सत्यमेव जयते

GOVERNMENT OF INDIA - MINISTRY OF RAILWAYS

SAFETY IN ELECTRICAL
LOW VOLTAGE INSTALLATIONS

VOL 6: ELECTRICAL SAFETY AUDIT IN LV INSTALLATIONS

CAMTECH/EL/2022-23/ Vol.06:Audit/ 1.0

END USER

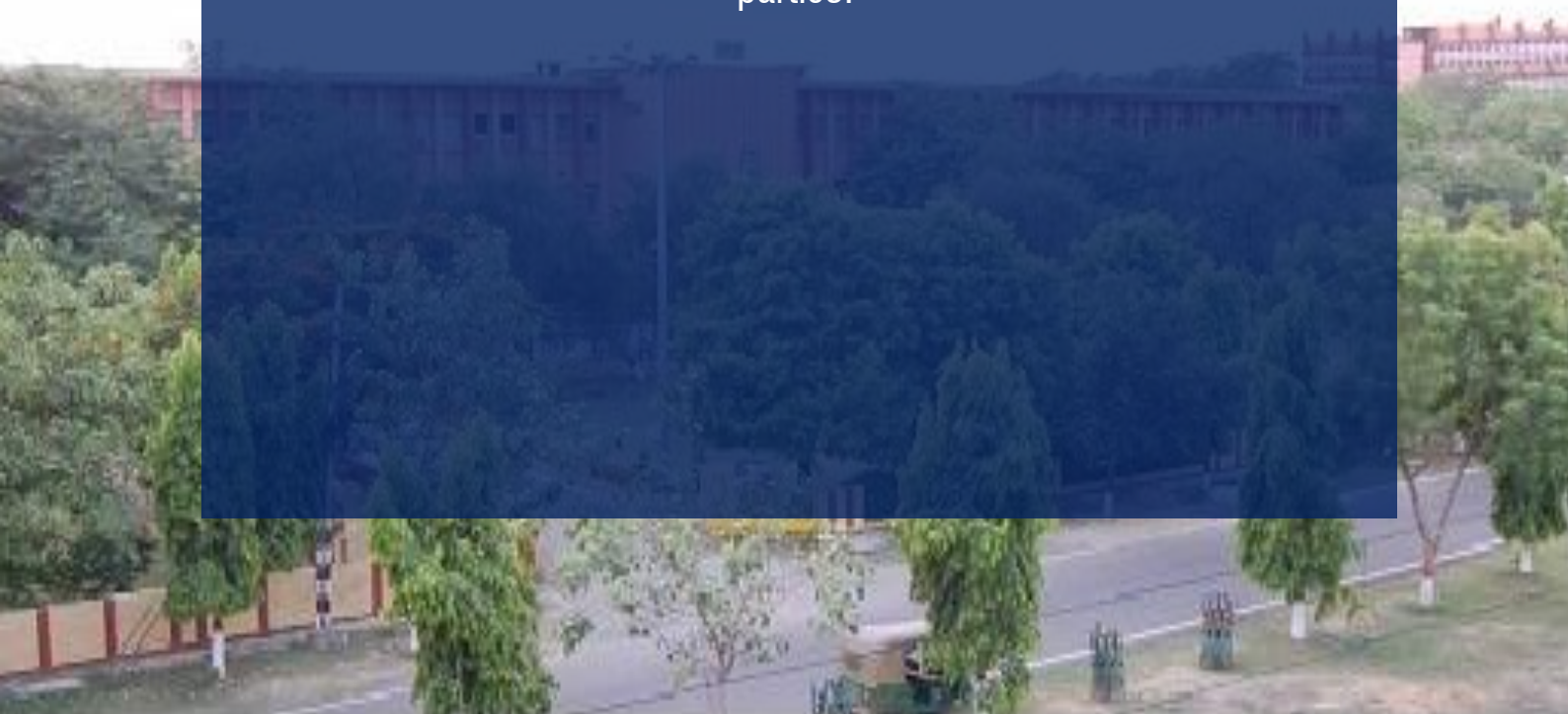
RAILWAY ELECTRICAL ENGINEERS AND TECHNICIANS DEALING WITH LV INSTALLATIONS

An ISO 9001-2015 Certified Organisation
उच्च अनुरक्षण प्रौद्योगिकी केन्द्र
EXCELLENCE IN MAINTENANCE

INDIAN RAILWAYS
Centre for Advanced Maintenance Technology (CAMTECH)
MAHARAJPURA, GWALIOR - 474005

QUALITY POLICY

"We at RDSO, Lucknow are committed to maintain and update transparent standards of services to develop safe, modern and cost effective railway technology complying with statutory and regulatory requirements, through excellence in research, designs and standards by setting quality objectives, commitment to satisfy applicable requirements and continual improvements of the quality management system to cater to growing needs, demand and expectations of passenger and freight traffic on the railways through periodic review of quality management systems to achieve continual improvement and customer appreciation. It is communicated and applied within the organization and making it available to all the relevant interested parties."



CONTENTS

ISSUE OF CORRECTION SLIP

The correction slips to be issued in future for this handbook will be numbered as follows:

CAMTECH/EL/2022-23/ Vol.6-Audit/1.0/C.S # XX date---

Where "XX" is the serial number of the concerned correction slip (starting from 01 onwards).

Sr. No.	Date of Issue	Page no. & Item no. modified	Remarks

DISCLAIMER

It is clarified that the information given in this booklet does not supersede any existing provisions of Indian Standards (IS) on the subject, related matters, and other existing provisions laid down by the Railway Board, RDSO. This is not a statuary document and instructions given are for the purpose of guidance only. If at any point contradiction is observed, then Indian Standards, regulations issued by Government bodies, Railway Board/RDSO guidelines shall be referred.

OBJECTIVE OF PUBLICATION

To prepare guidelines which can educate the Indian Railway (IR) engineers and technicians dealing with low voltage electrical installations and other IR officials about various provisions given in IS standards pertaining to IS 3043-2018, IS 732:2019 & other codes.

1 INTRODUCTION

Indian Railways is having a vast network of Low Voltage (LV) installations and these installations are having a direct contact with general public, Railway staff and their families. It is desirable to inspect and implement the safety provisions as per Standards in these LV Installations to ensure safety at large. Railway Board also directed to carry out Electrical Safety Audits of Low Voltage Installations over Indian Railways vide Railway Board's letter no. 2021/EEM/113/1 dated 18.10.2022. Further Regulation 12 (1), Chapter III of CEAR-2010 or latest also states:

"All electric supply lines and apparatus shall be of sufficient rating for power, insulation and estimated fault current and of sufficient mechanical strength, for the duty cycle which they may be required to perform under the environmental conditions of installation, and shall be constructed, installed, protected, worked and maintained in such a manner as to ensure safety of human beings, animals and property".

Electrical hazards continue to threaten safety of people and property in the form of shocks, burns, injury, fire and explosion. Sometimes we witness fire incidents reported due to electrical short circuits which is a very serious matter and due to ignorance of rules and regulations, this may happen anywhere at any time because, electricity cannot be smelt, heard or seen.

Electrical safety audit is a mechanism to examine the healthiness of the electrical installations, their protection systems and effectiveness during fault conditions. It is also a way of ensuring the implementation of various norms and provisions instructed by Indian Standards, Codes and Regulations.

2 IMPORTANCE OF SAFETY AUDIT

It is of utmost importance to handle the electricity adopting correct procedure and to use proper protective devices, conductor and equipment and observation of the safely aspects to minimize possibilities of electrical accidents.

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. Electrical Safety Audit brings out the non-compliances of

safety provision of an Electrical installation to the owner/ management, detects the incipient faults in the system, so that corrective actions can be initiated to avoid the major mishap.

Risk assessment of the installations and attention to high risk area can be done during safety audits. The concept of SAFETY audit may be adopted for new installations as well as for existing installations and following are the main objects:

1. Personnel Safety
2. Installation/ Equipment Safety

3 REFERENCES OF CODES & STANDARDS FOR AUDITING

The Electrical safety audit is based on the following for general & specific installation requirements:

1. CAMTECH, Gwalior Publications under the Series “Safety in Electrical Low Voltage Installations”
   - i volume-1: Basics of LV Earthing System
   - ii volume-2: Selection and Application of LV Protective Devices
   - iii volume-3: Inspection of Electrical LV Installations
   - iv volume-4: Testing of Electrical LV Installations
   - v Volume-5: Selection of Power Cables in Electrical LV Installations
2. IS 3043-2018: Code of Practice for Earthing (Second Revision).
3. IS 732-2019: Code of Practice for Electrical Wiring Installations (Fourth Revision)
4. National Electrical Code 2022 or Latest
5. National Building Code 2016.
6. Central Electricity Authority Regulations 2010 or latest

4 SCOPE OF ELECTRICAL SAFETY AUDIT

The scope of Electrical Safety Audit should be well defined, so that the objectives are well achieved. Electrical Safety Audit is broadly divided into following major parts namely:

- i Pre Audit and Installation details
- ii Visual Inspection and Circuit identification
- iii Measurements and Testing
- iv Thermography of Installation
- v Analysis of Observations
- vi Report preparation & Recommendations

It is recommended to provide resources, manpower and permissions required for Safety Audit.

4.1 Pre Audit

Pre Audit is the first step in safety audit and exchange of information with installation representative, this mainly consists of understanding the installation and collecting the details like single line diagram of installation, electrical safety systems and verification of documents related to electrical safety should be done. These details would be helpful to the audit team in inspection & certification.

Typical activities/Items of pre audit include:

a. Check the type of system earthing provisions (like TN, TT or IT etc.) used in supply system of installation.

b. Check the Electrical single line diagram (as built) of Installations. If this is not available, ask the installation in-charge to arrange it.

c. Details of Sanctioned load, maximum demand, Average power factor etc. should be collected.

d. Review of building category classification as IS 732 table 7 for external Influences, to check the provision of protection to limit fire propagation and protection against thermal effects. Building category covers the conditions of evacuation in an emergency, locations with Risks of Fire due to the Nature of Processed or Stored Materials etc.

e. Collect and check the details of major electrical equipment like capacity, rated power, operating voltage, duty cycle, year of installation etc. to access the risk involved due to duty cycle, aging etc.

f. Check the details of additions/ expansions done in the premises especially electrical installation, and also to ask for any planned or due if any.

g. Take overview of electrical maintenance system like preventive maintenance schedules, documentation, check lists, work permit, formats etc. Check the findings during preventive maintenance like frequently failed items, breakdown frequency etc.

h. Review of previous electrical accidents occurred in installation and their findings/ root causes. This will help in accessing accident prone locations/ circuits and to suggest corrective actions.

i. Review the electrical safety practices in the system. Procedure of isolation, lock out tag out practices, personal protective equipment etc.

j. Details of available tools and Machines/ plants required for preventive and break down maintenance with calibration details (if required)

k. Check the provisions for Medical emergency/ first aid box, fire safety arrangements etc.

l. Check the provision of Building lightning protection system (Yes/ No).

m. Check the qualifications, experience and training needs for the personnel responsible for electrical maintenance.

Pre-audit proforma is attached as annexure in this booklet, in which all basic details of installation are given which are to be audited. ANNEXURE-MDB/LT Panel /Emergency Panel & ANNEXURE-FDB/Emergency FDB are also attached with this proforma.

4.2 Visual Inspection

During this phase, Audit team shall do thorough visual inspection at the installation. Visual Inspection to be done as per formats which are made with reference to statutory regulations, Indian Standards and the best engineering practices keeping in mind the safety of the people and the installation.

Visual Inspection comprises of following sections/Items:

a. Incoming Supply details including switchgears/cables
b. System earthing & protective earthing.
c. Electrical room Panels / Main Distribution board(s)
d. Distribution board(s) if available
e. Final Distribution board(s)
f. Final circuits/ equipment / rooms
g. Locations containing wet areas (like bath or shower)
h. Emergency Lighting provisions if applicable
i. Power supplies to Fire alarm systems and Public address systems if applicable
j. Lightening protection provision (Yes/ No)
k. General Illumination for ease of maintenance / inspection
l. Labelling no. for circuits for easy identification, if not available, same may be done as given in volume-3.
m. Danger Marking

During this stage, the incoming electrical supply receiving section (Electrical panel Room/MDBs) is inspected first. Then other electrical equipment in this section are to be inspected. The technical requirements of incoming cables, ACBs, MCCBs/MCBs, DBs, circuitry, earthing system and Lightening protection, maintenance condition, loose cabling, temporary wiring, risk of electrical fire, shock potential etc., are critically looked into. This process is to be followed upto final circuits/ equipment.

All the relevant maintenance documentation, test records, electrical records, earlier inspection reports are subjected to detailed examination. All the relevant drawings (electrical single line diagram, earthing layout, protection system schematic, equipment layout, etc.) are also checked against actual installation and commented upon, with reference to applicable standards. Discussion with asset in-charge, maintenance personnel shall also be carried out with during the field visit.

For many other points which are required to be checked for specialized installations, the users can refer CAMTECH booklet on “safety in Low voltage installations Vol-3 Inspection of LV Electrical Installation”.

Asset incharge should ensure that labelling is done as per annexure given in volume-3 by proper means like stickers/Markers.

The Formats provided here are for guidance and more points may be added as per requirement keeping in mind electrical safety aspects.

4.3 Measurements and Testing

After visual inspection, measurements and testing of installation should be carried out. Fault loop impedance, insulation resistance of cables/ circuits, polarity, phase sequence, earth electrode resistance etc., are required to assess the condition and suitability of protective switch gears. The details of different tests, testing procedures, precautions and methods are given in the CAMTECH booklet Vol-4 "Testing of LV Electrical Installation" under the series of publications on safety in Low voltage installations.

The following tests shall be carried out where relevant and should preferably be made in the following sequence:

Table 1: Test Sequence

S.N.	Test	Test execution before / after Supply connected
1	Continuity of conductors	Tests before the supply is connected or in supply OFF condition
2	Insulation resistance of the electrical installation	
3	Automatic disconnection of supply	
(i)	Earth electrode resistance test	Tests before the supply is connected or in supply OFF condition
(ii)	Earth fault loop impedance test	Tests with the electrical supply connected
4	Additional protection (ELCB/RCCB) Test	
5	Earth leakage test	
6	Voltage drop test	
7	Load unbalancing Test	
8	N-E voltage test	
9	Test of the order of the phases	
10	Functional and operational tests	
11i	Polarity test (continuity measurement)	Tests before the supply is connected or in supply OFF condition
11 ii	Polarity test	Tests with the electrical supply connected

Measurement and Test results should be filled in respective formats.

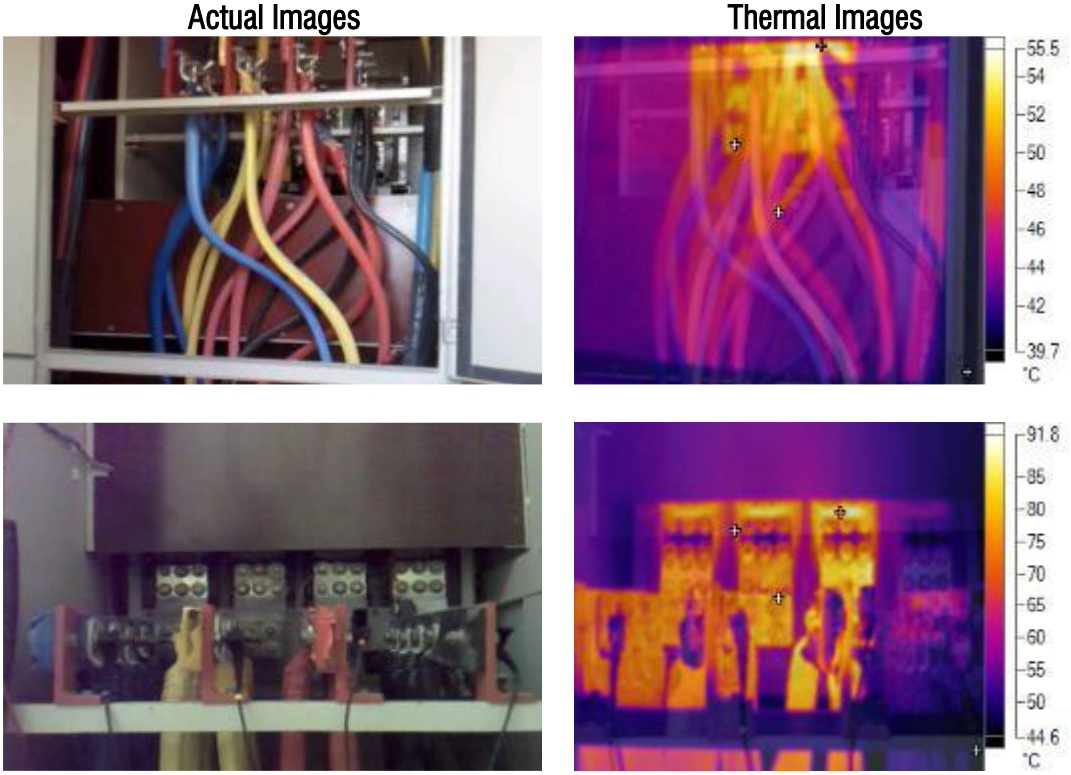
The following testing and measuring instruments should be available with Audit team:

a. Multifunction meter with facility to measure AC current. (clamp meter)
b. Earth resistance tester
c. Earth leakage tester
d. Insulation resistance tester
e. RCCB tester
f. Loop impedance tester/ Installation Tester

Note: Insulation resistance shall be checked as per site conditions & Power isolation timings for Panel/ DBs.

4.4 Thermography of Installation

Thermography is viewing of thermal images of objects/connections under load through sensing of infrared radiation emitted by them. Thermography is a part of preventive & predictive maintenance technique. Thermal imaging of an electrical apparatus gives heat flow in terms of temperature gradients. Through this, present loading condition, abnormal working condition can be detected and failure/damage can be prevented. It is carried out by Infrared camera which are generally available in division with TRD department.



The thermal imaging of the major load centres like complete MDBs, DBs, SDBs, joints, termination points, etc. should be carried out by Thermovision camera. It shall be ensured that complete assembly is examined rather than individual equipment since the analysis is based on relative temperature of sub-components and not on ambient temperature. The checking should preferably be carried out when there is load on the concerned circuit.

Limit for Temperature variation & duration for rectification of issue is given below.

S.No.	Variation of temperature compare with adjacent/ nearby similar components	Duration for rectification
i.	>20 °C	24 Hours
ii.	10°C - 20 °C	02 Days
iii.	5°C - 10°C	05 Days
iv.	< 5°C	Normal

4.5 Analysis of Observations

Post visual Inspection, measurements, Testing and thermography results are compiled in respective formats. These formats provide information about the all electrical parameters which help in analysing the healthiness of the installation. This analysis lists out the immediate or time bound action plan to be taken for attending certain improper or non-standard electrical conditions or practices.

The Analysis of details collected during visual Inspection, measurements, Testing and thermography to be done and shall be analysed for following criteria:

- Suitability of protection devices with reference to fault loop impedance and tripping characteristics to ensure automatic disconnection of supply in case of faults
- Coordination of protective devices with size of Conductors and cables for short circuit and overload conditions.
- Proper location of protective devices
- Availability & working of RCCB.
- Earthing system and equipotential bonding
- Availability of earth connection in every socket.
- Damages in the cables/wires, loose connections and unsecured joints
- Correct type of equipment (class 1 or class 2) and their plug connections.
- Thermal images to identify hot spots/ loose connections and action required.
- Damages due to Thermal effect in installations and precautions their off.
- bypassing of fuses/MCBs/ELCBs
- Storage of combustible materials near the Electrical panels/UPS/Battery if any.
- Sealing of ducts/voids to prevent fire propagation
- Electrical Panel installations / locations / clearances
- Mismatch in the as built drawings and actual installations
- Photos of the defective installations

4.6 Report preparation & Recommendations

The detailed 'ELECTRICAL SAFETY AUDIT REPORT' should also be prepared and submitted to the In-charge Officer of the Installation within the specific period. This Audit report should be prepared after detailed analysis based on the visual inspection & test reports.

This Audit report should also provide detailed report of the electrical installation comprising photographic illustrations of the actual conditions of the installations, thermal imaging, factual 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.

Electrical Installation audit report should be in following structure:

a. Cover page having details as per Annexure-A
b. Introduction and scope of Safety Audit
c. Pre Audit proforma with details as per Annexure-B
d. Visual inspection proforma (Annexure-1.1 to 1.4) with observations & recommendations.
e. Testing proforma (Annexure-2.1 to 2.6) with observations & recommendations
f. Thermography results with photographs if done
g. Summary including final observations & recommendations.

This report shall be presented/ discussed with the officer in-charge (preferably in presence of personnel responsible for electrical maintenance).

Annexure-A

For the Cover Page of the Audit Report

ELECTRICAL SAFETY AUDIT REPORT

INSTALLATION DETAILS

ZONAL RAILWAYS: .....

DIVISION/ UNIT: .....

INSTALLATION NAME: .....

LOCATION: .....

INSTALLATION INCHARGE: .....

AUDIT DETAILS

AUDIT TEAM LEADER: .....

AUDIT TEAM OTHER MEMBERS: .....
.....
.....

AUDIT CONDUCTED ON: .....

REPORT SUBMITTED ON: .....

Annexure-B

Pre-Audit Format

S.N.	Item	Description
1	Name of Installation	
2	Name/ Designation of Installation Incharge	
3	Type of Installation (Office/ Qtr./ Station/ Other building)	
4	Number of Floors in Building	
5	Number of Rooms	
6	Building Category (check para --- booklet inspection)	
7	Sanctioned Load (In KW)	
8	Maximum Demand (In KW)	
9	Average Power Factor	
10	Type of Load	
11	Single line diagram of Installation (Available or not)	
12	Number of Switch Room/Electrical Panel Room in Building	
13	Number of total MDB in switch room	
14	Detail of each MDB as per Annexure-MDB	
15	Number of Distribution Board (DB)	
16	Detail of each DB as per Annexure-DB	
17	Number of Sub Distribution Board	
18	Detail of each SDB as per Annexure-SDB	
19	Emergency supply available or not	
20	Fire Protection arrangement available or not	
21	Type of System Earting (TT/TN-S/TN-C-S)	
22	Major Load (type & capcaity in KW)	
23	Building lightning protection system	
24	Any previous audit done or not	
25	Review of past accident	
26	Any other Point	

Annexure-B1

Detail of MDB/ LT Panel/ Emergency Panel/ DB

1	Sr. No. of MDB/LT Panel/Emergency Panel/DB										
2	Year of Commissioning										
3	Wall Mounted or Floor Mounted										
4	Height from floor										
5	IP protection										
6	Bus Bar Type (Copper/Aluminium)										
7	Size of Bus Bar (Width x Thickness)										
8	Detail of feeder as per below detail										
	Name of Feeder	Type (ACB/ MCCB /MCB/ Fuse/ Changeover switch)	Rating in Amp.	No. of Poles	Breaking Capacity (In KA)	If MCCB than fixed/ variable type	Detail of location of DB/FDB/ Load	Cable connected to circuit			
								Type/ Core	Size	Approximately Length	Installation Method (to be checked as per Vol.5
(i)	Incoming										
(ii)	Bus Coupler										
(iii)	Change over switch										
(iv)	Outgoing Circuit No.1(X1)										
(v)	Outgoing Circuit No.2 (X2)										
(vi)	Outgoing Circuit No.3 (X3)										
(vii)	Outgoing Circuit No.4 (X4)										

Annexure-B2

Detail of FDB/Emergency FDB

1	Sr. No. of FDB/ Emergency FDB										
2	Year of Commissioning										
3	IP protection										
4	Type (Copper /Aluminium) Bus Bar										
5	Size of Bus Bar (Width Thickness)										
6	Detail of feeder as per below detail										
	Name of Feeder	Connection load (In KW)	Type (MCCB / MCB/ Fuse/)	Rating in Amp.	No. of Poles	Breaking Capacity (In KA)	Detail of location of Load	Wire connected to Load/MS Box			
								Type	Size	Length from feeder to Load	Installation Method (to be checked as per Vol.5
(i)	Incoming										
(ii)	Circcuit-1										
(iii)	Circcuit-2										
(iv)	Circcuit-3										
(v)	Circcuit-4										

Annexure-1.1

Visual Inspection of Switch Room

Name or Sr.No of SWITCH ROOM:

Sr.N.	Description	Observation	Recommendation
A	**Switch Room**		
1	Whether Single Line Diagram (SLD) for complete Installation available & Displayed		
2	Whether Electric shock treatment chart are displayed?		
3	Fire Extinguisher Operation chart are displayed?		
4	Whether emergency contact numbers of nearest Fire station, Hospital, etc. are displayed		
5	Weather electrical danger plate/sticker (fig of skull & cross bones, 440V / 230V) is provided on Main Electrical Panel/ Outside electrical room		
6	Safety equipment / materials like Fire extinguishers, Hand Gloves, PPE First aid box etc. are available		
7	Are Fire extinguishers mentioned refilled and inspected regularly?		
	If yes, mention Date of last refilling		
8	Whether the previous audit/inspection is done If yes, mention Date of Inspection		
	Status of compliance of Last audit Observations		
9	Whether proper arrangement for ventilation for the switch room		
10	Whether lighting is provided in switch room is sufficient/adequate for easy operation & maintenance works.		
11	Whether Emergency light is provided		
12	Whether Water Seepage is observed in switch room		
13	Whether File/paper, old material or any other scrap are stored in switch room		
14	Whether cable trench is sealed to avoid entry of any rodents/raptiles.		
B	**MDB/LT Panel**		
15	Whether MDBs/LT Panels are available for both supply (Emergency & Main Supply)		
16	If yes separate MDB/LT Panel for main or emergency sypply (separate DBs/LT Panels or combined MDB/LT Panel for both supply)		
17	Any sign Overheating or burn marks available inside MDB/LT Panel		
18	Whether Equipment of MDB panel are properly marked.		

Sr.N.	Description	Observation	Recommendation
19	Whether cable connected are under mechanical stress or not.		
20	Whether cables are terminated using glands and lugs of correct type/size and properly dressed,		
21	All meters like voltmeter/Ammeter/Energy meter are working properly		
22	Clearance of LT panel from wall		
23	Whether trench for cables are available or not		
	If yes covers are provided over trench for protection of working personnel against accidental fall		
24	Whether cable trench is sealed to avoid entry of any rodents/raptiles.		
25	Spare cable entry/exit holes are sealed or not		
26	whether Insulating Rubber mats are provided at MDB/LT panel working areas conforming to IS 15652 (Ref: Para 4.12 of Section 22 of NEC SP30:2022)		
27	Whether Clear space of at least 1m in width provided in front of MDB/LA Panel (Ref: Para 4.12 of Section 22 of NEC SP30:2022)		
28	Whether mechanical and electrical interlocks of critical equipments are working or not?		
29	Ammeters and voltmeters shall be tested and calibrated;		
30	A busbar provided with terminals (and if required links) for connecticn to the neutral condudoctor of outgoing and incoming circuits of distribution system;.:		
31	Proper gasket are provided in distribution board		
C	**Earthing System**		
32	Type of Earthing System (TT/TN-S/TN-C/TN-C-S)		
33	Whether MET is available at MDB		
34	Whether the MET are connected from independent Earth electrode?		
35	If yes Number of Earth Pit		
36	Type of Earth Electrode (Strip/Pipe/plate)		
37	Type & size of earthing conductor(conductor connected from earth electrode to MET)		
38	Whether proper nomenclature and painting is done on Earthing pits		
39	Whether Earthing Test reports are available		
40	Whether the Earthing pits are identified and free from obstruction for routine maintenance?		
41	Detail of MDB/LT Panel as per Annexure-MDB/LT PANEL/EMERGENCY PANEL		
42	The screens and armour of the cables shall be connected to earthing system properly		

Annexure-1.2

Visual Inspection of Room

Name or Sr.No of Room:-

Sr.N.	Description	Observation	Recommendation
A	**Room**		
1	Whether components such as switches, sockets, fan regulators, etc. complying with applicable IS		
2	Whether any switch board installation is in open or loosely fitted		
3	Whether each switchboard/socket provided with protective device		
4	Whether all switchboards are easily accessible		
5	Whether all switches for outgoing circuits wired through phase		
6	How many fixtures are controlled by one switch (Random checks)		
B	**Circuit wiring**		
7	Type & Quality of circuit wiring (like conduit, concealed, mechanical protection etc.)		
8	All circuits suitably identified		
9	All connections intact and secure		
10	Light/fan & power point Circuit to be sperate (No interconnection of neutral between circuits)		
11	Observations for any area where exposed wires, if any, need dressing		
12	Whether any exposed wiring is observed with frayed or deteriorated insulation repaired or replaced		
13	Is protective wire is run along all the fan /power circuits as required		
14	All live parts are either insulated or contained within enclosures		
	Enclosures have suitable degree of protection appropriate to external influences		
	Enclosures have cable entries correctly sealed		
15	Number of wires in a conduit shall conform to provisions of this Code.		
16	Whether false ceilings are available in room		
	If yes ,Wiring to be laid in proper PVC conduit under false celing		
17	Size of wire for lighting/ceiling fan/5A socket & power point are as per NEC guideline (Ref: Table 6 of Section 9 of NEC SP30:2022)		
18	Whether height of switch Board shall be reachable and 1.2 m above ground level for residential quarter		

Sr.N.	Description	Observation	Recommendation
	Whether separate protective device for power point & light, fan point		
19	Whether FRLSH / HFFR grade copper cables for internal wiring installation in residential building is used		
20	Correct colour coding or marking of conductors		
	Number of points in switch board are as per NEC guideline (Ref: Table 6 of Section 9 of NEC SP30:2022)		
21	Fire alarm and emergency lighting circuits shall be segregated from all other cables and from each other.		
C	**Lighting fixtures/Ceiling Fan**		
22	Whether any loosely fitted lighting fixture observed		
23	Whether lighting fixtures are extended earthing connection wherever provision is made in fixture for earthing connection		
24	Whether ceiling rose are provided with ceiling fan		
25	Ceiling fans are properly fixed		
D	**Separate Power Points**		
26	Are high rated electrically operated items plugged directly into power points (not on power boards)		
27	Check ratings of sockets outlets in switchboards w.r.t type of load/ appliance connected		
28	Check present condition of power point switches and sockets		
29	Are power points identified with the circuit details & easily located and unobstructed		
30	Whether electrical appliances such as photocopiers, AC, etc. have their own power point		
31	Is earth continuity satisfactory in socket outlets		
32	Whether use of multiple plug adapters prohibited or permitted		
E	**General**		
33	Is any electrical installation located in the building area with excessive dampness and humid atmosphere		
34	Are metallic parts, junction boxes, etc. used in interior wiring systems provided with earthing		
35	Protective conductors provided to every point and accessory		
36	Weather equipotential bonding has been provided for all Exposed & extraneous conductive parts		
37	Supplementary bonding has been provided		

Annexure-1.3

Coordination between conductor & Protective Device for Over load Protection

Name or Sr.No of MDB/DB:								
S.N	Name of Feeder	Circuit protection (MCCB/MCB/ FUSE) (Type/Rated Current)	Tripping Current due to overload (1.45x rating of MCB or 1.3 x rating of MCCB)	Conductor connected to circuit			Observation	Recommendation
				Detail of conductor (type/core/ Size)	Installation Method (to be checked as per Annexure- VII of Vol.5 "Selection of power cable in LV Installation"	Current rating of conductor after applying all reduction factors		
1	Outgoing 1 (X1)							
2	Outgoing 2 (X2)							
3	Outgoing 3 (X3)							
4	Outgoing 4 (X4)							

Note:

1. All reduction factor (like ambient temperature, grouping, Thermal resistivity of soil (applicable only for underground cables) to be applied for checking of size of line conductor.
2. Checking of Size of line conductor by applying all above reduction factor under overload condition are given in Para 5.4 of volume-2 on "Selection and Application of LV Protective Devices" and Para 3.2 of volume-5 on "Selection of Power Cables in Electrical LV Installations" under the series "Safety in Electrical Low Voltage Installations.

3. Size of Line conductor for lighting & power circuit of FDB should be as per Annexure-6 of volume-3 on "Inspection of Electrical LV Installations" under the series "Safety in Electrical Low Voltage Installations. Above Annexure is not required for these circuit.

Annexure-1.4

Coordination between Load & Protective Device

Name or Sr.No of FDB:					
	Name of Feeder	Connected fixed load (In watt/ Amp)	Type & Rating of /MCB/Fuse	Observation	Recommendation
(i)	Circcuit-1				
(ii)	Circcuit-2				
(iii)	Circcuit-3				
(iv)	Circcuit-4				
(v)	Circcuit-5				
(vi)	Circcuit-6				

Note:-

1. Checking of current rating of MCB for particular load in final circuit are given in Para 5.1 to 5.3.1 of volume-2 on “Selection and Application of LV Protective Devices” under the series “Safety in Electrical Low Voltage Installations.

Annexure-2.1

Continuity Test

Name or Sr. No of MDB/DB/FDB:					
Tester Type:			Sr. No. Of Tester		
S.N.	Circuit No.	Detail of Protective conductor (type/core/Size) connected to Load	PE continuity	Observation	Recommendation
			R1 (Protective Conductor)		

Note:

1. Detail & testing method of Continuity Test given in Para 2 of volume-4 on "Testing of Electrical LV Installations" under the series "Safety in Electrical Low Voltage Installations.

2. Testing to be done only on protective conductor.

Annexure-2.2

Insulation Resistance Test

Name or Sr.No of MDB/DB/SDB:-										
Test Voltage:-									Sr.No. of Megger	
S.N	Circuit/ Outgoing No.	Size(Sq.mm)/ Type (PVC/ XLPE)/ Core (1/2/3/3.5/4) of conductor	Insulation Resistance (M-Ohm)						Observation	Recommendation
			For 1-ø (For 3ø shoring all phase and test between :- (i) Shorting phase (P) & Neutral(N) (ii) Shorting phase (P) & Earth (E)3			P-P (for 3ø Only)				
			P-N	P-E	N-E	R-Y	Y-B	B-R		

Note:-

1. Minimum values of insulation resistance (Ref: table 15 of IS 732:2019)

Nominal Circuit Voltage (V)	Test Voltage D.C. (V)	Insulation Resistance (MΩ)
Up to and including 500 V, including FELV	500	≥ 1.0

1. Testing method given in Para 3 of volume-4 on “Testing of Electrical LV Installations” under the under the series “Safety in Electrical Low Voltage Installations.

2. For 3-phase circuit at first all 3-phase (R/Y/B) will be shorted and the insulation resistance to be checked between Shorting phase (P) to Neutral(N) and Shorting phase (P) to Earth (E).If value of insulation resistance not as per table in S.N.1, than insulation resistance to be checked individually (R-N/Y-N/B-N).

Annexure-2.3

Fault Loop Impedance and Prospective Fault Current

Name or Sr.No of MDB/DB/SDB:												
Tester Type:-							Sr. No. Of Tester					
S.N.	Circuit No.	Circuit protection (MCCB/MCB/ FUSE) (Type/Rated Current)	Conductor connected to Load		Fault Loop Impedance		Fault Loop Current		Observation		Recommendation	
			Detail of Line conductor (type/ core/ Size)	Detail of Protective conductor	L-N	L-PE	L-N	L-PE	Regarding tripping of Protective Device (MCCB/ MCB/ FUSE)	Regarding short circuit capacity of Line & Protective Conductor	Regarding tripping of Protective Device (MCCB/MCB/ FUSE)	Regarding short circuit capacity of Line & Protective Conductor

Note:-

1. Testing method for fault loop impedance & prospective Fault Loop Current given in Para 5.1 of volume-4 on “Testing of Electrical LV Installations” under the under the series “Safety in Electrical Low Voltage Installations.

2. Checking of type and capacity of MCB for particular fault loop impedance are given in para 5.3.2 of volume-2 on “Selection and Application of LV Protective Devices” under the under the series “Safety in Electrical Low Voltage Installations.

3. Instantaneous Tripping current of MCCB under short circuit & earth fault condition can be find out from the time-current characteristic graph of MCCB, which may be received from the catalogue/Manufacturer of MCCB. This tripping current may be compared with the testing fault loop impedance/current for checking of tripping of MCCB.

4. Checking of Size of line & protective conductor are suitable for short circuit /Earth fault current are given in Anneure-5 of volume-3 on “Inspection of Electrical LV Installations” & Para 3.2.8 of volume-5 on “Selection of Power Cables in Electrical LV Installations” under the series “Safety in Electrical Low Voltage Installations.

Annexure-2.4

RCCB Test

Name or Sr.No of MDB/DB/SDB:-							
Tester Type:						Sr.No. Of Tester	
S.N.	Circuit No.	RCCB			Touch voltage	Observation	Recommendation
		I_n	I_d	T_d			

Note:-

1. Testing method for RCD testing given in Para 6 of volume-4 on “Testing of Electrical LV Installations” under the under the series “Safety in Electrical Low Voltage Installations.

Annexure-2.5

Polarity Test

Name or Sr.No of MDB/DB/SDB:-					
Tester Type:-			Sr.No. Of Tester		
S.N.	Circuit No.	Circuit protection (MCCB/MCB/Fuse) (In (A))	Polarity test	Observation	Recommendation

Note:-

1. Detail of Polarity Test given in Para 7 of volume-4 on “Testing of Electrical LV Installations” under the under the series “Safety in Electrical Low Voltage Installations.

Annexure-2.6

Load Unbalancing Test

Name or Sr.No of MDB/DB/SDB:-							
Tester Type:-			Sr.No. Of Tester				
S.N.	Name of Feeder	Current in Each Phase (In Amp.)				Observation	Recommendation
		L1	L2	L3	N		

Note:-

1. Load unbalancing test may be checked any tongue tester. It may be also checked from 3-phase measuring instrument (Ammeter), (If 3-phase measuring instrument are available on MDB/DB/FDB)

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