HI-CALIBER ELECTRICAL DESIGN

ELECTRICAL SAFETY AUDIT PROPOSAL

Contents

1. INTRODUCTION

Electrical safety audit is an activity to examine the Electrical installation suitability for the continued use. As per National Crime records bureau more than a dozen deaths are recorded per day due Electrical related fire accidents. Today we cannot think of our life without Electricity usage, at the same time we cannot ignore the dangers involved in it because, Electricity cannot be smelt, heard or seen.

Electrical Safety Audit brings out the non compliances of an Electrical installation to the management, detects the incipient faults in the system, so that corrective actions can be initiated to avoid the major mishap.

2. WHY ELECTRICAL SAFETY AUDITS?

Periodic inspection and testing of an electrical installation is an imperative activity, to maintain the Electrical systems in safe condition. Electrical safety audit mainly constitutes inspection and testing activity. As directed by the Indian Electricity Rules-1956 (2000 amendment), Electrical installations should be subjected to periodic safety audits at regular intervals to identify the deformations in the installations, which impair safety.

Generally, the audit frequency will depend on the nature and type of activities within each area of operation. A reasonable general guide is that inspections should be carried out once each year, with more frequent inspections for specific areas or activities. Records of injury and damage accidents should be examined and use to identify high-risk areas and activities and consequently those needing more frequent inspection.

3. CODES AND STANDARDS

The Electrical safety audit is based on all or any of the following as per client specific requirements

- 1956 IE Rules / Electricity Act – 2003 / National Electricity Code – 2011
- National Building Code – 2005 (Indian)
- Bureau of Indian Standards
- National Electricity Code - 2011 / NFPA - 70 (American)
- BS 7671 : 2008 (2011) – IEE Wiring regulations
- Oil Industry Safety Directorate – OISD 137 – Inspection of Electrical equipment
- (for Oil & Gas facilities)
- Central / Local Electric Inspectorate recommendations and Electricity board/Power supplier requirements

NOTE: ALL THE ABOVE STANDARDS/CODES HIGHLIGHTS THE IMPORTANCE OF ELECTRICAL SAFETY AUDIT (PERIODIC INSPECTION & TESTING) FOR SAFE ELECTRICAL INSTALLATIONS

4. DANGERS OF ELECTRICITY

There are mainly 4 types (2 direct & 2 indirect) of Electrical injuries

- Electrocution or death due to direct Electric shock
- Burns due to direct arc flash over and sparks
- Falls and jerks (indirect)
- Sudden unbalanced reactions
  due to the feel of mild/significant Electric shocks (cuts & bruise, leg/hand bone fracture, head injury mainly due to falls from ladder or from heights) - indirect injury due to Electric shock

ELECTRIC SHOCK

- Electrical shock is received when current passes through the body
- Person gets an Electric shock if part of the body completes the Electric circuit by :
  - touching a live wire and an electrical ground
  - touching a live wire and an another wire at different voltage

EFFECTS OF ELECTRIC SHOCK

- 0.5mA – 6mA tingling sensation 'Threshold of perception'
- Currents above 10mA can paralyze or "freeze" muscles
- 10mA – 16mA muscular contraction can happen, this is 'Threshold of danger'
- 30mA – 60mA & above prolonged exposure can be FATAL , Death can occur in a fraction of a second
- Currents more than 75mA can cause a rapid, ineffective heartbeat -- death will occur in a few minutes unless a defibrillator is used

5. SCOPE OF ELECTRICAL SAFETY AUDIT

Electrical Safety Audit is broadly divided into 5 major parts namely:

- Pre Audit
- Circuit identification & labelling (Single line diagram)
- Visual Inspection
- Testing
- Post Inspection & Testing
- Management Briefing

a) Pre Audit

The scope of Electrical Safety Audit to be well defined, so that the objectives are well achieved. Highlighting the scope is the first step in audit. This part of work mainly consists of visual inspection and review of electrical safety systems and verification of documents related to electrical safety.

Typical scope of work could include:

- Physical visual inspection of the plant with reference to the applicable Indian standards, Indian Electricity rules and other international codes of practice.
- Reviewing of the role of electrical safety in the total safety system
- Review of protection devices of the electrical installation
- Examination of adequacy of Building lightning protection system
- Review of hazardous area classification
- Review of electrical accidents to identify root cause of the accidents
- Review of Electrical preventive maintenance program & to examine the documentation, check lists, work permit, energy consumption recordings etc.,
- To identify training needs for the maintenance personnel.
- To evaluate the earthing system
- To review the test results of Transformer oil, Insulation resistance and Earth resistance tests.

The details that would help the audit team in inspection & certification to be acquired during this stage from the client.
These could be the following:

- Process details
- Electrical single line diagram (as built)
- Name plate details of major electrical equipment
- Details of classified zones
- Details of flammable chemicals handled
- Details of addition / expansion in the premises including electrical installation
- Overview of electrical maintenance system

b) Visual Inspection

During this phase, Inspector does thorough visual inspection (based on the Annexure) at the client premises. Visual Inspection check list is made with reference to statutory regulations, international standards and the best engineering practices. The factors listed below are considered while suggesting a recommendation.

- Compliance to statutory requirement
- Safety of the people and the plant

The Visual condition Inspection contains following sections

- Distributor's/Supply intake equipment
- Earthing / Bonding arrangements
- Consumer unit(s) / Distribution board(s)
- Final circuits
- Locations containing bath or shower
- 11 KV / 433 V substation
- Electrical room
- Backup Generator (Diesel Generator – DG set)
- Uninterrupted power supply unit (U P S)
- Emergency Lighting
- Power supplies to Fire alarm systems and Public address systems

- Passive fire protection
- Lightening protection

During this stage, the incoming electrical supply receiving section (Outdoor station and main transformer) is inspected first. Then the main electrical room housing PCCs or MCCs and the cable shaft is inspected. Next are the Diesel Generator, UPS rooms and other electrical equipment's are inspected. The aspects such as MCB DBs, circuitry, earthing and Lightening protection, maintenance condition, loose cabling, temporary wiring, electrical fire hazards, shock potential etc., are critically looked into. The check list provided here is rather a comprehensive attempt, covering almost all electrical safety aspects.

The verification of the actual installation against available drawing (such as electrical single line diagram, earthing layout, etc.,) is also carried out during the field visit

Discussion with safety and Electrical safety personnel is carried out during the field visit. A senior electrical engineer and preferably, safety officer from the client side should also be part of this inspection team. Clarifications help to ascertain facts and to understand the system in a better manner. The on-site interaction will help to clear many doubts and to suggest many practical solutions to the client.

All the relevant maintenance documentation, test records, electrical records, earlier inspection reports, OEM (Original Equipment Manufacturer) service manuals, history cards are subjected to detailed examination. All the relevant drawings (electrical single line diagram, earthing layout, hazardous area classification drawings, protection system schematic, equipment layout, lightning protection drawings) are also checked against actual installation and commended upon, with reference to applicable standards.

c) Testing

Testing is carried out using various instruments to determine insulation resistance for power circuits, polarity, phase sequence, earth resistance and residual current etc., as required to assess the condition of the installation. Parts of Testing are given below:-

1. Continuity Test
2. Voltage test
3. Polarity test
4. ELCB Test
5. Earthing leakage test
6. Load unbalancing Test
7. Earth fault loop impedance test
8. Earth electrode resistance test
9. Insulation resistance test
10. Illumination Test
11. N-E voltage test

Testing is done on only few circuits, distribution boards, switch gears and earthing not for the entire installation as this is practically impossible. Test results are tabulated in Annexures (like Annexure-1 Schedule of Inspection Result for Distribution Board / Panels, Annexture-2– Schedule of ELCB/ELR Test Results & others)
*Insulation resistance will be checked as per site conditions &Power isolation timings for Panel/DBs

d) Post Inspection & Testing

Post field study, Inspection & Testing results are compiled, either during testing and inspection period itself or within the agreed period of time. These schedule of reports provides information about the values of specific electrical parameters which helps in expressing the healthiness of the installation. This also lists out the immediate actions to be taken for certain improper or non standard electrical installations as well as for the dangerous value of electrical parameters such as fault current, low insulation resistance etc.,

In addition to the Schedule of Inspection and Test results (Annexure) the detailed 'ELECTRICAL SAFETY AUDIT REPORT' is also submitted to the client within the agreed time scale. This report is done after detailed analysis (based on the visual inspection & test reports) and provides detailed report of the electrical installation comprising photographic illustrations of the actual conditions of the installations, Crisp details about the Electrical parameters of the installation, issues requiring immediate attention and recommendations to overcome defects and to improve the level of safety in electrical installations for safe continued use of the premises

Electrical Installation report contains the following:

- Abstract
- Overview
- Objectives
- Scope and Limitations
- Major details of Electrical installation
- Specific Observations & Recommendations
- Review of Electrical documents, drawings and records/registers
- Annexure (Schedule of Inspection and Test results)

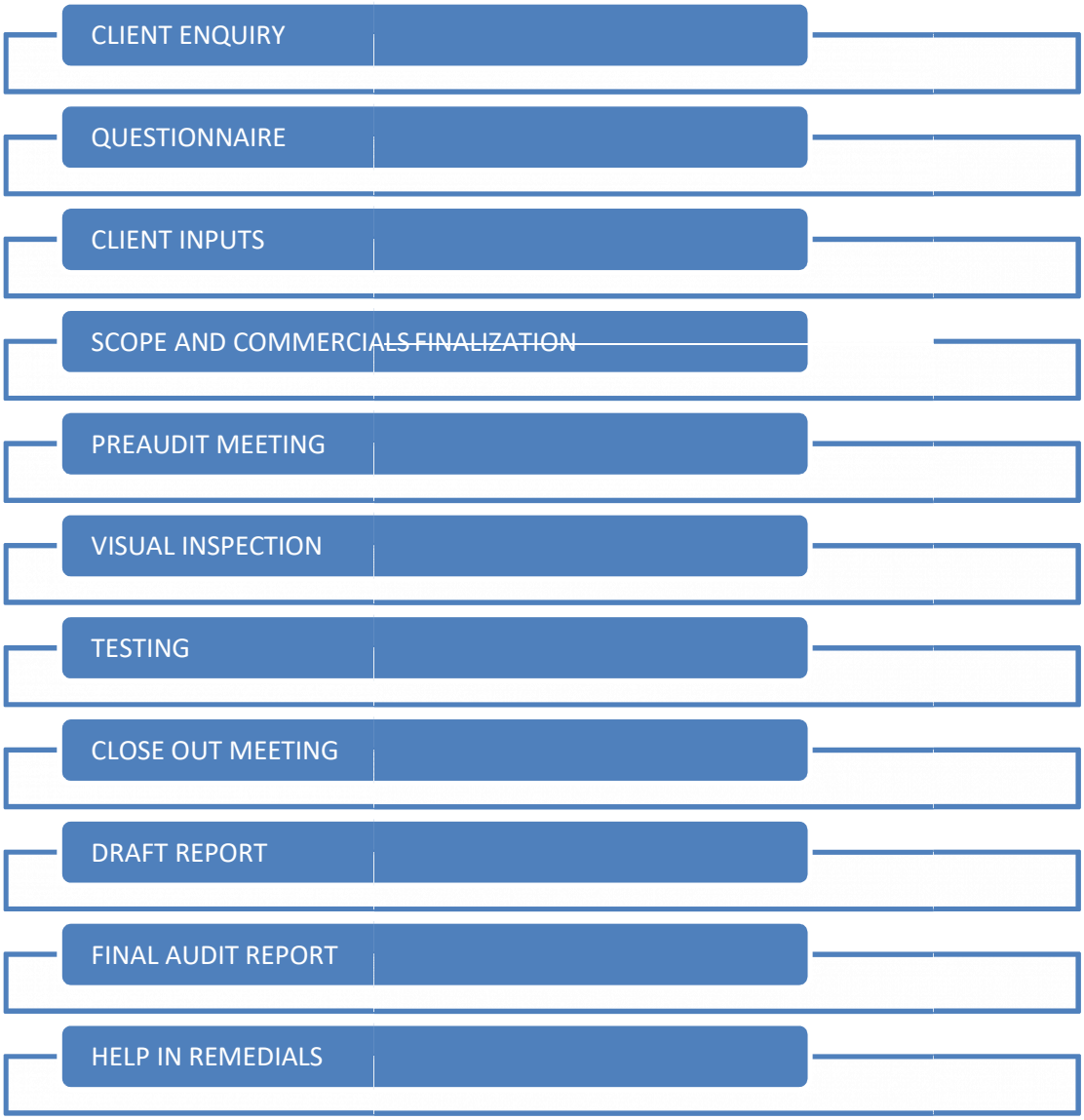
e) Management Briefing

(Part of the detailed 'Electrical Safety Audit' report)
The Management Brief Report provides best practices, innovative ideas and research data on Electrical safety that will help to stay up-to-date on the latest trends and practices in the areas of Electrical safety. The safe and cost effective solutions are described in this brief.
The detailed analysis about policy decisions and proposal for capital expenditure are presented (only if it is agreed in the contract terms) the Management Briefing.

Management briefing discusses about the importance of the board and the senior management involvement for the formal audit system and has committed resources, manpower and money to implement the recommendations suggested in the Inspection report. This also suggests the review of the inspection report by the senior management representative, which leads to an action plan and in subsequent formal reviews of progress on the plan.

METHODOLOGY

TYPICAL ELECTRICAL SAFETY AUDIT ACTIVITY FLOW IS GIVEN BELOW



INSTRUMENTS

The following instruments will be used during the audit

- Multifunction meter
- Clamp meter
- Earth resistance tester
- Earth leakage clamp meter
- Lux meter
- Insulation resistance tester
- Thermography
- Harmonic Testing

6. AUDIT OUTCOME

Electrical Safety Audit provides the information about the following:

- Bypassing of fuses/ELCBs
- Storage of combustible materials near the Electrical panels/UPS/Battery if any..
- Damages in the cables/wires
- Non compliance to codes/standards
- Earthing defects
- Sealing of ducts/voids to prevent fire propagation
- Damaged switch socket outlets
- Satisfactory presence of MCBs/MCCBs
- Lighting / Illumination / Glare
- Relay settings
- Electrical Panel installations / locations / clearances
- Mismatch in the As built drawings and actual installations
- Photos of the defective installations

7. BENEFITS

Electrical Safety Audit benefits for the different sectors listed below:

Residential apartments/welfare associations

To Safeguard occupants (especially children and elders)

To protect expensive house hold electrical/electronic appliances

Commercial / IT / Retail / Entertainment premises

To ensure safe environment for employees/customers/audience

To ensure timely functioning of emergency electrical services (exit , haul way lighting etc.,)

To protect capital equipment's (data storage devices/racks/servers etc., in IT facilities)

To ensure business continuity and to avoid down time

Hospitals/Health care facilities

To ensure safe isolation of electrical systems if a patient unintentionally comes in contact with live electrical devices

To protect expensive medical equipment's from insulation deterioration

Factories / Industries / Oil & Gas facilities

To ensure compliance with the statutory regulations, codes & standards

To ensure employee safety

To minimize plant downtime and reduce production losses due to accidents

To avoid machine / plant deterioration due to defective electrical systems & hence overall increase in life of the plant

8. Sample Test Results Annexures

Some of the sample test results Annexures are attached for reference

a) Annexure-1 Schedule of Inspection Result for Distribution Board / Panels,
b) Annexture-2–Schedule of ELCB/ELR Test Results

ELECTRICAL SAFETY AUDIT REPORT

Name of the Company	

Annexure-1.1Schedule of Inspection Result for Distribution Board / Panels (Part-A)

S.NO	DB/PANEL NAME	LOCATION	ISI MARK or AS PER IS	FIXING	GLAND	LUGS	SHROUDS	CONNECTIONS	IP RATINGS	FASTENERS	INCOMER CURRENT RATING (KVA/A)	OVERHEATING	N TO E VOLTAGE	INSULATION	NO. OF PHASES	EARTHING	CABLE TAGS	CIRCUIT IDENTIFICATION	DANGER NOTIFICATION	REMARKS
Please ✓ - for Satisfactory and × - for unsatisfactory or record the measured vales where appropriate or NA - for Not applicable and NV - for Not verified																				

This Area is intentionally left blank

ELECTRICAL SAFETY AUDIT REPORT

Name of the Company	

ANNEXURE - 2 - SCHEDULE OF ELCB/ELR TEST RESULTS

S.NO.	Feeder Description	Circuit No.	Functional Test	Nuisance Tripping Test		Full Leakage Current Test		5 Times Leakage Test		Remarks
				0°	180°	0°	180°	0°	180°	