




OGDCL PAKISTAN:
OIL & GAS DEVELOPMENT
COMPANY LIMITED

KPD-TAY COMPRESSION PROJECT

ISSUED FOR TENDER

0	07-JAN-2022	ISSUED FOR TENDER	JAB	ZHW	AIB	MPM	MAS		
A	29-OCT-2021	ISSUED FOR REVIEW	JAB	ZHW	AIB	MPM	MAS		
REV	DATE	DESCRIPTION	ORIG	CHKD	LE	QA	PM	LPE/TA	
REVISIONS			APPROVAL					OWNER APPROVAL	
<div></div> <div>ENAR Petrotech Services (Pvt.) Limited , 7-B , Sector 7-A , Korangi Industrial Area , Karachi Pakistan</div>		<div>TITLE:</div> <div>SPECIFICATION FOR EARTHING & LIGHTNING PROTECTION SYSTEM</div>							
		PROJECT NUMBER 14-0258		DOCUMENT NO: 0258 – ELA – 6504 – 0					
PROJECT CODE			DOC. TYPE		SEQ. NO.		REV		



CLIENT : OIL & GAS DEVELOPMENT COMPANY LIMITED

PROJECT : KPD-TAY COMPRESSION PROJECT

**SPECIFICATION FOR
EARTHING & LIGHTNING PROTECTION SYSTEM**



OIL & GAS DEVELOPMENT COMPANY LIMITED
KPD-TAY COMPRESSION PROJECT
SPECIFICATION FOR
EARTHING & LIGHTNING PROTECTION SYSTEM

DOC NO: 0258-ELA-6504
PAGE: 3 of 16
REV: 0
DATE: 07-JAN-2022

TABLE OF CONTENTS

1. PURPOSE4

2. REFERENCE STANDARDS & CODES7

3. SERVICE CONDITIONS8

4. EARTHING & LIGHTNING PROTECTION SYSTEM8

5. DOCUMENTATION REQUIREMENTS.....15



SPECIFICATION FOR EARTHING & LIGHTNING PROTECTION SYSTEM

1. PURPOSE

This specification is intended to specify the basic requirements for design, engineering, selection, sizing, supply, inspection and testing of Earthing & Lightning Protection System which deemed necessary for defining minimum requirement at preliminary stage and shall not be considered comprehensive and final for procurement. This specification does not absolve the CONTRACTOR from his responsibility of supplying, installing and commissioning suitable Earthing & Lightning Protection System complete in all respect. The CONTRACTOR shall develop detailed datasheets, specifications, ITP and installation details for the offered Earthing & Lightning Protection System based on this specification and submit to the COMPANY/CONSULTANT for approval during detailed engineering stage.

The offered Earthing & Lightning Protection System shall comply with the *Reference Standards* and *Codes*. Where the manufacturer's standards differ from other supplementary requirements of this specification details shall be submitted to the COMPANY/CONSULTANT for approval.

In case discrepancies are found between this specification and other documents, COMPANY/CONSULTANT shall be referred for correct interpretation.

1.1. Definition

Where used in this specification, the following terms shall have the meanings indicated below unless otherwise clearly indicated by context of their use.

COMPANY – Oil & Gas Development Company Limited (OGDCL)

CONCESSION REQUEST - A deviation requested by the CONTRACTOR or VENDOR, usually after receiving the contract package or purchase order. Often, it refers to an authorization to use, repair, recondition, reclaim, or release materials, components or equipment already in progress or completely manufactured but which does not meet or comply with COMPANY/CONSULTANT requirements. A Concession Request is subject to COMPANY/CONSULTANT approval.

CONTRACTOR - The party which carries out all or part of the design engineering, procurement, construction and commissioning or management of the project.

DRAWINGS - Drawings provided by the CONTRACTOR/VENDOR.

SUPPLIER/MANUFACTURER - The party which manufactures and/or supplies the material/equipment, and provides technical documents/drawings and services to perform the duties specified by the COMPANY/CONTRACTOR.

PROJECT – KPD-TAY Compression Project



1.2. Errors & Omissions

- The review and comment by COMPANY/CONSULTANT of any CONTRACTOR's/VENDOR's drawings, procedures or documents shall only indicate acceptance of general requirements and shall not relieve the CONTRACTOR/VENDOR of its obligations to comply with the requirements of this specification and other related parts of the Contract Documents.
- Any errors or omissions noted by the CONTRACTOR/VENDOR in this Specification shall be immediately brought to the attention of COMPANY/CONSULTANT.

1.3. Deviations

- All deviations to this Specification, other related specifications or attachments shall be brought to the knowledge of COMPANY/CONSULTANT as a section in the bid. All deviations made during the procurement, design, manufacturing, testing and inspection shall be with written approval of COMPANY/CONSULTANT prior to execution of Work. Such deviations shall be shown in the documentation prepared by the CONTRACTOR/VENDOR.

1.4. Conflicting Requirement

- In the event of any conflict, inconsistency or ambiguity between the CONTRACTOR's/VENDOR's scope of work, this Specification, National Codes and Standards, and referenced in the Project Specification or any other documents, the CONTRACTOR/VENDOR shall refer to COMPANY/CONSULTANT whose decision shall prevail.

1.5. Reporting Procedure

- A reporting and documentation system shall be agreed between the CONTRACTOR/VENDOR and COMPANY/CONSULTANT for the status of procurement, design, manufacturing, inspection, testing and shipment of the equipment/material to be supplied under this specification. The CONTRACTOR/VENDOR shall provide reports and summaries for production performance and testing operations in conformance with a manufacturing schedule approved by COMPANY/CONSULTANT.
- Daily, weekly, monthly and run summaries of all major aspects of the production process shall be provided as reports to COMPANY/CONSULTANT.

1.6. Third Party Inspection:

- In addition to the inspection and witnessing of tests by the inspectors to be appointed by the COMPANY/CONSULTANT during the manufacturing and shipment of the equipment/material, COMPANY/CONSULTANT may appoint a third party or its own inspector for witnessing of the inspection and tests to be carried out at VENDOR's facility under this specification.
-



**SPECIFICATION FOR
EARTHING & LIGHTNING PROTECTION SYSTEM**

- Information w.r.t inspection and testing purposes as per applied reference Standards and Codes shall be submitted to COMPANY/CONSULTANT.

1.7. Unit Responsibility

- The CONTRACTOR / VENDOR shall be responsible for the complete design, manufacture, supply, inspection, and testing of Earthing & Lightning Protection System, including full compliance with all applicable design codes and standards, including those listed in Section-2 of this document and the requirements of the certifying authority, if applicable. The CONTRACTOR/VENDOR shall handle and expedite drawings and data, and supervise and coordinate all inspection and testing.
- The CONTRACTOR/VENDOR shall guarantee that all material and parts included in construction of the specified Earthing & Lightning Protection System shall be new, unused and of the required/ specified grade.

1.8. Documentation

- Documents, calculation/data sheets, technical details, etc., to be submitted to the COMPANY/CONSULTANT shall be in English Language.
 - Unless otherwise specified, the metric units shall be used in documents and drawings by the CONTRACTOR/VENDOR.
 - The form of drawings and documents may be as per the CONTRACTOR/VENDOR's Standards. However, the format of the data sheet will be submitted to COMPANY/CONSULTANT for approval.
 - Variations from or additions to this specification shall be called to the attention of the COMPANY/CONSULTANT and approved in writing by the COMPANY/CONSULTANT prior to starting manufacturing.
 - Comments made by COMPANY/CONSULTANT on drawing/technical details submittal shall not relieve the CONTRACTOR/VENDOR of any responsibility in meeting the requirements of the specifications.
 - Such comments shall not be construed as permission to deviate from requirements of the Purchase Order unless specific and mutual agreement is reached and confirmed in writing.
 - The CONTRACTOR/VENDOR shall notify the COMPANY/CONSULTANT of any apparent conflict between this specification, the related data sheets, the Standards & Codes and any other specification noted herein. Resolution and or interpretation precedence shall be obtained from the COMPANY/CONSULTANT in writing before proceeding with the design manufacture.
-

**SPECIFICATION FOR
EARTHING & LIGHTNING PROTECTION SYSTEM****2. REFERENCE STANDARDS & CODES**

The Earthing & Lightning Protection System supplied by the CONTRACTOR/VENDOR shall comply with this Specification, and material selection shall confirm to the relevant and latest version of the following reference Standards and Codes.

It shall be manufacturer's responsibility to be, or to become, knowledgeable of the requirements of these reference Standards and Codes. Any changes, alteration and necessary re-certification of the equipment for compliance with the applicable Standards and Codes shall be at the expense of the Manufacturer.

STANDARD	DESCRIPTION
IEC 60364-5-54	Low-voltage Electrical Installations Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors
IEC 60364-5-548	Low-voltage Electrical Installations Part 5: Selection and erection of electrical equipment – Section 548: Earthing arrangements and equipotential bonding for information technology installations
IEC 61024	Protection of Structures against Lightning
IEC 62305	Protection against Lightning
IEC 61000-5-2	Electromagnetic Compatibility (EMC) - Part 5: Installation and Mitigation Guidelines - Section 2: Earthing and Cabling
IEC 60079-14	Electrical apparatus for explosive gas atmospheres, Part 14: Electrical installations in hazardous areas (other than mines)
API RP 540	Electrical Installations in Petroleum Processing Plants
API RP 2003	Protection against Ignitions Arising Out of Static, Lightning, and Stray Currents
BS 7430	Code of Practice for Earthing
BS 7671	Requirements of Electrical Installation (Wiring Regulations)
IEEE Std 80-2013	IEEE Guide for Safety in AC Substation Grounding
NFPA 780	Installation of Lightning Protection Systems

In the event of conflict between Standards, the most stringent shall prevail.

All standards, regulations and codes of practices used shall be of latest current issues at the date of contract award.

The CONTRACTOR/VENDOR shall be responsible for the availability of the above mentioned specifications/publications, standards, and codes of practices and any other relevant documents and shall collect these documents on its own. The CONTRACTOR/VENDOR shall make sure that these documents are available all times and shall submit/present to COMPANY/CONSULTANT on request.

**SPECIFICATION FOR
EARTHING & LIGHTNING PROTECTION SYSTEM****3. SERVICE CONDITIONS****3.1. Site Conditions**

Electrical design shall be based on the following environmental conditions:

PARAMETERS	VALUE/UNIT
MAXIMUM AMBIENT TEMPERATURE	118 °F
MINIMUM AMBIENT TEMPERATURE	36 °F
WET BULB TEMPERATURE (DESIGN)	88 °F
MAXIMUM RELATIVE HUMIDITY	77%
MINIMUM RELATIVE HUMIDITY	20%
WIND VELOCITY	101 (Miles/Hour)
ELEVATION ABOVE MEAN SEA LEVEL (GPF)	250 ft.
SEISMIC ZONE	Zone 2A of Uniform Building Code- UBC-1997.

3.2. Power Supply Characteristics

The rated characteristics of the power supplies are:

PARAMETERS	VALUE/UNIT
VOLTAGE	400 V ac \pm 10%, 3-PHASE 230 V ac 1-PHASE
FREQUENCY	50 Hz \pm 2Hz
NEUTRAL SYSTEM	SOLIDLY EARTHED

4. EARTHING & LIGHTNING PROTECTION SYSTEM

Earthing & Lightning Protection System will consist of the following:

- Earthing Network
- Electrical System Earthing
- Earthing Connection and Bonding (Equipment Earthing)
- Earthing Electrode
- Bonding for Electrostatic Discharge
- Instrumentation Earthing
- Lightning Protection

4.1. Earthing**4.1.1. Earthing Network**

In general, the earthing system shall be provided within the plant limits as per project requirement. The earthing network shall be installed around substation, process units, structures, switch racks, and other electrical installation. The earthing network shall consist of an earth main, earthing branch cables from earth main to individual earthing connection, and

**SPECIFICATION FOR
EARTHING & LIGHTNING PROTECTION SYSTEM**

earth electrodes. The earth main reference network shall be laid directly in the ground. Subsequently, this shall also include the laying of a number of sub-earth loops and rings provided for project packages (individual earthing connections). The earthing network system shall be interconnected with the existing main network to achieve the equipotential bonding resistance values i-e less than 1 (one) ohm.

All metallic non-current carrying parts of Switchgear/MCC panels and DBs, generator's frame, motors, cable armouring, cable trays, etc. shall be earthed. For protection against build-up of electro-static charges, tanks, vessels, pipe work, structural steel work and other conducting metal not forming part of an electrical equipment enclosure shall be bonded together and earthed.

Conductors for the earthing network i-e earthing main conductor and sub-loops shall be bare stranded copper conductor, and Yellow/Green PVC insulated copper conductor respectively as per project requirement.

The sizes of earthing cables shall be standardized and the number of the sizes be minimized as far as possible. Conductor size of main earth loop and sub-loops cable shall be sized as per BS-7430 to satisfactorily carry the fault current.

Interconnections in earthing network shall be directly clamped with compression type branch connectors for above ground installation and thermo-welded for underground installation.

Minimum depth requirement of the buried earthing conductor shall be 500 mm below ground level.

The CONTRACTOR shall ensure that the system network earth resistance must be less than 1 ohm; in case the minimum low value of network earth resistance less than one (1) ohm cannot be achieved, then earthing network will be supplemented by additional copper earth rods (multiple earth pits shall be made and joined) driven to a depth to achieve minimum earth resistance of less than one (1) ohm. The CONTRACTOR to refer typical installation detail drawings for earth electrode rod and pit design/construction.

Earthing conductors that emerge from below grade shall be protected with rigid steel conduit of minimum 150 mm (6") length; and any exposed above-grade ground conductors shall be protected to minimize mechanical damage.

All equipment and structures will be fitted with one or more earth bosses which will be bonded via earth conductor to the nearest electrical system earth bar or earth grid.

**SPECIFICATION FOR
EARTHING & LIGHTNING PROTECTION SYSTEM**

Electrical equipment and other equipment with electrical devices (such as packaged equipment) shall be individually bonded or earth.

4.1.2. Electrical System Earthing:

Earthing system to be carried out by the CONTRACTOR as per reference standards and national standards as applicable.

Main distribution transformer system shall have secondary solidly grounding system.

The neutral earthing for the transformer shall be connected to the earthing network.

Conductors for transformer neutral earthing shall be sized in accordance with the maximum fault current flow. Exposed conductors for transformer neutral earthing should be insulated at the voltage foreseen.

4.1.3. Earthing Connection and Bonding (Equipment Earthing)

The primary purpose of equipment earthing is to limit the difference in potential between personnel and metallic objects that might accidentally become energized in the event of a short circuit or ground fault within the equipment or wiring system.

Equipment earthing requires the connection to earth exposed conductive parts i.e the enclosures of electrical equipment, such as motors, DBs, control cabinets, and all metallic non-current carrying parts of the wiring system and equipment, etc., to earth, to ensure that they cannot reach a dangerous voltage with respect to any adjacent structure or component under fault conditions as cited above.

Generally, following items shall be connected to the earthing network:

- Motor frame
 - Non-current carrying metallic parts of electrical equipment and installations, such as enclosures for switchgear, motor control centers (MCC), auxiliary panels, control cabinets, CP transformer rectifiers and lighting distribution panel boards, heat tracing DB. All sort of fences i.e Substation fences, and transformer yard fences, plant entrance/exit gates (if requirement exists) shall also be connected to earthing network.
 - Tanks and process vessels
 - Coolers Fans
 - Junction Boxes
 - Local Control Station (LCS)
 - Welding Outlets
 - Area/Skid Lighting Poles
-



- Skid of packaged equipment containing electrical devices
- The metal framework of structures, piping earthing, pip-rack, buildings and housings
- Exposed conductive materials enclosing electrical conductors, such as metallic armor and sheaths of cable, metallic shields of cable, cable trays and racks, and bus duct enclosures
- The earthing strip in switchboards

Minimum criteria are followed as mentioned in API RP-2003 against accumulation of static charges

Minimum size requirement of electrical bonding conductor shall be 6 sq.mm

All earthing conductors shall be stranded copper conductor, Green/ Yellow PVC insulated.

Earthing conductors leaving the ground shall be protected by PVC conduit.

4.1.4. Earthing Electrode

The most commonly used type of electrode is the rod, which can be driven into the ground by a power driven hammer.

The earth resistance achievable, for given soil conditions, is mainly dependent upon the length of conductor incorporated in a horizontal grid or radial arrangement, the area, and the depth and spacing of rod electrodes.

Earth electrodes shall be of the extensible, solid copper rod type. Rods designed to meet the requirements of BS 7430 or equal shall be used.

Rods, couplers, driving tips and driving heads shall all be compatible.

Suitably sized, compression type cable lugs shall be used for all terminations to earth bus bars, equipment earth bosses, etc.

Suitably sized, tin plated copper compression type tap connectors shall be used for connection of branch conductors (or similar) to the earth ring conductor.

Suitably sized, mechanical, tin plated copper clamp type connectors shall be used for connections to earth electrodes. Connectors shall be purchased from the rod electrode manufacturer to ensure compatibility.

Connections of earth main to electrodes shall be in concrete hand-holes to facilitate inspection. Earth bus bars shall be fabricated from 300×50×5mm hard-drawn copper bar and tinned to prevent atmospheric corrosion.



Earth electrode inspection pits shall be provided and comprise a surround with removable cover.

The cover shall be fitted with a non-corrodible lifting handle or ring to aid removal.

Earth electrode pits shall be clearly identified as such by an appropriate label on the lid of earth pits and sufficient maintenance access to the earth electrode pit shall be provided.

PVC insulated earthing cables shall be supplied and installed within the new defined scope. This should be noted that the project earthing pits shall be constructed away from Cathodic Protection (CP) lines at a minimum defined space/distance as recommended by CP Vendor in case of presence of exiting bare earth conductor.

4.1.5. Bonding for Electrostatic Discharge (Static Electricity)

Static electricity is generated when liquids or gases move in contact with other materials. This is a common occurrence when liquid is being moved through pipes, mixed, poured, pumped, filtered, or otherwise agitated. Other causative processes include the settling of solids or immiscible liquid through a liquid, the ejection of particles or droplets through a nozzle, and the splashing of a liquid against a solid surface.

The charge generated will not be a direct hazard to personnel, although the reaction to the discharge of static electricity could initiate an accident. However, the risk of ignition of flammable substances through the accumulation of static electricity shall be taken into account.

The most important measure to prevent electrostatic hazard is to bond all metal objects together, eliminating risk of discharge between objects, and to assure that all components in a system handling flammable substances are at the same electrical potential.

Generally, the earthing and bonding arrangements provided for electrical safety will ensure adequate protection against the accumulation of static electricity.

Additionally, bonding straps for the control of static electricity are required for tanks, process plant and piping systems for flammable liquids and gases, which are not permanently connected to earth network of the plant, either directly or via their bolted or welded supports.

They may also be required for metallic components located in hazardous areas and in contact with insulating material (such as hoses, non-metallic gratings, etc.) where a mechanism for the generation of a static electrical charge by fluid flow or friction, exists.

Bonding straps for the control of static electricity shall be robust and are to comply with the relevant requirements for security and accessibility of connection and resistance to corrosion.



4.1.6. Instrumentation System Earthing

The primary goal of an earthing system is to assure safety against shock and the mechanical and thermal effects of electrical faults. However, an earthing system is also required to serve as a common voltage reference and contribute, by providing a path for return currents resulting from a source of disturbances, to the mitigation of disturbances in installations with sensitive and interconnected electronic and electrical systems.

It is recommended that instrument earthing system should not be connected to the main earth electrodes; mainly depending upon the manufacturer's recommendation.

4.1.7. Intrinsic Safety

All instrument cabinets containing intrinsically safe barriers, where barrier earthing outside a hazardous area is a requirement of the certification, shall contain an earth bar which shall be connected to the separate earth electrodes. The minimum requirements for these connections may be set out in the certification documentation or in the relevant code of practice or standard. It is commonly recommended that two cables of at least 4mm² cross-sectional area should be provided, to facilitate testing without total disconnection of the intrinsic-safety earth, and that the resistance of the earth connection should not exceed one (1) Ohm.

This includes information on earthing the following:

- Cable Shields
- Programmable Logic Controller (PLC)
- Unit Control Panels (UCPs)
- Intrinsic Safety Barriers
- Thermocouples and other Field Devices

Separate Clean Earth Pits shall be constructed/provided by the CONTRACTOR for Unit Control Panels (UCPs) at field mainly depending upon the manufacturer's recommendation; whereas for Control Cabinets separate earth bars shall be provided from existing safety grounding system.

4.2. Lightning Protection

4.2.1. General

Lightning protection shall be carried out as per detail engineering layouts (to be developed by the CONTRACTOR during the detail engineering after carrying-out risk assessment study for lightning protection as per IEC standards), to protect personnel, buildings and equipment from the electrical, thermal and electro-magnetic effects of lightning strike:

The principles of lightning protection are well known and straightforward: a metallic path is provided from the point which may be struck, to earth; this conductor is of adequate cross-

**SPECIFICATION FOR
EARTHING & LIGHTNING PROTECTION SYSTEM**

section to dissipate the stroke with minimum damage; adjacent metallic structures or equipment are earthed so as to allow induced charges to be safely dissipated.

Lightning protection, as described above, require the following elements to be in place, either as dedicated items or as secondary properties of the construction of the structure or equipment:

- Air Termination Network (Air-termination rods & accessories)
- Copper Conductors
- Earth Termination Network
- Bonding (to prevent side flashing)
- Lightning Strike Counter
- Test Joint Boxes

Prior to design of lightning protection system a lightning protection assessment study (Risk Assessment) shall be carried out by the CONTRACTOR which shall define the requirement and extent of lightning protection system (Zone of Protection). This study shall be carried out as per guidelines of BS EN/ IEC 62305-2 and API-545, and shall be submitted to COMPANY/CONSULTANT for review and record.

The “Zone of Protection” offered by the arrangements is the volume under and around the arrangement of air terminals which is considered to be at negligible risk of direct strike.

The extent of the Zone of Protection in terms of a sphere with a defined radius should be determined in accordance with the applicable Standard or Code.

This shall be responsibility of the CONTRACTOR; necessary to analyse the “Zone of Protection” for all directions around a structure, not just one side. Corners particularly require consideration, since these are known to be favourite targets for lightning stroke.

Any structure, tank, compressor skids, or other items may be considered to be adequately shielded against lightning as per reference Standard & Code.

Structures and equipment outside the protection zones (if any) shall be directly earthed at the point as close to the base as possible.

Where dedicated air terminals are provided, these will generally take the form of pointed rods or pipes, generally from 0.25m to 2m in length. The terminals are preferably to be of solid copper.

The bases of the air terminals will be constructed so as to permit the necessary interconnections between terminals and between the network and the down conductor.

**SPECIFICATION FOR
EARTHING & LIGHTNING PROTECTION SYSTEM**

Air terminals are connected together and run to ground by means of down conductors. The conductor sizing should be in accordance with the applicable code or standard. Minimum cross sectional area of down conductor shall be 35mm².

The radii of any bends in down conductors, or interconnections between air terminals, should be as great as is practicable, not less than 200mm, since sharp bends increase the reactance of the conductor.

Down conductors shall be located in accordance with the location of the air terminals, the size of the structure being protected, and the most direct routing to the earth electrode.

The down conductors should be secured to the exterior of the structure at intervals, typically 1m or less, as recommended by the Supplier of the lightning protection system, using purpose-made fastenings appropriate to the size and material of the conductor.

It is recommended that Test Joints be included within the run of each down conductor, to facilitate measurement of system resistance and verification of the integrity of the lightning discharge path.

Each down conductor must have a separate earth termination to an earth electrode. Earth pit main conductor loop shall be interconnected with plant main earth reference network.

The most commonly used type of electrode is the deep driven earth rod. Earth electrodes shall be of the extensible, solid copper rod type. Rods designed to meet the requirements of BS 7430 or equal shall be used. Earth rods, couplers, driving tips and driving heads shall all be compatible.

The copper earth rods should be spaced at a distance at least equal to their driven depth.

It is necessary to ensure that the lightning earth electrode resistance does not exceed the defined value as per recommended in to reference Standards & Codes.

Metal work such as metal cladding, metal roofs etc, in the vicinity of a down conductor may require to be bonded to it.

Bonding of metal handrails, window frames and door frames near to down conductors may also be necessary.

5. DOCUMENTATION REQUIREMENTS**5.1. Design Documentation**

The Contractor shall provide sufficient information for the construction of an adequately earthed and bonded installation. The information provided should include:

**SPECIFICATION FOR
EARTHING & LIGHTNING PROTECTION SYSTEM**

- Identification of the types of distribution system present in the installation (e.g. IT, TN-C-S);
- The principles of the earthing and bonding arrangements adopted;
- A plan showing the main earth electrode arrangements;
- Calculations of earth electrode resistance / Earthing Calculation;
- Cable route drawings, showing the layout and size of all Protective Conductors;
- Drawings showing the nature, dimensions, materials and position of all component parts of the lightning protection system;
- The nature of the soil and any special earthing arrangements;
- Detail drawings of connection arrangements for typical structures and items of equipment.

5.2. Construction Documentation

During construction, documented audits shall be carried out, if necessary before power and instrumentation cables are terminated, to ensure the earthing system is being installed correctly, that the design adequately covers all plant and equipment and that, where deviations from the design are required these are properly authorized and recorded. This, in particular, confirm:

- The adequacy of electrical connections;
- The correct size and type of conductor, for earthing conductors, Protective Conductors and main and supplementary Equipotential Bonding conductors;
- Provision of warning notices both in English (e.g. "Safety Earth – Do Not Disconnect") and in the local language
- Means of identification of conductors.

Test Documentation

At completion of construction and prior to bringing the plant into commission, measurement and recording of the following values shall be carried out to prove the earthing system will operate as the designer intended:

- Earth electrode resistance;
- Resistance to earth of each complete lightning protection earth termination system;
- Continuity and resistance of Protective Conductors, including main and supplementary bonding;
- Earth loop impedances.

The measurements shall include tests made between adjacent conductive surfaces and the earthing system to ensure good metal to metal contact exists and continuity tests across every bonding cable without disconnection of the bond. The tests shall be sufficient to prove the earthing system conforms, in all respects, with the requirements of the design. The results and readings shall be recorded for future maintenance use.
