ASEAN Engineering Inspectorate (AEI) – Guide to LV Electrical Installations


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The ASEAN Engineering Inspectorate (AEI) – A Guide to LV Electrical Installations provides a recommendation on the proposed minimum requirement for verification by inspection and testing for compliance to statutory and regulatory requirements and the IEC 60364-6 and BS 7671-6 standards for a low voltage electrical installation of buildings.

Low voltage is defined as voltage not exceeding 1000V AC or 1500V DC between conductors. The document details the inspections from planning to after erection, safety, functionality and performance testing as well as tests after energisation.

Inspection of an electrical installation checks for adherence to design and functional intent, compliance to statutory and regulatory requirements and standards, quality and condition of work done and equipment supplied at site, condition of site which may adversely affect performance or safety, with supervision by the submitting person.

Inspection before erection focuses on the design and factory documentation, quantity and quality of equipment and material as well as proposed method statements. During erection, the focus shifts to the correctness of the work done and material use in adherence to the proposed method statements, coordination of work between contractors and proper reporting and recording of any incidence. After erection, a final check is performed on all work and equipment quality, electrical system safety, integration and functionality and for any influence or impact of the actual site condition on the electrical system's safety or performance. The AEI guide also recommends the inspections be performed for installation with confined spaces, as defined by Occupational Safety and Health Administration (OSHA).

Testing will need to be carried out to ensure that all critical aspects of the electrical system that are difficult to determine with visual inspections alone, are verified and confirmed to be correct and safe. Elements of safety, functionality and performance are established through testing. Table 1 lists the recommended tests ought to be performed by competent person with calibrated and or verified test instruments.

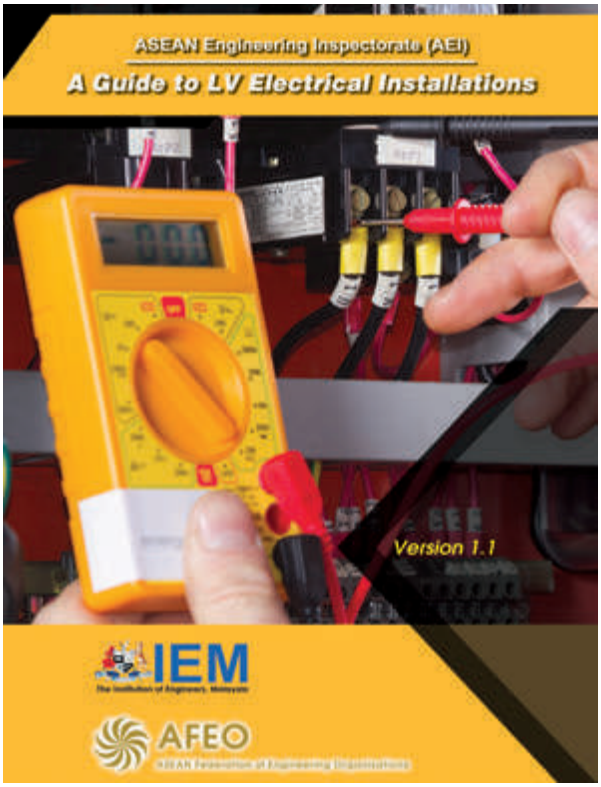

Figure 1: A Guide to LV Electrical Installations Book

The first test to be conducted is the circuit conductor continuity test. A multimeter or an Ohm meter is used to check the continuity from the power source such as the distribution box to the load or socket outlet, for the live, neutral and protective conductors. The continuity test verifies that all later tests will correctly measure the values for the entire length of conductor and will avoid any rise in potential if the circuit protective conductor and bonding are not in place or disconnected when carrying out other tests.

Table 1: Tests recommended by the AEI Guide

Continuity of circuit conductors test	Functionality of electromechanically/ mechanically operated devices
Insulation resistance (IR) test	Lightning and surge protection system
Polarity test	Circuitry check
Earth electrode resistance (EER) test	Lighting installation
Earth fault loop impedance (EFLI) test	Measuring and indicating equipment
Residual current device (RCD) complying with IEC 61008 or 61009	Functionality of all items of equipment/ systems, which include busbar, generator, power drive, low voltage switchgear and controlgear

It is recommended that the protection conductor, live and neutral conductor as well as final ring circuit conductor be subjected to continuity tests. An ohmic reading of less than 1Ω is strongly recommended as the acceptable level of continuity.

The insulation resistance test is then performed to verify the dielectric strength of the cable insulation and to detect any inadvertent connection between live conductors or from a live conductor to earth. An insulation resistance tester of 250V (DC) or 500V (DC) is used and the measured value is checked to see if it is above the allowed minimum values. Table 2 illustrates the minimum values of insulation resistance as per recommendation by IEC 60364-6.

Table 2: Minimum values of insulation resistance

Nominal Circuit Voltage	**Test Voltage (V_{dc})**	**Insulation Resistance (MΩ)**
Safety Extra Low Voltage (SELV) and Protected Extra Low Voltage (PELV)	250	0.5
Up to and including 500V, with the exception of the above cases	500	1
Above 500V	1000	1

Next, in the polarity tests, single-pole switches, fuses and circuit breakers are verified to be connected to the live conductor, not to the neutral conductor. Any wrong polarity connection can lead to a dangerous situation of a conductor that stays live, without the knowledge of the user, even when the switch is off. Again, a low ohmic reading of less than 1Ω as indicated by the measuring equipment, shall be recommended.

An effective earthing system is critical in an electrical system protection, to allow tripping of the protection device and to prevent any dangerous rise in potential. Therefore, the earth electrode resistance test is conducted to measure the resistance of any leakage current flow to earth. The fault loop impedance test measurement measures the complete loop impedance value while the earth electrode test instrument and the current clamps method measures the individual resistance of each earth electrode. Prior to performing the earth fault loop impedance test, it is paramount to ensure that the earthing conductor and all relevant earth connections are in place. In addition, the equipotential bonding connection to the electricity supplier's earthing facilities must also be disconnected. Finally, any earth leakage protective device must be isolated during the test.

Table 3: Partial checklist of low voltage switchgear and controlgear test

Nameplate information and labelling of equipment	Power factor correction capacitor bank
Adequacy of documentation from manufacturer	Harmonic filter/reactors
Arrangement of switchgear and components arrangement against manufacturer's operation and maintenance manual	Automatic changeover switch
Enclosure for proper alignment, foundation fixing, and grounding and vermin entry	Instrumentation and protection devices
Covers, sections and doors for paintwork and proper fit	Incoming/outgoing busbars and cables
Proper alignment of the primary and secondary contacts	Operating handles/ keys
Correct phasing connection of bus bar and cabling works	Torqueing test

Residual Current Devices (RCDs) minimises any danger associated with leakage current, but the RCD's proper operation is critical. RCD tests are carried out with an RCD tester which injects a specific leakage current through to earth, then measures and displays the time taken for the RCD to operate and open the circuit. The RCD in-built test button should also be tested for proper functioning of the RCD.

The low voltage switchgear and controlgear at the main switchboard and distribution boards as well as busbar systems, are tested for functionality, continuity and electrical insulation. Mechanical operations, alignments and bolt torques are verified. Protection relays and measurement instruments are calibrated and tested. Primary injection is performed to test the stability of the protection system. Table 3 lists some of the items that should be checked:

A complete lightning protection system consists of air terminations, down conductors and earthing terminations. Hence, the lightning protection system should be tested for continuity between air terminations, down conductors and earthing terminations, with the combined resistance to earth to be less than 10 Ohm. Visual inspections are performed to verify proper installation of the down conductors and earth electrodes.

In addition, the AEI guide describes the steps for circuitry check, lighting installation test and test of other major equipment such as the generator set and power drive system. Circuitry check is performed to verify that the installed circuit is in complete accordance with the

designated circuit. This is done via switching operation. On the other hand, the lighting installation test is performed mainly to check the luminaries, illumination level, lighting uniformity and a few other aspects.

Upon completion of the testing, and with all relevant authority approvals obtained, the electrical installation should only be energised by a competent person. After energisation, measurement of the nominal voltage and verification of the phase sequence should be performed on each circuit. The nominal voltage at no load shall comply with the requirements of IEC 60038. Equipment and appliances should be carried out in accordance with relevant product standards and manufacturer's specifications. ■

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