Future developments in the IEE Wiring Regulations (BS 7671:2008)

A brief overview

by Geoff Cronshaw

CENELEC, the European Committee for Electrotechnical Standardization, publishes two kinds of standards, the European Standard (EN) and the Harmonised Document (HD). The HD and EN differ slightly. The EN must be literally transposed as it is, word for word, in all CENELEC member countries, where as, for the HD it is only the technical content that must be transposed into national standards. BS 7671, *Requirements for Electrical Installations,* takes account of the technical intent of CENELEC Harmonization Documents.

Currently there are three main areas of development which it is expected will be included within a future amendment to BS 7671:2008; these are:

- Section 710 - Medical locations
- Section 444 - Measures against Electromagnetic Influences, and
- Section 534 - Devices for Protection against Overvoltage (Surge Protection Devices)

Section 710 applies to electrical installations in medical locations so as to ensure safety of patients and medical staff. These requirements, in the main, refer to hospitals, private clinics, medical and dental practices, healthcare centres and dedicated medical rooms in the work place. This Section also applies to electrical installations in locations designed for medical research. The requirements of this Section do not apply to medical electrical equipment.

Section 444 deals with measures against electromagnetic disturbances. Electromagnetic Interference (EMI) may disturb or damage information technology equipment/systems as well as equipment with electronic components or circuits. Currents due to lightning, switching operations, short-circuits and other electromagnetic phenomena may cause overvoltages and electromagnetic interference. Section 444 provides basic requirements and recommendations to enable the avoidance and reduction of electromagnetic disturbances.

Section 534 deals with the installation of surge protective devices (SPD). The requirements of Section 534 are for the selection and erection of SPDs for electrical installations of buildings in order to limit transient overvoltages of atmospheric

origin transmitted via the supply distribution system and against switching overvoltages. The requirements are also intended to protect against transient overvoltages caused by direct lightning strikes or lightning strikes in the vicinity of buildings, protected by a lightning protection system.

The requirements do not take into account surge protective components, which may be incorporated in the appliances connected to the installation.

SECTION 710 - MEDICAL LOCATIONS

The risks

There are particular risks associated with medical locations. Therefore stringent measures are necessary to ensure the safety of patients likely to be subjected to the application of medical electrical equipment.

Shock hazards, due to bodily contact with the 50 Hz mains supply, are well known and documented. Currents of the order of 10 mA passing through the human body can result in muscular paralysis followed by respiratory paralysis depending on skin resistances, type of contact, environmental conditions and duration. Eventual ventricular fibrillation can occur at currents just exceeding 20 mA. These findings are listed in IEC/TR2 60479-1 'Effects of current on human beings and livestock – general aspects'.

The natural protection of the human body is considerably reduced when certain clinical procedures are being performed on it. Patients under treatment may have their skin resistance broken or their defensive capacity either reduced by medication or nullified while anaesthetised. These conditions increase the possible consequences of a shock under fault conditions.

In patient environments where intracardiac procedures (see note1) are undertaken, the electrical safety requirements are even stricter, in order to protect the patient against 'microshock'. Patient leakage currents from applied parts introduced directly to the heart can interfere with cardiac function at current levels which would be considered safe under other circumstances.

Patient leakage current which can flow into an earthed patient is normally greatest when the equipment earth is disconnected. A limit is set to the amount of leakage current which can flow in the patient circuit when the protective earth conductor is disconnected. Patient leakage currents (see note 2) of the order of 10 µA have a probability of 0.2 % for causing ventricular fibrillation or pump failure when applied through a small area of the heart. At 50 µA (microshock), the probability of ventricular fibrillation increases to the order of 1 % (refer to BS EN 60601-1).

Note (1)
"intracardiac procedure": This is a procedure whereby an electrical conductor is placed within the heart of a patient or is likely to come into contact with the heart, such conductor being accessible outside the patient's body. In this context, an electrical conductor includes insulated wires, such as cardiac pacing electrodes or intracardiac ECG electrodes, or insulated tubes filled with conducting fluids (catheter).

Note (2)
"Patient's leakage current": Current flowing from a medical electrical equipment applied part via the patient to earth.

Additional to the consideration of risk from electric shock, some electromedical equipment (life-support equipment, surgical equipment) perform such vital functions that loss of supply would pose an unacceptable risk to patients. Medical locations where such equipment is used require secure supplies. This has implications not only for the provision of safety (emergency) power supplies but also render some conventional protection measures unsuitable. Hence, for example, when protecting circuits supplying critical medical equipment, restrictions are stipulated on the use of RCDs.

Additional measures

Since the type and description of these hazards can vary according to the treatment being administered, the manner in which a medical room is used necessitates some division into different areas for differing medical procedures. Section 710 segregates medical locations into different "Groups". These are:

Group 0 medical location where no applied parts are intended to be used and where discontinuity (failure) of the supply cannot cause danger to life.

Group 1 medical location where discontinuity of the electrical supply does not

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represent a threat to the safety of the patient and applied parts are intended to be used as follows:

- externally
- invasively to any part of the body, except where 710.3.7 applies

Group 2 medical location where applied parts are intended to be used in applications such as intracardiac procedures, vital treatments and surgical operations where discontinuity (failure) of the supply can cause danger to life.

To protect patients from possible electrical hazards, Section 710 requires additional protective measures to be applied in medical locations. These include:

- particular requirements for protection against electric shock
- medical IT systems
- requirements concerning supplementary equipotential bonding
- additional requirements for the selection and erection of electrical equipment including switchgear and controlgear
- safety services including the sources and detailed requirements for safety lighting

SECTION 444 - MEASURES AGAINST ELECTROMAGNETIC DISTURBANCES

Section 444 provides basic requirements and recommendations to enable the avoidance and reduction of electromagnetic disturbances. These include the use of surge protection devices and/or filters, the routing of conductors (live and protective conductors) of a power circuit to avoid inductive loops, by-pass equipotential bonding conductor for screen reinforcement and the separation of power and signal cables.

Section 444 requires that consideration must be given to the location of the sources of electromagnetic disturbances relative to the positioning of other equipment. Potential sources of electromagnetic disturbances within an installation typically include:

(i) Switching devices for inductive loads
(ii) Electric motors
(iii) Fluorescent lighting
(iv) Welding machines
(v) Rectifiers
(vi) Choppers
(vii) Frequency converters/ regulators including Variable Speed Drives (VSD)
(viii) Lifts
(ix) Transformers
(x) Switchgear
(xi) Power distribution busbars

Note: For further information refer to the BS EN 50174 Series of Standards

Section 444 includes the following measures to reduce the effects of electromagnetic interference:

(i) Metal sheaths, screens or armouring of cables shall be bonded to the CBN unless such bonding is required to be omitted for safety reasons.

(ii) Where screened signal or data cables are earthed, care shall be taken to limit the fault current from power systems flowing through the screens and cores of signal cables, or data cables.

(iii) The use of additional conductors shall be considered, e.g. a by-pass equipotential bonding conductor for screen reinforcement.

(iv) The impedance of equipotential bonding connections intended to carry functional earth currents having high frequency components shall be as low as practicable and this should be achieved by:

(a) being as short as possible, and either
(b) having a shape that results in a low inductive reactance and impedance per metre of route, e.g. a bonding strap/strip (with a width:thickness ratio of at least 5:1 and a length: width ratio of no greater than 5:1) or a braid or
(c) the use of separated multiple bonds

(v) The use of surge protection devices and/or filters to improve electromagnetic compatibility with regard to conducted electromagnetic phenomena for electrical equipment sensitive to electromagnetic disturbances.

(vi) The selection of a common route for all the conductors, (live and protective conductors) of a power circuit to avoid inductive loops.

(vii) The separation of power and signal cables.

Where a lightning protection system is installed, reference shall be made to BS 6651 (BS EN 62305).

Section 444 also includes requirements on earthing, equipotential bonding, segregation of circuits and cable management systems.

The appendices to this section include examples of protective conductors in star network, multiple meshed bonding star network, common meshed bonding star network, equipotential bonding networks in a structure without a lightning protection system and examples of Cable Separation and Segregation.

SECTION 534 - DEVICES FOR PROTECTION AGAINST OVERVOLTAGES

Section 534 deals with the installation of surge protective devices (SPD) where required by Section 443 of BS 7671:2008 or where otherwise specified by the designer.

This Section sets out the requirements for the selection and erection of

– SPDs for electrical installations of buildings to obtain a limitation of transient overvoltages of atmospheric origin transmitted via the supply distribution system and against switching overvoltages
– SPDs for the protection against transient overvoltages caused by direct lightning strokes or lightning strikes in the vicinity of buildings, protected by a lightning protection system.

Surge protective components incorporated into appliances are not taken into account.

Generally, any switching

operation, fault initiation, interruption, etc., in an electrical installation is followed by a transient phenomenon in which overvoltages can occur. The sudden change in the system can initiate damped oscillations with high frequencies (determined by the resonant frequencies of the network), until the system is stabilised to its new steady state. The magnitude of the switching overvoltages depends on several parameters, such as the type of circuit, the kind of switching operation (closing, opening, restriking), the loads and the protection device. In most cases, the maximum overvoltage is up to twice the amplitude of the system voltage but higher values can occur, especially when switching inductive loads (motors, transformers) or capacitive loads or even resistive loads connected very near to the terminals of a supply transformer. Also, interruption of short-circuit currents can cause high overvoltages. If current chopping occurs, relatively high energy can be stored in inductive loads and oscillations can occur on the load side of the opening switch or protective device.

As detailed within BS EN 62305 *"Protection against lightning"*, surges present a risk of dangerous sparking or flashover leading to possible fire and electric shock hazards. Surges also present risk of disruption, degradation and damage to electrical and electronic equipment leading to costly system downtime.

A surge protective device (SPD) is a device that is intended to limit transient overvoltages and divert surge currents. SPDs shall have the necessary capability to deal with the current levels and durations involved in the surges to be expected at their point of installation. In most cases, switching overvoltages are less damaging than lightning overvoltages and SPDs which are effective for protection against lightning overvoltages are also effective against switching surges. SPDs shall comply with BS EN 61643-11 and BS EN 61643-11/A11.

Section 534 contains detailed requirements for the selection, erection and co-ordination of SPDs in building installations. These include the use of SPDs and the connection of SPDs. Also, protection against overcurrent and consequences of an SPD failure are dealt with together with fault protection, SPD installation in conjunction with RCDs, Measurement of the insulation resistance, and the connecting conductors.

FURTHER INFORMATION

Important: this article is only intended as a brief summary of possible forthcoming requirements in BS 7671. Persons involved in these areas should seek specialist advice. For information on the installation of surge protective devices see HD 60364-5-534. For information on medical locations seek advice from the UK Health Departments.

CONCLUSION

Under these new sections designers and persons involved in electrical installations will have detailed requirements to follow for:

(i) the avoidance and reduction of electromagnetic disturbances
(ii) the installation of surge protective devices (SPDs)
(iii) medical locations.

A future amendment to the IEE Wiring Regulation (BS 7671:2008) incorporating these changes is expected during 2011. ■