be subject to contamination. Cable routes not detailed on drawings shall also comply with the above and be agreed with OGDCL / Consultant before starting the installation. Changes to approved cable routes shall only be made with the prior approval of OGDCL / Consultant.
- 4.1.2. Withdrawal spaces and dropping areas will have been shown, where specific allowances have been made. When routing cables, care must be taken not to obstruct these locations, nor to impede access to, and movement of any plant.
- 4.1.3. Storage and handling of cable before and during installation shall take account of ambient conditions and manufacturer's recommendations. Cable drums shall be rotated only in the direction indicated by drum markings and open ends of cable are to be effectively sealed immediately after cutting to prevent the ingress of moisture. Open cable ends, in outdoor installations shall be protected by heat shrink end caps.
- 4.1.4. At all times the utmost care is to be exercised to avoid damaging the protective sheathing of cable or the causing of excessive bending or twisting which may result in bird caging of wire armor or damage to core insulation and sheaths. The manufacturer's minimum bending radii for cables shall be observed at all stages of the installation.
- 4.1.5. Under no circumstances shall metal levers or tools be used in direct contact with cable during installation unless of a proprietary type specifically designed for the purpose.
- 4.1.6. Cable shall be run in continuous unbroken lengths and joints will not be permitted unless the route length exceeds the maximum manufactured drum length, or there is specific authorization for jointing of the cable by OGDCL / Consultant.
- 4.1.7. Where cables pass through floors, or rise from grade level they shall have mechanical protection in the form of sleeves or kick plates projecting not less than 150mm above floor level, unless otherwise indicated. Kick plates shall be positioned so that they will not cause trip hazards. Where mobile equipment will be used in normal plant operation e.g. warehouses and loading areas, this protection shall extend to 2 meters and warning labels shall be fitted.



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- 4.1.8. Where cables pass through gas, dust or fire barriers, the hole provided for them shall be sealed as required by the IEE Wiring Regulations with cable transits, gland plates or proprietary systems as detailed in the drawings.
- 4.1.9. All cables other than lighting and small power sub-circuits shall be identified and tagged at each end adjacent to their termination point with approved markers on carrier strip. In addition, all underground cables shall be fitted with non-corrodable identification bands at all points where they enter or leave buildings, cable ducts, trench ducts or similar. Steel tags shall be provided at every 15 meter distance. Lighting and small power sub-circuit cables shall be identified at each luminaries/socket outlet.
- 4.1.10. Cables of power systems shall be segregated from intrinsically safe, electronic instrumentation and communication circuits in accordance with the relevant specification issued for the job and the drawings bearing the general notes for power and lighting installations.
- 4.1.11. Cables will be de-rated, during design, for method of installation and the arrangements detailed in the approved drawings shall be strictly adhered to unless changes are agreed upon by OGDCL / Consultant representative.
- 4.1.12. Each cable shall be subjected to an insulation resistance and continuity test after installation and prior to final dressing into position and termination; results shall be recorded and approved by OGDCL / Consultant.
- 4.1.13. Cables shall be located and dressed into their final positions as work proceeds. The practice of pulling all cables on a route and then attempting to tidy up afterwards will not be accepted. The Contractor shall be responsible for proper dressing of cables.
- 4.2. Direct Buried Cables Underground & Paved Trenches**
- 4.2.1. The excavation, sanding, tiling and back filling of trenches for the installation, (if requirement for direct-buried cables occurs), shall be carried out by the EPCC Contractor.
- 4.2.2. Cables must be laid in existing concrete trench in accordance with the specified or agreed route as marked in project reference drawings. If deviation is necessary for any reason, authority must be obtained in the form of the OGDCL / Consultant's written approval.
- 4.2.3. Surface route markers shall be installed as shown on the installation details but in any event at not more than 30 meter intervals and at significant changes of direction.
- 4.3. Cables Installed above Ground**
- 4.3.1. Cables installation above ground shall run on continuous cable tray (ladder type). For branches from the cable tray or when cables are small in number, cables shall be protected by perforated cable tray or steel conduit with OGDCL / Consultant's approval. Cable tray (ladder type) systems shall be selected for maximum resistance to environmental corrosion.
- 4.3.2. EPCC Contractor shall carefully check the cable tray (ladder type) locations shown on the OGDCL / Consultant - accepted drawings for possible interference with other equipment, such



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as steelwork, piping, and ducting. Cable tray (ladder type) accessories e.g., nuts, bolts, and clamps shall be of 316 stainless steel material.

- 4.3.3. Cable tray (ladder type) supports shall be spaced along cable tray length in a manner that prevents sagging and misalignment of cable tray under maximum design load.
- 4.3.4. Supports for cable trays (ladder type) not shown on routing drawings shall be standardized and shall conform to the type and arrangement of main cable run supports.
- 4.3.5. Cable trays shall be bolted or clamped to supports with 316 stainless steel bolts or clamps. Welding of trays shall not be permitted.
- Structural members shall not be drilled for purposes of securing trays unless called for on OGDCL / Consultant accepted drawings, or unless authorized in writing by OGDCL / Consultant representative.
 - Any drilling authorized as in item a above shall be done in a manner to minimize effect on the strength of the structural members being drilled.
- 4.3.6. Cable trays shall not be used as walkways or scaffolding, or for any other purpose for which they are not intended.
- Cable trays shall not be used as a means of support for other raceways, cables, or non-electrical equipment.
 - EPCC Contractor shall be responsible for correcting any damage incurred to cable trays to the satisfaction of OGDCL / Consultant representative.
- 4.3.7. Cable trays (ladder type) shall be cut only along a line of plain metal and not through any perforation.
- After cutting, sharp edges shall be smoothed and, where applicable, the finish shall be restored.
 - Exposed steel shall be treated with a cold-galvanized treatment, including hot-dip galvanized steel trays.
- 4.3.8. Cable tray fittings shall provide a smooth and tangential transition between cable tray elements.
- 4.3.9. Electrical continuity shall be maintained at joints between sections of metallic cable tray.
- Metallic cable trays shall be bonded to the support structure at intervals not exceeding 50 feet (15 m).
 - If cables leave one tray and enter another, a bonding jumper shall be installed between cable trays section.
- 4.3.10. Cable trays may be installed without top covers allowing adequate ventilation except where:
- Mechanical damage of the cables is likely to occur during plant maintenance.
 - Chemical spillage or the trap can be expected.



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- 4.3.11. It is only permitted for cable route with one cable to install directly on the surface of structure or wall without tray. All cables for installation on surface of wall, column, ceiling, channels, etc., shall be fixed to the surface by means of non corrosive, non flammable P type clips, secured to a steel channel using suitable stud plate, nuts and washers. Common mounting channels are to be furnished for cable along the same route.
- 4.3.12. The erection of cables and position of support shall be so arranged that cable crossing one another be minimized, if cannot be avoided.
- 4.3.13. Cables and Equipment fixed to a building fabric, i.e., brick Work, concrete, etc. shall be fixed by means of appropriate fixing devices, i.e., rawl bolts, hilti fixing devices, etc.
- 4.3.14. Grease or other injurious lubricants shall not be used in pulling cables. The use of talc or non-injurious lubricants is permissible, if desired.
- 4.3.15. Each cable shall be supported and secured in a manner, which minimizes sagging and ensures that no strain is imposed on the terminations.
- 4.3.16. Cable routes shown on project reference drawings will have been selected to avoid areas subject to risk of damage from fire, leakage or spillage
- 4.3.17. Cables above 35mm diameter shall be individually cleated. Cables up to 35mm diameter shall be arranged in bank but shall not form more than two layers. Bunching of cables will not be permitted. Spare capacity of 20% shall be allowed on all cable trays (ladder-type).
- 4.3.18. Cables passing from a pressurized enclosure or building or through a firewall leading from a safe to a hazardous area shall be sealed.

4.4. Cable Supports and Fixings

- 4.4.1. The cables trays (ladder type) shall run on the new pipe-rack as mentioned in project reference drawing. The system shall be mechanically continuous as far as practicable. The length of a gap shall be limited to the width of the pipe rack or tray involved, the ends of which shall be rigidly supported.
- 4.4.2. Cable tray shall be heavy-duty mild steel, galvanized, of minimum thickness 2mm up to 300mm width with 100mm depth / height. The minimum width installed shall be 100mm.
- 4.4.3. Manufactured junction pieces, bends and the like, shall be used in cable tray (ladder type) runs wherever possible. Where site fabrication is permitted they shall be of equal quality, strength and dimensions.
- 4.4.4. Electrical continuity throughout the runs of cable tray (ladder type) and steel cable supports shall be ensured. Proprietary bonding links shall be used wherever necessary. Gaps in cable supports shall have earth-bonding connections.
- 4.4.5. All runs of cable and supporting systems shall be installed such that water cannot collect or remain in any part.



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4.4.6. Cable tray (ladder type) shall be secured at intervals laid down in the IEE Wiring Regulations or cable manufacturer's recommendations. Cables secured individually shall be fixed with non-corrodable, non-flammable P-clips or cleats. Cables shall be fixed throughout their length by means of approved saddles, cable clips, etc., at every 4m horizontally and 1m vertically. Hardwood will not be permitted. Cables in bank shall be strapped overall with PVC covered galvanized steel strip (e.g. "All Round Bank") and cadmium plated screws, washers and nuts. Fixings for banks of cables shall be spaced for the smallest cross-section cable in the group. All cable fixings shall be secure without such excessive pressure that would cause damage to the cable sheath.

4.5. Cable Termination and Jointing

4.5.1. All jointing and termination work shall be carried out by practicing, fully trained tradesmen, qualified in such work for the operating voltage concerned. Written proof and/or demonstration of this may be required from OGDCL / Consultant.

4.5.2. Jointing and termination work must be carried out using crimped compression type conductor connections where lugs or wire pins are required and mechanical compression glands. Soldering methods should not be employed in order to avoid insulation damage due to the application of excessive heat compression tools and dies shall be designed and supplied for specific use with the connectors used and shall be maintained in order and used in accordance with the manufacturer's instructions.

4.5.3. Glands for use in hazardous areas shall be installed in accordance with IEC 60079 and have component approval for use with the associated cable and the type of protection (e.g. EExd) and apparatus grouping of the certified / approved equipment. The installer shall use the specific types identified in the cable schedule.

4.5.4. The degree of protection of equipment enclosures (IP) shall be maintained at cable entries. Protection against ingress of moisture shall be provided by one of the following preferred methods:

- Tapped entries – threads shall be sealed using an application of component approved sealing compound or grease.
- Clearance hole entries – fiber sealing washers shall be fitted externally between the gland body and gland plate/enclosure.

4.5.5. Sealing washers may also be used on equipment with tapped entries. On EExd certified equipment the required number of full threads of engagement must be ensured.

4.5.6. The glands shall be assembled strictly in accordance with the manufacturer's instructions, particular attention being paid to ensuring good mechanical and electrical contact between parts without excessive stain or distortion of the cable.

4.5.7. Glands made off into equipment having a restricted breathing enclosure, must utilize the seals provided with the equipment, to ensure the effectiveness of this feature.

4.5.8. Electrical continuity between non-current carrying metal parts and the cable armor and/or metal sheath shall be ensured by the integrity of the gland termination which shall also



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preserve the type and the degree of protection of the enclosure. Where thread-sealing compounds are used they shall be of a conducting type such that the electrical continuity between gland and enclosure is maintained.

- 4.5.9. Where, cable entry is through a clearance hole, in an enclosure or gland plate of conducting material and finish, electrical continuity shall be maintained by fitting a serrated steel washer internally and securing the gland using a brass lock-nut. Alternatively, a brass earthing tag may be fitted (in place of the serrated washer) connected to an internal earthing stud/terminal. Where an enclosure or gland plate is of non or semi-conductive material or has a painted finish, a brass earth tag shall be fitted, in contact with the gland, for connection to an external earth terminal or in contact with the locknut for an internal earth terminal.
- 4.5.10. The entire body of the cable must enter the gland. The cable shall be on a straight axis from a point at least six diameters before entering the gland. Seals shall be checked for correct size at the point of application.
- 4.5.11. Top cable entry shall be avoided wherever possible in outdoor installations. It is preferred that cables should be terminated at the bottom of enclosures. Where this is impractical they shall be terminated at the side; towards the on-driving end in the case of motors. A drop loop shall be formed in cables, at least six diameters from the gland.
- 4.5.12. Wherever safe and practical, the maximum amount of tail shall be left to enable future changes and the remaking of connections.
- 4.5.13. Tunnel type conductor terminals shall be of the clamp type i.e. Not pinch screw. Not more than one single or multi-stranded wiring lead shall be connected into either side of any terminal. Conductor insulation shall extend to, but not enter, the metal throat of the terminal, and all terminal screws shall be tightened down.
- 4.5.14. Care shall be taken to ensure that creep-age and clearance distances are maintained e.g. no washers or loose strands.
- 4.5.15. Unused cable entries shall be closed with plugs suitable for the degree of protection of the equipment and having component approval for apparatus in hazardous areas.
- 4.6. Circuit Identification**
- 4.6.1. In addition to cable identification cable cores shall be positively identified at every terminal point, in accordance with the drawings. Cables steel tags shall be provided at every 15 meters.
- 4.6.2. Three conductor circuits connected to a 3 phase, 3 wire system shall have Red, Yellow and Blue core colours.
- 4.6.3. Four conductor circuits connected to a 3 phase 4 wire system shall have Red, Yellow and Blue core colours for phases and Black colour for neutral core.
- 4.6.4. Two conductors connected to a single phase and neutral circuit shall have phase core coloured Red and neutral core Black.



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4.6.5. Three conductors connected to a single phase and neutral with earth shall have the following core identification for 3 core PVC/SWA/PVC cables:

Phase conductor	Red/Yellow/Blue with red sleeve at all termination points.
Neutral Conductor	Black with black sleeve at all termination points.
Earth Conductor	Green with yellow sleeve at all termination points.

4.6.6. D.C. circuits shall have red colour for positive and black for negative conductor of 2 wire circuit D.C. circuit.

4.6.7. For core identification at the terminations of cables, tapes, sleeves or dices shall be used duly coloured with appropriate colour.

4.6.8. Every core of a flexible cable or flexible core shall be identified throughout its length according to its function. Table 52B of I.E.E. Regulations for Electrical Installation 15th edition shall be followed along with its relevant notes.

4.6.9. Ferrules used for identification shall be of the interlocking permanently engraved type, designed to encircle the core completely. Markers of the adhesive type will not be permitted. Ferrules shall be correctly sized. There shall be no improvisation and engravings must not be altered.

4.6.10. Core markings shall be strictly in accordance with the drawings. Where references are not provided a system shall be agreed with OGDCL / Consultant and recorded on the "As Built" drawings.

4.7. **Cable Rule Laying Underground**

4.7.1. The cable trench shall be excavated if any requirement exists during the detail engineering. Wet or flooded excavations shall be de-watered and all mud removed before cables are installed. Before laying of cable and after the trench has been cleared of all loose earth and debris, the bed of the trench shall be levelled and filled with a 100 mm thick layer of stone free fine sand (1.3 min diameter maximum particle size). The sand layer shall be levelled and the cables placed thereon. The cables to be installed directly underground shall be laid in trenches in single tiers.

4.7.2. Sufficient slack shall be left in cables. The cables in the trench shall be arranged so as to minimise cables crossing where they leave the trench. Control cables shall be run next to power cables. The earth continuity conductor shall be laid in the trench with the cables.

4.7.3. The cables shall be covered with a layer of fine sand 100 mm thick measured from the top of largest cable. Cables shall be protected by means of cable warning tiles. The cable warning tiles shall be minimum 50 mm thick. These shall be laid 100 mm above the top of the cables to cover the entire length and breadth of the cable trench.

4.7.4. The depth of cable below finished ground level shall be 700 mm minimum measured from the top of the largest cable to the general ground level. The burial depth may be increased as required due to Site conditions or when crossing other service pipes and roads. A minimum clearance of 250 mm vertically and 500mm horizontally shall be maintained between cables



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and other services. These shall be effectuated at ninety degrees as far as possible. Burial depth less than 700 mm and more than 1500 mm shall require Owner's approval.

- 4.7.5. After the warning tiles are placed, the remainder of the trench shall be back filled with earth in layer 400 mm thick (loose measurement). Each layer shall be thoroughly tamped and compacted.
- 4.7.6. Material for backfill shall be free of large lumps of stone, rock, concrete, debris, and foreign material. In general, material excavated for cable trench shall be suitable for back fill provided it is free from large lumps of stone, rock, concrete, debris, foreign material and the moisture content at the time of back fill is within acceptable limits so that the back fill material can be compacted. Level of trench after compaction shall be same for surroundings / adjacent areas.
- 4.7.7. Cables entering the buildings shall be laid in protective pipes. The protective pipe ends, after installation of cables, shall be plugged watertight.
- 4.7.8. Cables shall be pulled through duct bank system for road / dyke crossings. Duct bank shall be PVC or non-metallic pipes encased in concrete of thickness as specified by relevant codes and standards.
- 4.7.9. The top of the concrete encasement shall be at least 600 mm below grade when the duct bank cross the roads.
- 4.7.10. Cables shall not be pulled into ducts until the duct system has been completed, cleared and free from obstruction and sharp edges.
- 4.7.11. A clean rag or brush shall be drawn through each cable duct before cable is drawn in. Cables shall be put into ducts in such a manner that there will be no cuts or abrasions in the cable insulation, protective braid and jackets. There shall be no kinks in the conductors.

4.7.12. Handling

Damage to cable can occur due to incorrect handling to which the drums and cables may be subjected, causing breakdown of the drum flanges and in exceptional cases, movement of the drum barrel takes place. Once this breakdown of the drum occurs the cable shall be immediately exposed to damage.

Forklift trucks shall be used in handling provided that care will be exercised not to damage or remove the protective lagging when pushing the 'fork' under the drum flanges. Unloading can also be safely accomplished by means of ramps and winches. Under no circumstances should a drum be rolled off a vehicle on to a 'cushion' of sand, tarpaulin, etc. This action could crumple the flanges and barrel of the drum, driving splinters and / or nails into the cable.

a) **Rolling Drums**

Drums of cable must always be rolled in the direction shown by the arrow painted on the flanges, but such rolling should in any case be kept to a minimum.



b) Turning Drums

The best way to turn a cable drum is to roll it on to two well greased thin plates or boards about 2 feet square. The plates can then be used as a turntable and the drum rotated to the desired direction.

4.7.13. Lowering of Lifting Drums

When drums are moved from one level to another, e.g. truck to ground, wharf to ship, etc. lifting and lowering gear must always be used. When drum are lifted from the upper layer of a tiered stack, care must be taken to ensure that no movement of the bottom layer occurs so as to cause collapse. Drums, whether loaded or empty, and too heavy to be man handled, should always be slung; they should never be dropped. When lifting drums of cable for loading or unloading, spindles must always be used in conjunction with crane slings, chain or lifting beams. On no account any drum be lifted by wire slings.

When lifting drums of cables, lifting beams or stretchers between the sling of chain pairs must be used to prevent flanges crushing on to the cable.

Normally the hooks or slings should be close to the drum flanges.

4.7.14. Storage

If at any time the drums of cable are required to be stored for reasonably long periods, e.g. prior to shipment or installation, the following points should be noted.

- The site for storage of drums should be well drained, hard packed soil, or preferably a concrete surface, which will not allow the drums to sink and so give rise to damage due to the extreme difficulty in moving drums when they are sunk into the ground.
- All drums should be stored with the lagging intact, and in such a manner as to leave sufficient space between them for air circulation. Check and tighten barrel bolts on the drums at regular intervals.
- Tier stacking of drums is not recommended. In no circumstances must the drums be stored on the flat i.e. with flanges horizontal.
- All drums during installation (i.e. when the lagging have been removed) should be stored with the rims of flange touching, so that there is no danger of the flanges of drums coming into accidental contact with unprotected cable on other drums.
- Cable ends must be sealed with end cap during storage.

5. JUNCTION BOXES, DISTRIBUTION BOARDS

- 5.1. All junction boxes shall be accessible from grade or walkway level. The cable or conduit connections shall be effectuated at the bottom, or possibly on the side, when the cable comes from the bottom.



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- 5.2. The locations of distribution boards shall be as per detail design drawings. The actual location shall be determined at Site, keeping in view the Site conditions and other Equipment, as approved by the Owner.
- 5.3. During all stages of work, coordination is necessary to ensure the accurate location and alignment of equipment foundations, channels and fixing bolts with the manufacturer's and Project Drawings.
- 5.4. During the course of work it is necessary to ensure that all equipment is protected from the normal hazards that arise on construction sites (e.g. dust, condensation, mechanical damage etc.).
- 5.5. All damage to equipment finishes shall be touched-up/repared to the satisfaction of OGDCL / Consultant.
- 5.6. The cable entry in the distribution boards shall be provided from top or bottom as required.
- 5.7. All cable connections to circuit breakers, etc., shall be made neatly and firmly to ensure good contact and properly identified by the use of alphanumerical ferrules.
- 5.8. When outdoor apparatus is installed in open air, an extra protection of the type, by means of a cover, shall be fitted on the pedestal or supporting frame.

6. LIGHTING & SOCKET OUTLETS

- 6.1. The EPCC Contractor shall develop lighting layout and mark the positions of luminaries and socket outlets, etc. Locations shall take into account adjacent pipe work and equipment and the luminaries positioned to provide the maximum use of the light output and access for maintenance. Any deviation from the drawings shall be agreed with OGDCL / Consultant and all changes recorded on the 'As Built' drawings.
- 6.2. The locations of luminaries outdoors shall favour platforms, landings or stairways, ladders, gauges, indicating instruments.
- 6.3. Lighting switches shall generally be mounted 1500mm above floor level.
- 6.4. Socket outlets shall be mounted 1500mm above floor level, or as dictated by the location (e.g. supported from hand-rails).
- 6.5. Enclosures within 2 meters of each other and containing single phase circuits on different phases of the supply shall have their covers marked with their respective phase identifications. Where colours are used markings shall be distinguishable from other coloured identifications.
- 6.6. Distribution board circuit charts shall be completed neatly and permanently with the protective device rating and circuit description.

7. EARTHING, SUPPLEMENTARY BONDING & LIGHTNING PROTECTION



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- 7.1. Earthing shall be carried out as per EPCC Contractor's detailed drawings after OGDCL's / Consultant's approval and fully in accordance with the latest standard regulations. Where deviations are necessary they shall be subject to the prior approval of OGDCL / Consultant.
- 7.2. The earthing system consists of earth electrodes; tap connectors, earth connecting bars, earth continuity conductors and all accessories necessary for the satisfactory operation of the complete earthing system.
- 7.3. The earth system shall be installed to ensure that when any part of the earth system is disconnected for the purpose of carrying out periodic testing, an alternative path to earth is available.
- 7.4. The earth system shall be loop-connected, with cross sections as per detailed design requirements. The concept of the loops and the way they are connected shall be such that the apparatus can be easily removed without requiring a complex disconnection operation nor risking interruption of, or damage to the loop itself.
- 7.5. The resistance of the loop system with respect to the ground shall be less than the 1 ohm. If that does not have a resistance to ground of 1 ohm, it shall be augmented by driving additional electrodes at a suitable inter-distance until the required resistance is achieved.
- 7.6. A particular grounding circuit, to separate ground pits shall collect the grounding of instrumentation, as well as their cable screens at one extremity, and in general, all electronic instrumentation with low signal levels, requiring particular care of noise rejection.
- 7.7. Earth electrodes shall be round copper rods. Rod type earth electrodes shall be 20-mm diameter of fixed length required per detailed design. A concrete casing with concrete cover shall be installed to provide an easy access to the rod for inspection and test measurements.
- 7.8. Connection of earth conductor to earth electrode shall be by proprietary clamps made so that they can be disconnected for testing.
- 7.9. The ends of earth conductors shall be tinned after twisting so as to ensure the minimum contact resistance throughout its useful life.
- 7.10. All metal Work used to enclose or contain current carrying conductors or components including the metal sheathing and armoring of cables shall be mechanically and electrically bonded together to form an efficient and effective earth return path for the maximum prospective earth fault current that may occur.
- 7.11. Apparatus shall be connected to the earth system via cable armour, in addition to other means of earthing, except in the case of single core armoured cable.
- 7.12. Where distribution boards, motor starter panels – motors (if required) distribution boards, cable trays (ladder type), piping, steel Work, junction boxes, socket outlets, lighting fixtures, as well as frames, supports, pedestals, etc., are connected to the earth system or bonded together by means of earth conductors, the conductors shall be fitted with robust compression lugs and the Equipment shall be provided with earth terminals, lugs or bosses made of flat bar.



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- 7.13. The parts on which they are connected shall be conveniently cleansed and surfaced. Equipment earth conductor shall not be smaller than 16 sq. mm. Care shall be taken in the termination of the cable glands to ensure adequate earth continuity between Equipment and cable armour.
- 7.14. The lightning protection system shall be installed accordingly as per material designed. Supplied by EPCC Contractor during the detail engineering.

Static Earthing and Bonding

- 7.15. Pipe lines, vessels, steel structures and Equipment not directly bonded to the electrical Equipment shall be bonded and earthed to the main earth system by one or combination of the following:
- a) Separate earth conductors.
 - b) Electrical continuous metal Work.
- 7.16. Any structure or other items within the plant boundary limits and outside the protection zone of neighbouring taller structure shall be directly connected to earth as close to the base as possible and shall also be connected to the main earth net-work.
- 7.17. In hazardous area, all vessels, steel structures and also services (i.e. pipe lines) that enter and leave the area shall be earthed by earth conductors. Static earth conductors shall not be sized less than 16-sq. mm.
- 7.18. The EPCC Contractor must check that effective bonding has been achieved by testing the resistance to earth at any point of the piping and steel structures to be less than one ohm.
- 7.19. All incoming services to the Site area and to individual buildings shall be connected to earth and bonded at their points of entry to the earthing system, (i.e., water, gas, etc.).
- 7.20. Conductors shall be terminated at bus-bars (if required), electrical equipment and plant items by means of bolted connections.
- 7.21. Contact faces of connections shall be cleaned, wire brushed and lightly smeared with 'Copper-grease' or an approved equivalent. Brass set screws, nuts, plain washers and phosphor bronze single coil spring washers shall be used.
- 7.22. Tape conductors shall not be drilled for any purpose other than for bolted or riveted connections. The hole diameter shall not exceed one half the width of the tape or one quarter the width of a busbar.
- 7.23. Connections between identical and different sizes of stranded copper PVC covered earthing cable shall be made using BICC'CEETAP' compression connectors or equal. The Contractor shall ensure that the connectors supplied, in accordance with the manufacturer's recommendations. Connections shall be greased "Copper-grease" (or approved equivalent) and taped with Green/Yellow coloured PVC self-adhesive tape as protection against corrosion.



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- 7.24. Each conductors run above ground shall be fixed by means of non-corrodible saddles or clips, the spacing of which shall not exceed 600mm for horizontal runs or vertical surfaces and 1200mm for vertical runs and where horizontal runs are continuously supported.
- 7.25. Where earth conductors exit from trenches to run above grade, they shall be protected by kick pipes for a minimum height of 1150mm above grade level.
- 7.26. Particular attention shall be paid to the assembly of cable termination glands to ensure the maximum effectiveness of the earth continuity between equipment and the armor and/or metallic sheaths of cables.

8. INSTALLATION OF CONDUIT AND ACCESSORIES

8.1. Steel and G.I. Conduit

- 8.1.1. The minimum size of conduit shall be 20mm.
- 8.1.2. The use of solid or inspection elbows, bends or tees will not be permitted and 120o bends shall be limited to one between any two drawn-in boxes.
- 8.1.3. Conduit coupling joint shall not be used where conduits enter spout entry conduit boxes.
- 8.1.4. Conduit running joints shall not be used where conduit enter conduit boxes or spout entry boxes.
- 8.1.5. Equipment that is required to be removed for maintenance shall be provided with conduit unions in all conduits that enter such equipment.
- 8.1.6. The use of conduit nipples shall be avoided as far as practicable.
- 8.1.7. All conduits shall be cut square and reamed at the end. All conduit ends and the inside of conduits shall be clean and free from burrs.
- 8.1.8. Where bushed spouts or tapped holes are not provided at conduit terminations the conduit shall be terminated in a flanged socket and a smooth bore brass hexagon bush, with a lead washer fitted between the flanged socket and the equipment or box.
- 8.1.9. All exposed threads and parts where the galvanizing has become damaged shall be thoroughly cleaned and painted with galvanized paint. The exposed conduit ends shall be capped to protect threads from being damaged before installing cables.
- 8.1.10. Repair painting shall take place before any making good on site or buildings is carried out.
- 8.1.11. The lids of all boxes, including motor terminal boxes, etc., which rely on machined face metal to metal joints shall be lightly smeared and greased to prevent corrosion and to ensure water tightness.

The entire conduit system shall be checked for continuity. Any obstruction found shall be removed without damaging the installation.



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- 8.1.12. The conduit system shall be installed empty with a 16 SWG steel wire drawn through the conduits for pulling of cables.
- 8.1.13. Joints in underground conduits shall be avoided or reduced to the absolute minimum.
- 8.1.14. Where adjustable dies are used they shall be so adjusted that threads cut with them shall be the same depth as machine made threads.
- 8.1.15. The use of manufactured bends shall be avoided and instead smooth bends shall be provided by using approved type of bending tools.
- 8.1.16. Flexible steel conduits shall be installed at all points/locations where flexible connection is required, as directed by the OGDCL / Consultant.
- 8.1.17. The flexible conduits, when used, shall be protected by external PVC sheath, resistant to oil damages.
- 8.1.18. GI pipes for underground installations shall be given bituminous paint coating and wrapped with suitable paper or cloth before installation.

8.2. Fixing Of Conduits And Fittings

- 8.2.1. Conduits in process units and on steelwork shall be fixed with "U" bolt G.I type fixings.
- 8.2.2. Conduits in buildings shall be fixed with galvanized distance saddles.
- 8.2.3. Where a number of conduits follow a single route they may be fixed to mild steel brackets.
- 8.2.4. Conduits shall be supported on both vertical and horizontal runs as follows:
- Conduit sizes 20mm and 25mm maximum spacing of fixing 1000mm.
 - Conduit sizes larger than 25mm maximum spacing of fixing 1500mm.
- 8.2.5. All conduit boxes that support fittings shall be securely fixed.
- 8.2.6. All conduits shall be fixed 150mm before and after every right angle or off set.
- 8.2.7. All conduit fittings and equipment shall be fixed true and line able.
- 8.2.8. All conduit bends shall be made with an approved conduit bending machine or hickory. The radius of curvature of the inner edge of any bend shall not be less than the following table:

<u>Conduit Size</u>	<u>Radius</u>
20mm (3/4")	Not less than 130mm
25mm (1")	Not less than 150mm
32mm (1-1/4")	Not less than 200mm
38mm (1-1/2")	Not less than 255mm



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50mm (2")	Not less than 305mm
70mm (2-1/2")	Not less than 380mm
82mm (3")	Not less than 460mm
100mm (4")	Not less than 610mm

8.2.9. Underground conduit stud-up or kick pipe through concrete envelope shall be extended a minimum of 150mm above grade and adequately braced to prevent shifting during concrete pouring work. The concrete envelope shall extend at least 76mm above grade.

8.2.10. Under floor conduit installation shall be at a minimum depth of 120mm from finished floor level.

8.2.11. The G.I. pipes/conduits shall be installed at a minimum depth of 1000mm measured from the top of the size to the finished road level.

8.3. Location of Conduits and Fittings

8.3.1. Before conduits are installed confirmation shall be obtained that the conduit may be installed in that position.

8.3.2. Particular attention shall be given to the location of conduits to prevent the infringement of headroom and access ways.

8.3.3. Conduits shall be located to avoid obstructions, furnaces, hot lines and other places of high temperature.

8.3.4. Conduit shall not be located closer than 150mm (6") where it runs parallel to or crosses hot surfaces.

8.3.5. Underground conduit runs shall be kept to minimum in both number and length.

8.3.6. Conduits shall not be recessed in fair brickwork.

8.3.7. Not be located in the corners or other such locations and shall be positioned to avoid tight bends, bending and cable kinks.

8.3.8. Conduits shall not generally be installed having a greater length than 12,000mm (40 feet) between drawn in boxes.

8.3.9. Conduit entries shall wherever possible be located in the bottom of boxes and equipment etc.

9. STEELWORK & FIXINGS

9.1. Steel supports and brackets shall be properly fabricated and fitted in accordance with the power, lighting and earthing drawings. All rough edges shall be removed and bare steelwork shall have one coat or primer before installation. Painting shall be in accordance with the Project Painting Specifications.

9.2. Adequate sizes of steelwork shall be used with a minimum thickness of 6mm.



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- 9.3. Welding to structures shall be the main fixing medium. The prior permission of OGDCL / Consultant shall be obtained.
- 9.4. Pre-cast concrete and structural steelwork may be drilled only when authorized by OGDCL / Consultant, and only in the positions agreed.
- 9.5. The use of cartridge fired studs will not be permitted.
- 9.6. When the fixing of electrical equipment or materials to fireproofed structures is unavoidable, any brackets required for such fixings shall be installed before the fireproofing material is applied. Consideration must be given to the likelihood of heat conduction through such fixings causing damage to the fireproofed member and appropriate safeguarding action taken in agreement with OGDCL / Consultant. Alternatively, and subject to the nature of the fireproofing, prefabricated clamping brackets may be employed subject to approval from OGDCL / Consultant.
- 9.7. Enclosures of an alloy construction shall be spaced off the supporting structures by a minimum of 3mm and mating surfaces of fixings protected by an approved anticorrosive coating.
- 9.8. All fixings shall be adequate for their duty and shall have a rustproof finish e.g. cadmium plates or sheradiesed. Fiber wall plugs for wood or coach screws shall be used. Single coil spring washers shall be used for all bolted connections.
- 9.9. Threads shall be ISO metric type.

10. HAZARDOUS AREA CLASSIFICATION

- 10.1. The Contractor shall take into consideration, when carrying out the works and supplying the equipment, the following requirements:

The electrical equipment installed in hazardous areas shall meet with the following classification and selection criteria.

- Areas where gases or combustible vapours may occur in normal operation. The equipment shall have adequate protection for these conditions. Equipment suitable for installation in Zone-1 shall be used.
- Areas where gases or combustible vapours may occur under abnormal circumstances. Equipment suitable for installation in Zone-2 and Zone-1 shall be used.

- 10.2. EPCC Contractor shall refer the project reference document for selection of equipment w.r.t area classification as defined.
- 10.3. Plastic housings are not accepted for junction boxes, push-button stations, socket outlets, switches or plastic cable glands, in so far as they are connected to armored cables metallic conduits.

11. CATHODIC PROTECTION SYSTEM



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- 11.1. A Cathodic protection system shall be designed, supplied and installed by EPCC Contractor for corrosion protection against underground pipes i-e Oily Water Sewerage pipeline and Fire Water Network lines at new front compressors area as per piping layout (to be developed by EPCC Contractor).
- 11.2. The Cathodic protection shall be an impressed current system with auto control having provision of manual also.
- 11.3. Transformer rectifiers shall be oil immersed transformer with Selenium or SCR type rectifier rated 400 volts 3 phase, 50 Hz. Transformer rectifier shall be installed in non hazardous area, and of weather proof, outdoor use type suitable for the area to be installed.
- 11.4. Electric power to the transformer rectifier shall be confirmed during detail engineering By EPCC Contractor and accordingly all the relevant document / drawings will be developed for OGDCL / Consultant approval.
- 11.5. Cathodic protection equipment to be installed in hazardous area shall be suitable for the area where the equipment shall be installed as per IEC 60079.
- 11.6. Objects of the cathodic protection system shall be insulated from the other structures and above ground pipes by insulation flanges, insulation sheet or equivalent in order to minimize the spilt current.
- 11.7. Soil investigation shall be carried out to determine the soil resistivity and corrosivity.

12. ELECTRICAL HEAT TRACING

- 12.1. Electrical heat tracing shall be provided if warranted during detail engineering by EPCC Contractor.
- 12.2. EPCC shall Design, supply and install, Testing, pre-commissioning, commissioning and start-up of all equipment and material for the execution of the Electrical Heat Tracing system.
- 12.3. Trace heating shall nominally be carried out using self regulating tape. Where the requirements of the trace heating system are outside the limits of self regulating tape constant wattage type shall be utilized. Heat tracing method shall be as per manufacturer recommendation subject to OGDCL / Consultant approval.
- 12.4. Electric power for heat tracing junction box / or distribution box shall be supplied from emergency source and will be confirmed during detail engineering By EPCC Contractor and accordingly all the relevant document / drawings will be developed for OGDCL / Consultant approval.
- 12.5. Supply feeder characteristics are 230Vac, single phase and neutral

13. IDENTIFICATION

- 13.1. All distribution boards and isolators shall be identified with circuit designations and source of incoming supply. Lighting switches on large installations shall also be identified.



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- 13.2. Labels for indoor or weather protected areas shall be white-black (or red) – wire, laminated plastic with lettering engraved to show the middle layer. Identification and instructions shall be in black lettering. Warning or danger shall be in red.
- 13.3. Fixings shall be screws or rivets, adhesive methods are not permitted. Enclosures of Certified Apparatus in hazardous areas shall not be drilled. Labels shall be mounted alongside the equipment. Other enclosures may be drilled to affix labels subject to the prior approval of OGDCL / Consultant, provided the degree of protection is maintained.

14. CARE OF EQUIPMENT

- 14.1. Equipment removed from covered storage or packaging may not necessarily be fully protected until installation has been completed. Conduit and gland entries and removable covers are particular examples of this and arrangements shall be made, and maintained, to ensure protection against the effects of local weather and construction environment.
- 14.2. Particular attention shall be paid to protect and safeguard equipment and materials installed in outdoor locations and unfinished buildings. Such equipment is vulnerable to damage during plant construction. Covers which are temporarily removed during installation shall be reassembled correctly on completion of work and replaced when such work is suspended or otherwise left incomplete, even for short periods e.g. meal breaks. Similarly all cable entries shall be effectively sealed at all times. Unused conduit cable entries shall be permanently sealed by the insertion of stopper plugs.
- 14.3. Machined flanges of flameproof equipment installed in exposed position shall be liberally treated with a coating of approved grease unless such equipment has been factory treated and the flanges left unbroken during erection procedure. Any grease seal, which has been broken during installation, or during testing and commissioning procedures, shall be re-established.
- 14.4. Anti-condensation heaters shall be energized from the temporary construction supply until the permanent installation is energized. Isolation and warning labels shall be provided. OGDCL / Consultant may require temporary heating facilities to be provided for other equipment. Such heaters as are needed shall be safe and adequate for the purpose, cause no risk of fire to adjacent materials and rigidly secured. Lamps shall not be allowed to be used as heaters.

15. TESTING & INSPECTION

- 15.1. Inspection, testing and pre-commissioning & commissioning shall be carried out in accordance with a Field Testing Inspection and Pre-commissioning & commissioning Specification to be issued by the EPCC Contractor. The specification shall be subject to approval by OGDCL / Consultant.
- 15.2. Certificates of Test shall be compiled, for each section of the installation. A master set of these documents shall be kept as the original of the Test Dossier. This dossier will bear the signatures of OGDCL's / Consultant's representative witnessing the tests.



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- 15.3. All tests shall be carried out by suitably qualified and experienced staff using recently calibrated test equipment provided by the EPCC Contractor.
- 15.4. Notice of testing shall be given in reasonable time (24 hours minimum) to allow the tests to be witnessed by OGDCL's / Consultant's representative.

16. ASSOCIATED CIVIL WORKS

16.1. The expression 'Associated Civil Works' shall mean civil Works in relation to electrical Works to be carried out by the EPCC Contractor. The installation Works shall adhere to drawings prepared during detailed design phase giving details of all fixings, bases and other civil Work requirements. Following are some of the main Works to be carried out by the EPCC Contractor:

- Excavation / formation of trenches, etc., and the filling in of it properly after the cables are laid, including lying of sand and brick tiles. (If required).
- Excavation for underground cable ducts and covering / back filling. (If required)
- Construction of earthing pits, etc.
- Cutting and forming of chases, recesses, holes for conduits or pipes, or conduit or pipe fixings through walls, floors, ceilings, partitions, roofs, etc., and making them good.
- Construction of Equipment foundations and light poles, LCS, welding outlet.

16.2. All the civil work required for the aforementioned activities i.e. pole foundation, structure mounted equipments foundation, direct buried trenches, floor cuttings & reinstatement work is also covered in EPCC Contractor scope even not mentioned in tender document. Cutting, Fitting, Repairing, patching or plastering and finishing of Work, shall be done by craftsmen skilled in their respective trades. When cutting is required, it shall be done in such a manner so as not to weaken structure, partitions or floors.

17. AS-BUILT DRAWINGS

17.1. During the progress of the installation work, the EPCC Contractor shall maintain a set of master drawings on which EPCC Contractor shall record as-built changes to the design as the installation proceeds. These drawings shall also be used to record all changes agreed with OGDCL / Consultant on site.

17.2. On completion of the installation, inspection and testing procedures, the EPCC Contractor shall furnish to OGDCL / Consultant, as-built issues of all contract drawings. One reproducible and two prints of each drawing will be required for the approval of OGDCL / Consultant.