WiringMatters

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Amendment No. 3: lighting and luminaires

Chief Engineer Geoff Cronshaw looks at how lighting and luminaires have been affected by Amendment No. 3.

Sections 559, 714 and 715: luminaires and lighting installations

Amendment No. 3 introduces a number of notable changes to align the BS 7671 requirements with the latest versions of both the IEC and CENELEC standards. Examples of these intended changes include:

- moving the requirements for outdoor lighting and extra-low voltage lighting installations from Section 559 to two new sections, Section 714 and Section 715;
- requirements for the type of devices that are to be used for the connection of luminaires to the supply and the protection of cables against heat and UV radiation effects within luminaires; and
- the introduction of requirements for protection against electric shock for display stand luminaires.

Section 715 Extra-low Voltage Lighting

Amendment No. 3 makes a number of notable changes to align the latest IEC requirements with the latest CENELEC requirements, including:

- the types of wiring systems permitted;
- voltage drop in consumer's installations; and
- requirements for isolation, switching and control.

Section 714 Outdoor Lighting Installations

Amendment No. 3 makes only minor changes to outdoor lighting installations. One important change is that individual circuits will be required to be isolated.

Protection against fire: the fire officer's view

The London Fire Brigade have an extremely busy, full time team of professional fire investigators. The team attend about 2000 fires a year across London. As part of the Fire Safety Regulation department, the team seek to produce quality evidence to help improve public safety.

Fires in plastic consumer units
A pattern of fires emerges

Back in 2011, the Fire Investigation Team identified an increase in the number and severity of fires involving consumer units. The team started looking carefully at the cause of those fires and established that there were issues with high resistance connections, where cables were not secured properly. This had the potential to lead to localised heating, arcing and, in some cases, to fires. There was also an emerging problem due to a large batch (over 1 million units) of non-compliant miniature circuit breakers (MCBs), which were subject to a product recall and which could also fail catastrophically.

Severe fires

The team were also seeing more fires that were spreading beyond the consumer unit and putting people's lives at risk. Through a careful process of laboratory examinations and tests at Brigade consultant scientists Bureau Veritas, concern was raised about the flammability of the plastic enclosures of consumer units. Working closely with Electrical Safety First, more extensive tests of five plastic consumer units from different manufactures were carried out in 2012. These tests gave significant cause for concern due to the intensity of the fire and the levels of toxic smoke produced.

Testing of a small piece of plastic from a consumer unit with a heated 'hot wire'.

Note the strong flame and large amount of toxic smoke being produced from the small plastic sample.

A consumer unit test in progress - the fire rapidly burnt through mountings causing the test to be stopped.

Location, location, location

A significant cause for concern when a consumer unit becomes involved in a fire is that it is commonly located on an escape route, for example, under the stairs or behind the front door. When this is combined with the fairly usual situation of coats, outdoor wear and other household items being stored nearby, once the fire starts, it often develops very quickly. London Fire Brigade was becoming extremely alarmed at the number of injuries occurring at such fires and the need for people to be rescued as they became trapped when the escape route was involved in fire.

A way forward

Working with Electrical Safety First, industry body BEAMA and other stakeholders, the process of presenting evidence for change began. A JPEL/64 project group was set up and 'robust' discussions about possible changes to BS 7671 (the Wiring Regulations) continued over several months.

Representatives from the Department of Communities and Local Government (DCLG) attended and raised concerns about possible changes. As a result of these concerns, DCLG commissioned independent tests at the Building Research Establishment (BRE). BRE tested two plastic and two metal consumer units and the subsequent report appeared to strongly support the need for change, stating:

"Both plastic consumer units caught fire and their casings became involved in the fire"… … "Both metal consumer units contained the fire within the unit" (Source: BRE report BD2890)

Also, some manufacturers ran their own tests, the outcomes of which again demonstrated the need for change.   This led to a new regulation to be included in Amendment No. 3 to BS

7671, effectively requiring consumer unit enclosures in domestic households to be manufactured from non-combustible material (such as steel) or to be enclosed in a cabinet or enclosure constructed of non-combustible material. This new regulation is a welcomed step-change improvement in fire safety.

Following a fire under the stairs, the stair treads have burnt through, the ceiling has failed and the plaster has come off the wall.

This photo shows a fire involving a plastic consumer unit (bottom) and a metal consumer unit (top). In the experience of the LFB, when a fire originates within a metal consumer unit (even without sealed grommet holes and the plastic MCB cover failing), the fire is still generally contained to the consumer unit.

Wiring in escape routes

Fire and Rescue Services up and down the country have been acutely aware of this problem for some time, with cable entanglement directly or indirectly contributing to the death of 8 firefighters.

2005: 2 Firefighter deaths in Stevenage – the Coroner at the inquest stated that cabling and trunking contributed to their deaths and issued a 'Rule 43' report.

2007: 4 Firefighter deaths in Warwickshire – the Coroner stated that the failure of the trunking was a factor.

2010: 2 Firefighter deaths in Southampton – the Coroner reiterated the Rule 43 report from the 2005 case in Stevenage.

Firefighters enter buildings on fire to save life and reduce property damage, often working in intense heat, toxic smoke and with very poor visibility. To do this, they have to wear breathing apparatus and fire resistant clothing for protection. The problem has been that cables and plastic trunking have fallen from the ceilings at a very early stage during the fire's development, leaving the cables hanging. These cables have then become tangled around the firefighter's breathing apparatus, leaving them trapped and running out of air. Fire and Rescue Services such as London Fire Brigade have tried to reduce the risk to their firefighters by modifying the breathing apparatus and issuing firefighters with wire cutters, but this is only a 'best fix', it does not address the real issue.

The evidence that arose from such tragic incidents has been used to support change, which resulted in the new regulation in Amendment No. 3, requiring cables in escape routes to be adequately supported against their premature collapse in the event of a fire. The regulation precludes the use of non-metallic cable clips, cable ties or cable trunking as the sole measure of support. Firefighters have enough dangers to face without the additional risk of becoming entangled in dropping cables, so this new regulation is applauded.

This photo shows a face mask of a London firefighter who had a lucky escape after cables got tangled round the face mask.

Group 2 medical locations: designing IT systems

Paul Harris, an independent consultant working with the medical locations working group for BS 7671 and author of *Electrical Installations in Medical Locations* (due to be published by the IET later this year), discusses medical IT system final design.

This article focuses on the specific challenges that may arise when designing medical IT system final circuits for Group 2 medical locations in healthcare environments. It highlights the application of regulations that are located in the general requirements that are important to medical IT circuit design.

 A medical location is defined as 'Group 2' in BS 7671 and supporting books, such as IET Guidance Note 7, as a:

Medical location where applied parts are intended to be used, and where discontinuity (failure) of the supply can cause danger to life…

For a number of reasons, designers are often faced with the challenge of providing medical IT system final circuits, often referred to as IPS circuits, that are longer than those that are laid out in current standard arrangements provided by manufacturers and associated guidance.

Electrical designers working in the design of healthcare facilities are faced with a number of questions relating to Group 2 medical locations and, in particular, the design of medical IT system final circuits. The questions range from: 'Can the IT system be run in the same containment system as TN circuits?' to 'How far can I run an IT final circuit?'

The latter question is usually based on the fact that there is insufficient space to accommodate the medical IT system cabinet in the necessary area. There is currently a trend amongst design teams to maximise useable floor space within a given footprint. Consequently, in trying to push the boundaries of design, often to the cost of electrical distribution, there is little or no space available for switchgear. This can particularly affect the siting of medical IT System cabinets, which are usually referred to as 'the IPS unit'.

Designers are then challenged as to why this piece of equipment cannot be located in a plantroom on another floor. This often happens, particularly on retrofit projects where the footprint has already been used for many years. In refurbishing the area and accommodating the medical IT cabinet this may mean that a clinical service space needs to be surrendered for use as equipment space, which is obviously not ideal.

Designers should consider the fact that although it is referred to as an 'IPS unit', it is in fact a distribution board for specialist circuits with isolation transformer and monitoring systems integral to the unit. Consequently, designers should consider the physical access connectivity between IT system cabinets and the location it serves, resisting where possible the temptation to hide these units in remote plant rooms – i.e. the IT system may be directly above the final circuit it serves but it is a considerable distance for maintenance staff to operate and maintain.

In standard circuit design there are obvious lengths of run limitations, which will determine this value such as voltdrop, disconnection times etc. These values can be corroborated through simple calculation, usually using proprietary software, which usually focuses on maximum Z_s values to meet disconnection times. However, as proprietary software does not directly deal with IT systems, an alternative approach needs to be taken.

Looking at the challenges for a designer, they are faced with the fact that a medical IT system is so designed that it does not fail on first fault to earth, so the usual concept of disconnection times for TN systems is not applicable.

Chapter 41 of BS 7671 deals with this by requiring IT systems that do not disconnect the supply on first fault by having warning measures, which is augmented in Section 710 Medical Locations.

Where a supply does not disconnect upon first fault, it effectively means that the system has now temporarily become a TN system. Regulation 411.6.4 requires that an IT system where the midpoint conductor is not distributed (as it is with a medical IT system) is able to meet the following requirements:

$$Z_S \leq \frac{U \times C_{min}}{2I_a}$$

where:

U   is the nominal a.c. rms or d.c. voltage, in volts, between line conductors.

Z_s is the impedance in ohms of the fault loop, comprising the line conductor and the protective conductor of the circuit.

I_a is the current in amperes (A) causing operation of the protective device within the time specified in Table 41.1 of Regulation 411.3.2.2, or as appropriate, Regulation 411.3.2.3, for a TN system.

C_{min} is the minimum voltage factor to take account of voltage variations depending on time and place, changing of transformer taps and other considerations. The value used is currently 0.95.

This has always caused an element of confusion as, technically, with an isolated system there is no Z_s. However, in a healthy circuit, considering the following scenario, the term Z_s is applicable even if it's not in the usual context.
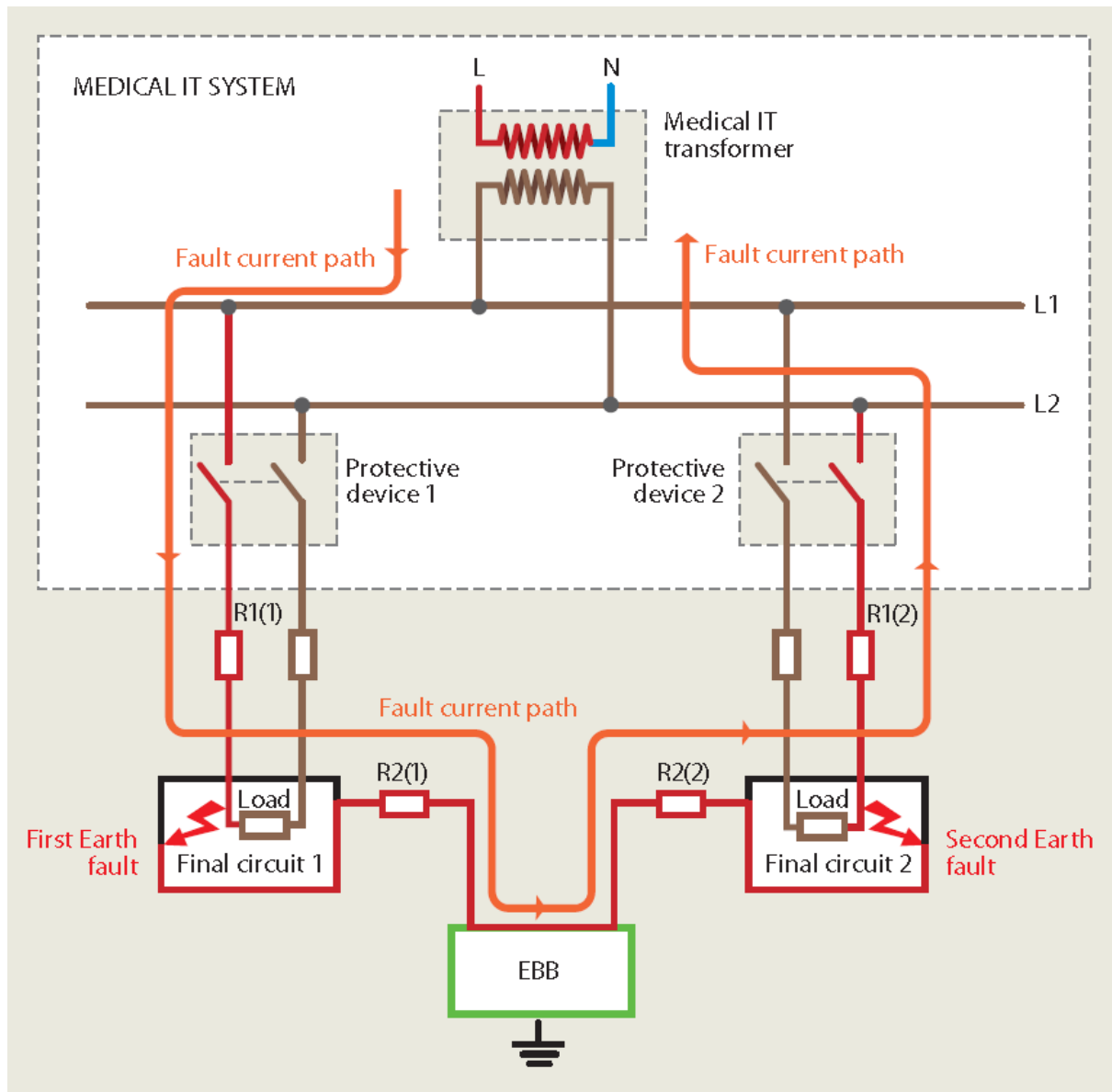
We can therefore see that there is an earth fault loop that is comprised of the impedance of:

(a) the secondary winding (which effectively would be Z_e);
(b) L1 to the point of fault (which would be R1(1) in the diagram);
(c) L2 to the point of fault (which would be R1(2)in the diagram); and
(d) the earth path in the diagram, which would be between the points of fault and, in a Group 2 medical location, would be through the protective conductors and the supplementary bonding conductor for that location.

Relating the values back to the standard formula as above, we would find that:

$Z_s = Z_e + (R1 + R2)$

where:

Z_e is the impedance of the transformer secondary.

LOR   is the length of run of the cable in metres (m)

R1 = (R1(1) x LOR) +(R1(2) x LOR)Ω

R2= (R2(1) x LOR) +(R2(2) x LOR)Ω

We can use the manufacturer's data to find Z_s, for example:

Z of 10 kVA transformer = 0.158 Ω

Z of 8 kVA transformer = 0.198 Ω

I_a for a 20 A Type B MCB =100 A

I_a for a 20 A Type C MCB =200 A

Consequently, applying the formula in Regulation 411.6.4 for a 20 A Type B device with a 10 kVA transformer gives the following maximum Z_s:

$$Z_s= \frac{230 \times 0.95}{2 \times 100 \text{ A}} = \mathbf{1.0925 \ \Omega}$$

Using the same transformer with a 20 A Type C MCB:

$$Z_s= \frac{230 \times 0.95}{2 \times 200 \text{ A}} = \mathbf{0.54625 \ \Omega}$$

Using the same transformer with a 20 A Type D MCB:

$$Z_s= \frac{230 \times 0.95}{2 \times 400 \text{ A}} = \mathbf{0.2731 \ \Omega}$$

Using the 20 A type B results:

$$Z_s= 1.0925 = Z_e + (R1+R2)$$

Resulting in (R1+R2) = 1.0925-0.158= **0.9345 Ω**

If the maximum impedance for any exposed or extraneous conductive part to the equipotential bonding busbar (EBB) is 0.1 Ω (set out by previous guidance) then the R2 maximum value would be 0.2 Ω.

Applying this to the formula:

R1 = 0.9345-0.2 = **0.7345 Ω**

As the formula in Regulation 411.6.4 uses the factor 2 x I_a the formula takes into account that there are two circuits involved. The R1 impedance divided by the length of run (LOR) will

therefore provide the theoretical maximum cable length (subject to volt drop and energy let-through limitations).

Using the 70 °C copper cable values from IET Guidance Note 1 we can see the following values for Ohms per metre of cable at a particular size:

2.5 mm = 0.0889 Ω/m, 4 mm=0.0553 Ω/m, 6 mm = 0.037 Ω/m

Consequently, if R1 =using a 4.0 mm^2 cable, this would give a maximum theoretical length (subject to capacitive coupling, volt drop and energy let through limitations) of:

Max LOR = 0.7345/0.00553 = **132.8 m**

If we use the same equipment but using the 20 A Type C device we find the following:

Using the same transformer with a 20 A Type C MCB:

$$Z_s= \frac{230 \times 0.95}{2 \times 200\ A} = \textbf{0.54625 Ω}$$

Applying the above formula we find that the value for R1 is now **0.34625 Ω.**

This equates to a theoretical **62 m** maximum length of run using 4.0 mm^2 cable.

If a smaller value of transformer is used the corresponding increase in impedance of the transformer will affect the LOR available for the designer to use.

Having obtained a theoretical LOR we still need to satisfy touch voltage requirements of Regulation 710.411.3.2.5, which limits the touch voltage on simultaneously accessible parts to 25 V.

We therefore apply the following formula:

for a.c. systems:

$$R_A \times I_d = 25\ V$$

where:

R_A is the sum of the resistance in Ω of the earth electrode and protective conductor for the exposed-conductive-parts.

I_d is the fault current in A of the first fault of negligible impedance between a line conductor and an exposed-conductive-part. The value of I_d takes account of leakage currents and the total earthing impedance of the electrical installation.

Applying this formula we see that with a 20 A Type B device I_a = 100 A.

Thus:

0.2 x 100 =20 V

A value of 20 V is acceptable.

However, applying this to a 20 A Type C device:

0.2 x 200= 40 V

This is not acceptable, and we therefore need to determine a value to meet the requirement.

R_A = 25 V/200 = **0.125 Ω**

Likewise for a Type D with I_a being 400 A, the value would be:

R_A = 25 V/200 = **0.0625 Ω**

As this demonstrates, the standard values indicated in early guidance are provided for pre-determined protective device solutions.

Using the above information, where a design varies from a 20 A Type B protective device, the practice of providing separate protective conductors and isolation washers appears almost counterintuitive in terms of reducing touch voltages (U_L).

Designers are to take into account inrush currents etc., which may cause the characteristics of protective devices to be changed from the 20 A Type B devices implied in guidance such as HTM 06-01 A. In those instances account should be taken of the resulting touch voltage U_L, which is potentially created by using standard impedance values.

In summary, this article is not advocating that designers should go out and extend all the medical IT system circuits to maximum permissible lengths, as there may be other factors that affect the design and ultimately compliance. Nor is it suggesting that medical IT system cabinets 'have' to be located in the medical location, which may compromise clinical functionality.

As with most design scenarios, the design of medical locations is often a balance of a number of factors. What this article intends to demonstrate is that there is no definite 'one size fits all' solution. It is the responsibility of the designer to consider all the relevant factors in each individual installation design.

Consumer unit forum – video

FIRE PROTECTION: PANEL DISCUSSION 1 AT THE ELEX SHOW IN HARROGATE

The IET industry forum brought together a panel combining the technical expertise of the NICEIC, ELECSA, NAPIT and STROMA to discuss key issues affecting installers.

Escape routes forum – video

FIRE PROTECTION: PANEL DISCUSSION 2 AT THE ELEX SHOW IN HARROGATE

The IET industry forum brought together a panel combining the technical expertise of the NICEIC, ELECSA, NAPIT and STROMA to discuss key issues affecting installers.