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Guest Article - Concepts of safety in IEC and IS standards in LV system

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Concepts of Safety in IEC and IS standards in **LV system**

As you saw in the previous article, the applicable international standard in India as per TBT agreement of WTO are ISO, IEC and ITU standards. Standards such as BS, VDE, EN, ANSI are not interpreted as international, but are national/regional standards applicable for the respective country/region.

Worldwide, in IEC member countries electrical safety regulations are based on the fundamental principles explained in clause 13 of IEC 60364. This IEC standard is prepared by IEC/TC64: Electrical installations and protection against electric shock. Clause 13 explains

"Where countries not yet having national regulations for electrical installations deem it necessary to establish legal requirements for this purpose, it is recommended that such requirements be limited to fundamental principles which are not subject to frequent modification on account of technical development. The contents of Clause 13 may be used as a basis for such legislation".

Detailed technical requirements are explained in other clauses / parts of IEC 60364.

The British regulation "The Electricity Safety, Quality and Continuity Regulations 2002" simplifies the task of confirmation to IEC 60364 in the regulation 1 (Citation, commencement and interpretation) subclause (5) In these Regulations, unless the context otherwise requires - "British Standard Requirements" means the British Standard Requirements for Electrical Installations BS 7671. Requirements in addition to BS7671 are avoided in the regulation, resulting in strict enforcement of BS7671, avoid misinterpretation. Fundamental principles explained in section 13 of IEC 60364 are thus abided. From 1985, BS7671 follow IEC 60364.

Fundamental principles to be considered in National Regulation (as per IEC 60364)

Fundamental principles to be considered for creating a national electrical safety regulation are methods of protection for safety, design, selection of electrical equipment, erection, and verification.

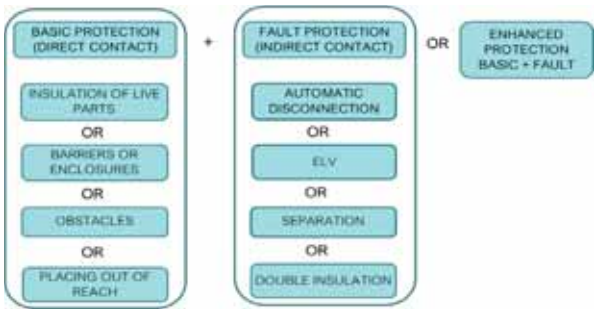

Fig 1: Concept of protection for safety

Protection for safety

The requirements are intended to provide for the safety of persons, livestock and property against dangers and damage which may arise in the reasonable use of electrical installations. Required safety measures are

Protection against electric shock consisting of basic protection and fault protection (also called as direct contact and indirect contact), protection against thermal effects, protection against overcurrent, protection against fault currents, protection against voltage disturbances and measures against electromagnetic influences.

Design

The design shall consider protection for safety and proper functioning of the electrical installation for the intended use.

The design shall be based on characteristics of available supply or supplies, nature of current (a.c/d.c), function of conductors, values and tolerances, (such as voltage, frequency, current, earth fault loop impedance, prospective short-circuit currents, etc), protective provisions inherent in the supply (such as system earthing or midpoint earthing), nature of demand, supply for safety services, environmental conditions,

The design shall comply cross-sectional area of conductors, type of wiring and methods of installation, protective equipment, emergency control, disconnecting devices, prevention of mutual detrimental influence, accessibility of electrical equipment, documentation for the electrical installation

Selection of equipment:

Selection of the electrical equipment is based on compliance of IS/IEC standards, characteristics (such as Voltage, Current, Frequency, Load factor), conditions of installation, prevention of harmful effects.

Erection of electrical installations:

Good workmanship by competent persons and proper materials shall be used in the erection of the electrical installation. Electrical equipment shall be installed in accordance with the instructions provided by the manufacturer of the equipment.

Verification of Electrical installation:

Conditions of Initial verification and sequence of periodic verification shall be selected based on the local conditions by the national regulating body.

From the structure of IEC 60364 it is clear that there are several important subjects which need to be carefully implemented in an installation. An analysis of verification (inspection and testing) can reveal some interesting facts.

Verification of an Installation

As explained in the previous article, the only mandatory testing required as per CEAR-2010 is insulation resistance (as existed from the electricity regulation 1937) and testing of resistance of the earth electrode in soil.

With this background it is interesting to find out the requirements of verification of an LV installation in IS732, Code of practice for electrical wiring.

IS732: 1989 Code of practice for electrical wiring installations (third revision)

IS732: 1989 follows the safety methods of IEC 60364. The foreword of this standard explains

> **There was also a strong need to align the code with the work being accomplished at the international level, namely, at the level of IEC/TC 64 'Electrical Installations of Buildings', which cover comprehensively the relevant issues. This revision of IS:732 (third) is an attempt to improve the contents of the code to meet this need.**

This code of practice for electrical wiring installations shall be considered equivalent to BS7671 of UK or VDE 0100 of Germany or NEC (NFPA70) of USA.

In UK, Germany or USA, an installation in confirmation with the respective national standards are only accepted. The owner may face legal obligations for non-confirmations. In case of an accident, insurance companies reject the claims with the simple reason “not confirming the standard”.

IS 732: 1989: Testing of an installation

Foreword of IS732:1989 further explains

> **There was also a strong need to align the code with the work being accomplished at the international level, namely, at the level of IEC/TC 64 'Electrical Installations of Buildings', which cover comprehensively the relevant issues. This revision of IS:732 (third) is an attempt to improve the contents of the code to meet this need.**

> **"It is emphasized that the information contained in this code is oriented towards electrical safety. The accent is on protection from the various hazards arising from use of electricity and the rules relating to wiring practice are based on the international guidelines on such matters"**

Out of the recommended parameters for testing, majority are not followed in India, few of them are even unknown.

Eg:

1 Main and Supplementary equipotential bonding is not carried out in most modern multi-storeyed buildings in 2020 (31 years after publication of the referred standard). In several critical installation this mandatory electrical safety measure is treated as "dangerous". This subject will be explained in future article.

2 Earth fault loop impedance test has been introduced in 1989, majority of electrical engineers are unaware of the importance of this test and its serious relation with safety.

Both these tests are basic mandatory tests to ensure safety. From this experience, the simple conclusion is "BUILDINGS IN INDIA ARE NOT UP TO NATIONAL STANDARDS". Insurance companies can easily reject claims of accidents on grounds of non-confirmation to IS standards.

The claim "50 to 70 % of fire in buildings are due to SHORT CIRCUIT in buildings" is true if we analyse the implementation of rules in IS732 in a building.

Instead of the mandatory testing as per IS732, industrial consumers often carryout modern testing such as thermography and arc flash study, which in comparison to the mandatory testing's, provide little improvement, finally fail in offering safety.

Practical deteriorations

Installations higher than the notified voltages are to be verified by the electrical inspector. As a result, most large buildings undergo mandatory initial and periodic verification. Consumers try to fulfil the requirements mandated by the Inspector. In contrast a building tested as per IS732:1989, is yet to be found out, unfortunately exhibit the level of seriousness in electrical safety.

How others improve and keep high level of knowledge??

Probably the situation in developed countries few

Section 5 (clause 12 onwards) of IS732:1989 explains the requirements of inspection and testing.

Testing

General - The following items, where relevant, shall be tested in the sequence indicated. Standard methods of testing, in respect of some of the following clauses of this section, are given in appendix C, the use of other methods is not precluded provided that they give no less effective results:

a) Continuity of ring final circuit conductors,

b) Continuity of protective conductors include main and supplementary equipotential bonding.

c) Earth electrode resistance,

d) Insulation resistance,

e) Insulation of site-built assemblies,

f) Protection by electrical separation,

g) Protection by barriers or enclosures provided during rection,

h) Insulation of non-conducting floors and walls,

i) Polarity

j) Earth fault loop impedance,

k) Operation of residual current devices and fault voltage operated protective devices.

decades back was also similar to the present situation India. Those countries initiated the concept of "Chartered Engineer", who are knowledgeable to design, erect and test and electrical installation. It is mandatory for the practicing engineers to undergo regular trainings and write examinations to continue their registrations in the accreditation service.

Several countries made regulations in such a way that large and critical installations, a three-party final certificate (namely Designer, Installer, and Inspector) is mandated by the government in a consumer installation. All the three are practicing engineers listed in the accreditation system. Basic requirement to be a practicing professional is the knowledge on BS7671. This means when there is a change in BS7671, additional trainings and written examinations are necessary.

Eg. Of Accreditation for the Inspection of Low Voltage Electrical Installations in UK by UKAS (United Kingdom accreditation service)

In UK, UKAS provides accreditation to organisations performing various types of inspection, surveys and risk assessments as per ISO/IEC 17020 (Conformity assessment: Requirements for the operation of various types of bodies performing inspection). Electrical Assessment Specification explain the minimum requirements necessary for an engineer to determine his competence to carry out electrical design, construction, maintenance, verification and/or inspection and testing work in compliance with BS 7671.

A person/organisation listed in UKAS system is only eligible to conduct a work related to design, erection, maintenance and inspection of an electrical system. The accreditation service coordinates various agencies to ensure training, conducting tests, supporting the listing process, thereby ensuring proper implementation of the safety rules and standards, in a real "easy of business" way.

However, the practice of a listed engineer in an accreditation system do not exist in India, resulting in wrong installation and finally accident.

Chartered Electrical Safety Engineer: Probable threat for electrical safety in future

Electrical safety is not part of our education system in India. The only way people learn is from field. Standards are available but not in reach to practicing engineers. As a result, rather than adopting new and innovative installation methods, engineers follow the existing and old field practices. New and innovative products are accepted, but the knowledge on installation techniques deteriorated due to misinterpretation. CEAR amendment 2015 made an attempt to create chartered electrical safety engineer. The following regulations are created/amended for this purpose.

Regulation 5A. Chartered Electrical Safety Engineer.

The Appropriate Government may authorise Electrical Safety Engineers having the qualification and experience as specified in sub-regulation (2) of regulation 5 to assist the owner or supplier or consumer of electrical installations for the purpose of self-certification under regulation 30 and regulation 43.

Regulation 43. Approval by Electrical Inspector and self-certification.

(1) Every electrical installation of notified voltage and below shall be inspected, tested and shall be self-certified by the owner of the installation before commencement of supply or recommencement after shutdown for six months and above for ensuring observance of safety measures specified under these regulations and such owner shall submit the report of self-certification in the Form-I or Form-II or Form-III, as the case may be, of Schedule-IV to the Electrical Inspector.

Improvement of electrical safety in future.

The new provisions of the regulation simplify the system to "easy of business". However, its implementation is going to create a wide gap in knowledge due to the lenient guidelines in the regulation, which is evident from the list of instruments required for an inspection. Hence the following recommendations may be adopted for improvement;

1 Syllabus of the safety engineer - modern safety measures and installation practices from IS and IEC standards must be included in syllabus. Remove the parts in syllabus which are of administrative purpose.

2 Forms for testing an installation - not in line with the modern international requirements. In the current version of regulation, the forms look like an information collection.

3 Majority of accidents are in LV system – Make verification as per IS732:2019 and National Electrical Code of India, mandatory in all LV installation. Chartered electrical safety engineer shall test the installation based on this standard, which is similar to electrical safety standards such as BS7671 in UK or VDE0100 in Germany.

4 A centralised written examination based on the syllabus shall be included. State governments can enlist anyone who gets qualified. A further improved version is to implement a system similar to UK (if the government is interested in safeguarding life and property). Implement a national accreditation system for safety engineers or implement an IEC

Conformity Assessment Systems, similar to the one followed in developed nations.

5 A new provision in the regulation to ensure that the Chartered Electrical Safety Engineer is responsible in case of an accident in the installation.

Lack of knowledge on modern installation standards among law enforcing authority is one of the major causes of electrical accidents now. Implementing Chartered Electrical Safety Engineer, with the current methods adopted in regulation 2015 will allow convenient negligence of safety requirements due to lack of knowledge by the chartered electrical safety engineer.

Convenient negligence of safety requirements:

Majority of accidents in LV system are due convenient negligence. The next articles discuss about this subject. Main reason for the negligence is the misinterpretations of the standards and regulations by the engineering community.

Practical solution for India

In 1992, The Government of India established The Quality Council of India (QCI) as an accreditation body in the country to establish internationally acceptable mechanism for recognition of conformity assessment results. The main objective of QCI as per their website is

a)	To lead nationwide quality movement in the country through National Quality Campaign aimed at creating awareness amongst citizens, empowering them to demand quality in all spheres of activities, and promoting and protecting their well-being by encouraging manufacturers and suppliers of goods and service providers for adoption of and adherence to quality standards and tools.
b)	To develop apropos capacities at the level of Governments, Institutions and enterprises for implementing & institutionalizing continuous quality improvement.
c)	To develop, establish & operate National Accreditation programmes in accordance with the relevant international standards & guides for the conformity assessment bodies certifying products, personnel, management systems, carrying out inspection and for the laboratories undertaking testing & calibration and such other areas of organized activities that have significant bearing in improving the quality of life and well-being of the citizens of India.
d)	To develop, establish and operate National Accreditation Programmes for various service sectors such as education, healthcare, environment protection, governance, social sectors, infrastructure sector, vocational training etc., to site a few, as may be required, based on national/international standards and guidelines and where such standards are not available, to develop accreditation standards to support accreditation programs.
f)	To build capacities in the areas of regulation, conformity assessment and accreditation to overcome TBT/SPS constraints.
g)	To encourage development & application of third-party assessment model for use in government, regulators, organizations and society.
h)	To promote quality competitiveness of India's enterprises especially MSMEs through adoption of and adherence to quality management standards and quality tools.

A simple, practically possible and easy solution for India is to set up a national accreditation service for engineers and organisations working in electrical safety

based on ISO/IEC 17020 guideline, a system similar to European countries.

The regulation 5 A in CEAR:2015 shall be amended to in a meaning such as Chartered electrical safety engineer is an engineer accredited by the national accreditation body.

Creating an accreditation system ensure

- Improvement in knowledge about electrical safety requirements, avoid mis-interpretations;
- Proper implementation of safety rules and regulations to the mass, one rule across India;
- Easy of business;
- Mass skill development and new employment opportunity;
- Reduction of electrical accidents, reduction of loss of life from current average 15000 annually, reduction in number of cases related to “FIRE DUE TO SHORT CIRCUIT”;
- Proper functioning of IOT based electrical distribution, microgrids and PROSUMER installations, which is on the verge of starting in the nation.

Conclusion

1. Internationally adopted technique for Low Voltage electrical safety is to follow IEC 60364 for design, erection and testing of an LV system. Product standards follow the requirements of IEC 60364. India already adopted the latest version of IEC 60364 as IS732:2019 (Code of practice for electrical wiring installations).

2. Simplify CEAR-2010, recognising IS732:2019 as national wiring rule (similar to the systems in UK, Germany, USA, France etc) is the only easy and practically possible solution for safety inside a consumer installation.

3. If conclusion as no.2 is not possible, include complete IS732 in regulation.

4. Create an accreditation system for Chartered Electrical Safety Engineer and ensure that they are responsible for design, and verification of the installation at least in high raise buildings and industries. ■

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Member in Working group 3 and 5 in sectional committee 37 A of IEC. MT 3, MT 12, MT 41, PT 60364-8-3, WG 43 TC-64 of IEC. National Building Code-2016 (electrical committee) of Bureau of Indian Standards. ETD 20 & ETD 30 of Bureau of Indian Standards