Mythbuster #9 - ‘Flexible cables are not permitted in fixed installations’

By: James Eade

This myth was inspired by a comment on the IET EngX Forum and is not uncommon. The origins of it are unclear but seem to date back to the 15th Edition of the IEE Wiring Regulations (if not before) and is believed to have stemmed from the types of insulation materials used for flexible cables in years gone by.

In the 16th Edition there were definitions for flexible cables (for example, a cable designed to be flexed in use) and flexible cords (a flexible cable with conductor CSAs of 4 mm² or less), but no reference to them being specifically prohibited.

Like phase separation, the memories of some old requirements linger on. In the 16th Edition (including AM2, 2004), Regulation 521-01-04 did state that “A flexible cable or flexible cord shall be used for fixed wiring only where the relevant provisions of the regulations are met”. This requirement does come across in a negative fashion, giving the impression that flexible cables may be used as something of a last resort. Interestingly this requirement still exists today in BS 7671:2018+A2:2022 in Regulation 521.9 as follows:

521.9 Use of flexible cables

521.9.1 A flexible cable shall be used for fixed wiring only where the relevant provisions of the Regulations are met. Flexible cables used for fixed wiring shall be of the heavy duty type unless the risk of damage during installation and service, due to impact or other mechanical stresses, is low or has been minimized or protection against mechanical damage is provided.

NOTE: Descriptions of light, ordinary and heavy duty types are given in BS EN 50565-1.

Continuing with the current edition, Regulations 521.9.2 and 521.9.3 go on to require flexes to be used for connecting equipment that may be moved during use. The definition of flexible cords has also gone, leaving just flexible cables listed in Part 2. However, there is still no prohibition on their use.

The main differences between cables used for installations and flexible cables are the use of Class 5 finely stranded conductors rather than Class 1 (solid) or Class 2 (semi-stranded), coupled with differences in insulation materials to allow for the flexibility. Such cables are in widespread use from construction sites to events (where they are used almost exclusively), as well, of course, as final connections in installations for lighting fixtures or from fused connection units to equipment such as heaters for example.
Having decided to wire your installation in flexible cable, what are the ‘relevant provisions of
the Regulations’ alluded to in 521.9.1? As well as complying with the general rules, there are
a couple of key points to note with this as follows:

(a) The flexible cable should have appropriate mechanical robustness for the application as
described in the note to the Regulation which refers to BS EN 50565-1. This Standard
describes various categories, summarised thus:
   i. “Heavy duty” describes the stresses that might be expected in, for example,
      industrial and agricultural premises;
   ii. “Ordinary duty” describes the stresses that might be expected in, for example,
       domestic, commercial and light industrial applications;
   iii. “Light duty” applications might include flexible cables for small appliances; and
   iv. “Extra light duty” applications are, for example, very small appliances such as electric
       shavers, chargers for mobile phones, etc.

Where this protection cannot be achieved using the cable alone, suitable additional
mechanical protection should be provided.

(b) The temperature rating of the flexible cable should be suitable for the connected wiring
accessories (Regulation 526.4).

(c) Wiring terminations may need to be finished in an appropriate termination as required of
Regulation group 526.9. Guidance Note 3 has details on appropriate wiring accessory
terminals and their markings in Table 2.1.

(d) Generally, all the current-carrying capacity and voltage drop tables in Appendix 4 are for
Class 1 and Class 2 stranded, with the exception of Tables 4F1 to 4F3. The current carrying
capacity and voltage drop may need to be corrected if using tables for other cables, such as
PVC cables complying with the insulation and temperature requirements of Table 4D2.

Information is given in section 2.4 of Appendix 4.

Far from being prohibited, flexible cables are required in some parts of BS
7671:2018+A2:2022 and examples include:

- Regulation 422.3.201 permits their use for locations where a particular risk of fire exists,
  although has some requirements for their construction or protection as detailed in
  Regulation Group 521.9;
- Regulation 413.3.4 has a particular requirement concerning their use in parts of the
  installation with protective measure double or reinforced insulation;
- Regulation 418.3.6 for electrical separation to more than one item of equipment requires
  flexible cables to incorporate a protective conductor;
- They are required to be used for suspended current-using equipment (Regulation 522.7.2);
- They are required in installations in flexible structures, or where structures are intended to
  be moved (Regulation 522.15.2);
- There are minimum cross-sectional areas for flexible cables "for any other application" in
  Table 52.3;
- Flexible cables are required for the connection of equipment that may be regularly or
  occasionally moved in use (Regulations 521.9.2 and 521.9.3);
- Flexible cables are required a method of connection of equipment having a high protective
  conductor current as detailed in Regulation 543.7.1.202; and
- Some Part 7 special locations specify certain wiring systems, for which flexible cables are
  options, or mandated as noted in Regulation 522.15.2: (Regulation Group 704.522.8,
As ever, it is worth reviewing the fundamental principles in Part 1. Of relevance here are Regulations 132.6 and 132.7 for the cross-sectional area of conductors and types of wiring and installation methods, plus Regulation group 133 for the selection of equipment. Flexible cables can tick all the boxes and if the extra cost over more rigid types is not a concern, then there is no reason why they can’t be used.

With thanks to Graham Kenyon for his contributions to this article.
Corrigendum 2023 to BS 7671:2018+A2:2022

By Michael Peace CEng MIET MCIBSE

BS 7671:2018+A1:2020 has been withdrawn for over six months now and it could be said that the effects of BS 7671:2018+A2:2022 are now bedding in and we have started to receive feedback about some of the changes.

All British Standards are subject to review at least every five years. The outcome of the review will result in the standard either being confirmed for continued use, withdrawn or updated.

Information is received daily and sometimes it is necessary to make changes before the next planned Amendment to BS 7671.

This article provides an overview of the changes and the reasons for Corrigendum 2023 to BS 7671:2018+A2:2022.

What is a corrigendum?

BS 7671 is the largest British Standard in terms of the number of pages and could be said is one of the most complex to produce. Despite the hard work, heroic efforts and best intentions of many organisations and individuals, it is inevitable that some errors will be introduced.

The word ‘corrigendum’ is derived from the Latin verb corrigere, which means ‘to correct’. The plural form of ‘corrigendum’ is ‘corrigenda’.

Why is a corrigendum issued?

A corrigendum is issued where an error is inadvertently introduced during the drafting or production of a standard that could lead to incorrect or unsafe application of the standard. Trivial errors such as editorial issues are usually left uncorrected until the next amendment of BS 7671.

Has a corrigendum been issued previously for BS 7671?

This is not the first time a corrigendum has been published for BS 7671. For example, one was issued in May 2020 for corrections to Section 722 of BS 7671:2018+A2:2020 for electric vehicle charging installations. Another was also issued in January 2016 for corrections to various issues identified with BS 7671:2008+A3:2015. Updates can be downloaded for free from the updates to the 18th Edition page on the IET electrical website.

How do I obtain a copy of corrigendum 2023 to BS 7671:2018+A2:2022?

The Corrigendum 2023 to BS 7671:2018+A2:2022 will be available for free on the IET electrical website on the ‘updates to the 18th Edition’ page. It will be included in the IET’s
What are the changes in Corrigendum 2023 to BS 7671:2018+A2:2022?

Broadly speaking, the changes can be summarised in four main areas as below:

- Section 422 - Protected escape routes
- Section 443 - Overvoltage protection
- Section 701 - Birthing pools
- Section 710 - Protected escape routes in medical locations

The biggest change in terms of numbers of people affected and likely to impact most electricians relates to the requirements for overvoltage protection, specifically SPDs. The changes to protected escape routes are also likely to affect a large number of projects. Medical locations are a niche sector so the changes will probably impact fewer people, but that is not to say the issues highlighted in this area are of any less importance.

Section 422 - Protected escape routes

What is a protected escape route?

It is important to note that the fire strategy and fire engineering requirements are the responsibility of a fire engineer. It is not the job for an electrician to determine which areas are considered protected escape routes or not. Professional advice from a fire engineer should be sought.

The term ‘protected escape route’ is defined in BS 7671:2018+A2:2022 as below:

Protected escape route. A route enclosed with specified fire-resisting construction designated for escape to a place of safety in the event of an emergency (see also Escape route).

The term ‘protected escape route’ is an all-encompassing term used in Part B of the Building Regulations to cover a range of key terms, such as, ‘protected corridor’, ‘protected lobby’, ‘protected shaft’ and ‘protected stairway’.

Why has Regulation 422.2 been amended?

The publication of BS 7671:2018+A2:2022 introduced changes to Regulation 422.2 which affects protected escape routes. Effectively this prohibited the installation of cables and other electrical equipment in protected escape routes unless they were part of:

1. an essential fire safety or related safety system
2. general needs lighting
3. socket-outlets provided for cleaning or maintenance

This creates difficulties for the construction industry, for example, take a typical multi-storey residential building. The route for services is through a building vertically through service risers to each floor and horizontally the common route for services to each flat is above the ceiling through the corridors.
What are the changes and implications for electrical designers?

It was decided to specifically state the exact type of protected escape route in which wiring systems are not permitted, such as ‘firefighting lobby, shaft or staircase of a protected escape route’. Following the corrigendum, the term ‘protected corridor’ is not included, therefore it is permitted to install wiring systems within a protected corridor.

However, it is not just a case of any wiring system will do, for example, PVC materials are not permitted as they produce toxic gases and vapours including hydrochloric acid, dense smoke and are flame propagating under fire conditions.

What are the requirements of Regulation 422.2.1 of BS 7671:2018+A2:2022?

The requirements of Regulation 422.2.1 of BS 7671:2018+A2:2022 specify types of wiring systems that can be installed in protected escape routes. For example, where cables and containment are used, they shall meet requirements for resistance to flame propagation and shall be of limited smoke protection.

The requirements of Regulation 422.2.1 of BS 7671:2018+A2:2022 have not changed in Corrigendum 2023. Previously, the requirements only applied to the services listed in the three indents which were for essential fire related safety systems, lighting or socket-outlets for maintenance purposes within the protected escape route. Whereas now it is permitted to install wiring systems within a protected corridor of a protected escape route, these requirements also apply to protected corridors.

In addition, the requirements of Chapter 527 of BS 7671:2018+A2:2022 relating to selection of wiring systems to minimise the spread of fire must be complied with.

Section 443 - Overvoltage protection

Why have the requirements for overvoltage protection been amended?

Following the introduction of the risk assessment method in BS 7671:2018, many comments were received on the DPC for BS 7671:2018+A2:2022 saying that the requirements for overvoltage protection were too complicated. The comments were reviewed by the committee responsible and a decision was made to remove the risk assessment to make the process simpler.

Subsequently, reports were received that the requirements for overvoltage protection were over prescriptive, particularly for additions and alterations to existing installations and in some cases, it prevented housing association rollouts of grade D smoke alarm systems in domestic (household) premises.

The requirements for BS 7671 apply to new installations and it is easy to think of a completely new installation, however, the requirements also apply to additions or alterations to existing installations. The requirements for SPDs effectively meant retrospective upgrade of the installation, which was seen to be over prescriptive and not beneficial for all installations.

The requirements of BS 7671 are not retrospective but installations to earlier editions to the IEE/IET Wiring Relations may be potentially dangerous depending on their age. This is confirmed in the note by the HSE in the introduction. It states ‘Installations to which BS 7671 is relevant may have been designed and installed in accordance with an earlier edition, now superseded but then current. That, in itself, would not mean that the installation would fail to comply with the Electricity at Work Regulations, 1989’.
The additional cost of SPDs for a new installation may be quite small in comparison to a whole new installation. However, for additions and alterations to an existing installation, such as the installation of grade D smoke alarm systems in domestic (household) premises, it can significantly increase the project costs, hence reduce the number of properties which can be installed with smoke alarms on the same budget.

Smoke alarms have been proven to save many lives over the years and it is important that the requirements of BS 7671 do not restrict the installation of such an important life saving device. Equally, it could be said that a life saving device, such as a smoke alarm, should have overvoltage protection where necessary and both sides of the argument have been heard and discussed at length.

**What are the issues?**

The issue mainly relates to the term ‘safety service’ in indent (ii) of Regulation 443.4.1 of BS 7671:2018+A2:2022, which states that overvoltage protection is required where an overvoltage could result in the failure of a safety service, as defined in Part 2.

One problem is that terms mean different things which depends on the standard you are reading. ‘Safety services’ is an all-encompassing term, depending on which document you read as it covers everything from smoke alarms and medical services to firefighters lifts.

The requirement in indent a) of Clause 443.4 of IEC 60364-4-443:2007+A1:2015 is to provide protection against transient overvoltage where the consequence caused by overvoltage affects human life. The terms ‘safety services’ and ‘medical care facilities’ are provided as examples. In some cases, examples can be helpful but in other situations they can lead to ambiguities and this is an example of that confusion, due to the wide reaching nature of the term ‘safety services’.

**What is a risk of serious injury to, or loss of, human life?**

At this point, it’s perhaps worth highlighting that the technical intent for overvoltage protection in BS 7671 is based on the BS EN 62305 series of standards for lightning protection systems. BS EN 62305-2:2012 does not use the term ‘safety services’, instead the term ‘internal systems’ is used, which are defined as ‘electrical and electronic systems within a structure’.

In the context of protection of transient overvoltages, the BS EN 62305 series describes risk to human life as ‘where failures of internal systems immediately endanger human life, this includes permanent injury’. This standard is referred to in the Note to Regulation 534.4.1.1 of BS 7671:2018+A2:2022. The examples of failure of internal systems cited in BS EN 62305-2:2012 are structures with the risk of explosion and hospitals with lifesaving equipment.

As the consequence of the failure of a safety service and serious injury to, or loss of, human life is practically the same thing when it comes to BS EN 62305 and failure of internal systems, it was decided to delete indent (ii) as it is already covered by indent (i), which covers serious injury to, or loss of, human life.
What is a safety service?

A safety service is defined in Part 2 of BS 7671:2018+A2:2022 as:

“Safety service. An electrical system for electrical equipment provided to protect or warn persons in the event of a hazard, or essential to their evacuation from a location.”

According to the definition of a safety service in Part 2 of BS 7671:2018+A2:2022, a smoke alarm system is a safety service. However, the failure of a smoke alarm does not immediately endanger human life. A smoke alarm, like any safety system is designed to be fail-safe, in that if there is an issue with the device it is designed to alert the user. The risk of overvoltages for domestic (household) premises is a consideration for economic loss and is not an immediate risk to human life.

Safety services are covered in Chapter 56 of BS 7671:2018+A2:2022. The requirements relate to the supply to safety services as opposed to the equipment itself. It could be said that the requirements for safety services were much clearer in the Fifteenth Edition of the IEE Wiring Regulations 1981.

The title of Regulation 313-2 in the Fifteenth Edition of the IEE Wiring Regulations was ‘Supplies for safety services and standby purposes’. It describes the person specifying the installation, the characteristics of the source and it being of adequate capacity and rating for the operation specified. It does not describe the connected electrical equipment.

Do smoke alarms need SPDs?

The first consideration is that where an installation is supplied by a low-voltage underground cable and a lightning protection system is not required or installed, there is minimal risk of overvoltages due to atmospheric origin. The risk of overvoltages due to switching in domestic (household) premises is unlikely. It is important to remember that part of engineering judgement is to balance the risk against the cost.

There are effectively two methods of overvoltage control. The first is protective control, where SPDs are installed, and then there is inherent control, where insulation coordination of equipment is relied on, referred to in; IEC 60664 *Insulation coordination for equipment within low-voltage supply systems.*
Products intended for the UK market must comply with the requirements of all applicable UK legislation. The Electrical Equipment (Safety) Regulations 2016 (EE(S)R) implements into UK law an EU Directive (2014/35/EU), commonly called the Low Voltage Directive. This applies to all electrical equipment that is designed or adapted for use between 50 V AC and 1,000 V AC, and 75 V DC and 1,500 V DC.

Mains operated smoke alarms to BS EN 14604:2005 are self-contained devices with backup power supplies intended to be connected directly to the mains supply, therefore, required to meet overvoltage category II (OVC II) requirements. The Ei electronics declaration of conformity for mains operated smoke alarms declares the applied standard EN 62368-1:2014/AC:2017 for compliance with the Low Voltage Directive 2014/35/EU, which states:

“For equipment to be supplied from the a.c. mains, the value of the mains transient voltage depends on the overvoltage category and the a.c. mains voltage and is given in Table 13. In general, clearances in equipment intended to be connected to the a.c. mains, shall be designed for overvoltage category II.”

Like all electrical products conforming to the (EE(S)R), smoke alarms are required to meet the requirements for OVC II, which means it has a rated impulse voltage withstand of 2.5 kV and inherent overvoltage control is sufficient, referred to in Regulation 443.6 of BS 7671:2018+A2:2022.

However, this may be different if there is a lightning protection system but that is covered in the BS EN 62305 series.

What is sensitive electronic equipment?

It is often said that computers and home electronics are 'sensitive' equipment and vulnerable to damage by overvoltages. However, these products are connected to the mains via a power supply unit which is required to meet the requirements for OVC II. Table 443.2 of BS 7671:2018+A2:2022 has therefore been amended to reflect the discussions. The examples of fire and security alarm systems have also been deleted from the note to Regulation 534.4.1.1 of BS 7671:2018+A2:2022.

Annex I, Table I.1 of IEC 62368-1:2020 Audio/video, information and communication technology equipment - Part 1: Safety requirements, states that home electronics and most information technology equipment (ITE) used in the building will be OVC II as shown below.
Table I.1 – Overvoltage categories

<table>
<thead>
<tr>
<th>Overvoltage category</th>
<th>Equipment and its point of connection to the AC mains</th>
<th>Examples of equipment</th>
</tr>
</thead>
</table>
| IV                   | Equipment that will be connected to the point where the mains supply enters the building | • Electricity meters  
                       |                                                      | • Communications ITE for remote electricity metering |
| III                  | Equipment that will be an integral part of the building wiring | • Socket outlets, fuse panels and switch panels  
                       |                                                      | • Power monitoring equipment |
| II                   | Pluggable or permanently connected equipment that will be supplied from the building wiring | • Household appliances, portable tools, home electronics  
                       |                                                      | • Most ITE used in the building |
| I                    | Equipment that will be connected to a special mains in which measures have been taken to reduce transients | • ITE supplied via an external filter or a motor driven generator |

**What if an installation has a lightning protection system?**

Where an installation incorporates a lightning protection system, or where there is a risk of overvoltages transmitted by information and communications technology systems, this is outside the scope of BS 7671:2018+A2:2022 and the requirements of the BS EN 62305 series apply.

**Can SPDs still be installed?**

BS 7671 provides the minimum requirements for safety. There is nothing to prevent the installation of SPDs and it may provide some assurance against economic loss, however, the owner of the installation is best placed to make that decision.

Where a lightning protection system is installed or may be required, the BS EN 62305 series shall be used.
Section 701 - Birthing pools

Why has Section 710 of BS 7671:2018+A2:2022 been amended?

Including birthing pools within the scope of Section 701 had an unintended consequence of prohibiting the installation of socket-outlets to supply medical electrical equipment in these rooms. However, as the rooms containing birthing pools are designed for the purpose of delivering babies, in order to provide a room that met the functional needs of the clinicians and ultimately safety of the patients, it is necessary for socket-outlets to be installed closer than the requirements of Regulation 701.512.3 of BS 7671:2018+A2:2022.

After identifying this unintended consequence as a problem, birthing pools have been removed from the scope of Section 701 on the basis that specialist medical electrical equipment provides additional protection to the patient and that separating socket-outlets from the appropriate position close to the birthing pool presents an added risk to the occupants of the room.

The IET understands that it is intended to provide further guidance regarding the location of socket-outlets in industry specific guidance such as HTM 06-01 when it is next revised.

Section 710 - Protected escape routes in medical locations

Why have the requirements for protected escape routes in medical locations been amended?

The changes to Regulation 422.2 in BS 7671:2018+A2:2022 also affected medical locations. Fire precautions and means of escape in hospitals differ from many other buildings mainly because of the use of progressive horizontal evacuation. Progressive horizontal evacuation avoids evacuating patients from the building as, in many cases, this can have a significant impact on the patient’s health and wellbeing.

As progressive horizontal evacuation is employed in the majority of hospitals, the fire strategy is such that most routes from patient areas are considered escape routes. These escape routes have structural fire protection with the fire strategy incorporating methods of keeping the occupants away from fire and smoke. This allows patients and staff to remain in relative safety and only move to another area of relative safety should the fire progress or not be contained.

The reference to protected escape routes within BS 7671:2018+A2:2022 impacted the design of electrical installations within healthcare premises.

Whilst in the original Note 2 in Regulation 422.2 of BS 7671:2018+A2:2022 it was acknowledged that hospitals may have special requirements, the details set out in Appendix 13 and Section 710, as published, did not provide enough information for designers to allow for the special requirements for healthcare premises that complied with fire safety guidance set out in the relevant HTMs.

Following the Corrigendum, Regulation 710.422.2.201 of BS 7671:2018+A2:2022 makes provision for cables or other electrical equipment to be installed in a protected escape route. This is subject to specific circumstances where they are part of a healthcare facility conforming to Health Technical Memoranda (HTM) and healthcare fire safety guidance. The particulars relating to the design and installation of the electrical installation in the protected escape route are required to be documented and recorded within the fire strategy for the building.
Regulation 710.422.2.201 of BS 7671:2018+A2:2022, also provides information relating to which specific guidance documents should be used in which of the devolved nations that the healthcare facility is located in, i.e. England, Scotland, Wales or Northern Ireland.

What is the content of Corrigendum 2023 to BS 7671:2018+A2:2022?

The amended text is shown below with red strikethrough text indicating text which has been deleted, and green text indicating new text.

CONTENTS

422 PRECAUTIONS WHERE PARTICULAR RISKS OF FIRE EXIST

443 PROTECTION AGAINST TRANSIENT OVERVOLTAGES OF ATMOSPHERIC ORIGIN OR DUE TO SWITCHING

534 DEVICES FOR PROTECTION AGAINST OVERVOLTAGE

701 LOCATIONS CONTAINING A BATH OR SHOWER

710 MEDICAL LOCATIONS

SECTION 422

PRECAUTIONS WHERE PARTICULAR RISKS OF FIRE EXIST

422.2 Protected escape routes

Cables or other electrical equipment shall not be installed in a firefighting lobby, shaft or staircase of a protected escape route unless part of:

(i) an essential fire safety or related safety system
(ii) general needs lighting
(iii) socket-outlets provided for cleaning or maintenance.

NOTE 1: Guidance is provided in Appendix 13.

NOTE 2: Generally, this means cables in a firefighting lobby, shaft or staircase of a protected escape route should be limited to lighting and associated accessories, emergency lighting and fire detection and alarm systems, although cables for other safety systems may be necessary. Hospitals may have special requirements as detailed in Section 710.
SECTION 443
PROTECTION AGAINST TRANSIENT OVERVOLTAGES OF ATMOSPHERIC ORIGIN OR DUE TO SWITCHING

443.4.1 Transient overvoltages due to the effects of indirect lightning strokes

Protection against transient overvoltages shall be provided where the consequence caused by the overvoltage could result in:

(i) serious injury to, or loss of, human life
(ii) failure of a safety service, as defined in Part 2 Deleted by Corrigendum 2023.
(iii) significant financial or data loss.

For all other cases, protection against transient overvoltages shall be provided unless the owner of the installation declares it is not required due to any loss or damage being tolerable and they accept the risk of damage to equipment and any consequential loss.

443.6.2 Rated impulse voltages of equipment and overvoltage categories

Category IV equipment is suitable for use at, or in the proximity of, the origin of the electrical installation, for example, upstream of the main distribution board. Equipment of category IV has a very high impulse withstand capability providing the required high degree of reliability, and shall have a rated impulse voltage not less than the value specified in Table 443.2.

Category III equipment is suitable for use in the fixed installation downstream of and including the main distribution board, providing a high degree of availability, and shall have a rated impulse voltage not less than the value specified in Table 443.2.

Category II equipment is suitable for connection to the fixed installation, providing a degree of availability normally required for current-using equipment, and shall have a rated impulse voltage not less than the value specified in Table 443.2.

Category I equipment is only suitable for use in the fixed installation where SPDs are installed outside the equipment to limit transient overvoltages to the specified level, and shall have a rated impulse voltage not less than the value specified in Table 443.2. Therefore, equipment with a rated impulse voltage corresponding to overvoltage category I should, preferably, not be installed at or near the origin of the installation.
### TABLE 443.2 – Required rated impulse voltage of equipment (Uw)

<table>
<thead>
<tr>
<th>Nominal voltage of the installation V&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Voltage line to neutral derived from nominal voltages AC or DC up to and including V</th>
<th>Required rated impulse voltage of equipment&lt;sup&gt;b&lt;/sup&gt; kV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overvoltage category IV (equipment with very high rated impulse voltage)</td>
<td>Overvoltage category III (equipment with high rated impulse voltage)</td>
</tr>
<tr>
<td></td>
<td>For example, energy meter, telecontrol systems</td>
<td>For example, distribution boards, switches socket-outlets</td>
</tr>
<tr>
<td>120/208</td>
<td>150</td>
<td>4</td>
</tr>
<tr>
<td>230/400&lt;sup&gt;c&lt;/sup&gt;</td>
<td>300</td>
<td>6</td>
</tr>
<tr>
<td>277/480</td>
<td></td>
<td></td>
</tr>
<tr>
<td>400/690</td>
<td>600</td>
<td>8</td>
</tr>
<tr>
<td>1000</td>
<td>1000</td>
<td>12</td>
</tr>
<tr>
<td>1500 DC</td>
<td>1500 DC</td>
<td>-</td>
</tr>
</tbody>
</table>

<sup>a</sup> According to BS EN 60038.

<sup>b</sup> This rated impulse voltage is applied between live conductors and PE.

<sup>c</sup> For IT systems operating at 220-240 V, the 230/400 row should be used, due to the voltage to earth at the earth fault on one line.
SECTION 534
DEVICES FOR PROTECTION AGAINST OVERVOLTAGE

534.4.1.1 Where SPDs are required:

(i) SPDs installed at the origin of the electrical installation shall be Type 1 or Type 2

(ii) SPDs installed close to sensitive equipment to further protect against switching transients originating within the building shall be Type 2 or Type 3.

NOTE: Type 1 SPDs are often referred to as equipotential bonding SPDs and are fitted at the origin of the electrical installation to specifically prevent dangerous sparking which could lead to fire or electric shock hazards. In accordance with BS EN 62305-4, a lightning protection system which only employs equipotential bonding SPDs provides no effective protection against failure of sensitive electrical and electronic systems. Further SPDs (Type 2 and Type 3) are required to protect sensitive and critical equipment (for example, hospital equipment and fire/security alarm systems) downstream of the origin of the electrical installation.
SECTION 701
LOCATIONS CONTAINING A BATH OR SHOWER

701.1 Scope

The particular requirements of this section apply to the electrical installations in locations containing a fixed bath (bath tub, birthing pool) or shower and to the surrounding zones as described in these regulations.

This section does not apply to emergency facilities such as emergency showers used in industrial areas or laboratories.

SECTION 710
MEDICAL LOCATIONS

710.422.2.201 Within a healthcare facility, cables or other electrical equipment may be installed in a protected escape route, where:

(i) the healthcare facility complies with Health Technical Memoranda (HTM) and healthcare fire safety guidance, and

(ii) the particulars of the electrical installation within the protected escape route are documented as part of a fire strategy.

NOTE: Specific guidance on fire safety for healthcare premises can be found in relevant Health Technical Memoranda as published by the Department of Health/NHS England. There are equivalent guidance documents in other devolved administrations, e.g. Scotland (SHTM) and Wales (WHTM).

Acknowledgements

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It’s Electrical Safety Month and the IET is keen to remind the industry of the risks you need to always consider when working with electricity.

How many times have you heard - “If only we had switched it off it wouldn't have happened” or “But we never followed the procedure. It would have taken too long!!!”

All electrical incidents can be upsetting, and every associated injury causes suffering and some with life-changing effects. However, it is so often the case that simple steps could have prevented the incidents.

Many people are exposed to electrical risk and many of them do not have an electrical background or sufficient electrical knowledge to minimise the risk. Those people include, cleaners, equipment operators, maintenance fitters and managers for example. To these categories can be added third parties such as members of the public and school children.

All incidents have costs. To an individual these costs can be greater than a larger penalty to a big organisation. The financial costs can be paid off quickly, but the most telling costs are more often the longer term reputational and emotional costs to all those involved. Some people never recover.

The most common incidents involve low voltage equipment and installations resulting from:

(a) **Poor design** – this may be the wrong cable or equipment in a wet, dusty, hot, or otherwise adverse environment, or an overloaded circuit.

(b) **Poor installation** – there are many complex installations that have problems, such as damaged cables or equipment, but something as simple as wiring up a plug wrongly can be fatal.

(c) **Poor operational procedures** – the most frustrating incidents often result from work where the circuit had not been switched off and securely isolated. This could be because of incorrect identification due to poor labelling, or perhaps because someone thought they did not have to isolate. Many incidents involved flashovers on low voltage equipment or switchgear, where electrically experienced workers used inappropriate procedures or tools adjacent to exposed live conductors or terminals. Workers are also exposed to other risks such as asbestos, working at height, or flammable or corrosive materials.

(d) **Poor maintenance** – basic poor work such as taped joints, broken plugs, socket-outlets and switchgear, loose connections, poor earthing, incorrect fusing, damaged or unsupported cables, poor asset records or lack of testing are all signs of poor maintenance that can have serious consequences.
There are significant consequences for any business if there is a serious error or incident. For example, disruption to work with productivity loss and unpredictable effects to business continuity. In addition, costs arise for the business from the injured person, the additional work, and consequential costs for the company, for the community and prevention of further incidents. Ignoring these consequences and hoping they will not happen can be an expensive mistake.

Managers and technical personnel are responsible for managing the risks, the control of the electrical installation and the activities affected by it. The health and safety of an organisation’s workers, contractors, and others potentially at risk must be managed. There should be policies, procedures, and competent people in place for the electrical installation. It is necessary to ensure that persons working at that installation are capable and have their limitations recognised and formally managed.

Often clients and managers lack the competence and confidence to improve their safety management. Safety management must be made accessible to technical and non-technical people so that risks to people and their business are safely reduced. This involves electrical risk awareness for all who are exposed to risks at work.

There are serious effects of an incident on the company, injured person, other workers, families, and members of public, and so on. Directors and managers can be sent to prison, while large fines and costs can adversely affect the organisation together with other consequential costs and psychological damage.

Risk awareness is important in preventing incidents. Workers can be asked to go beyond their limitations of competence if those involved do not understand the risk. There are workers who appear to be unaware of the dangers from electricity, experienced workers who believe that a 230V shock cannot kill you, that you cannot get a shock if there is an RCD, that you cannot get an explosion from a low voltage circuit, or that having no circuit or equipment records does not matter. Managers need to ensure that all workers, whether ‘electrical’ or not, who may be exposed to electrical risk are suitably trained and aware of the dangers.

Workers should have suitable and sufficient procedures and instructions to allow them to complete their tasks safely and not endanger those affected by their work. Rules to control risk are important.

Responsibilities and worker limitations should be clear. There should be adequate information, instruction and supervision and failure to do this could lead to danger.

Business owners and managers should be aware of the risks, responsibilities of their installations and consequences of failure to comply with standards and regulations. They must ensure that there are sufficient resources so that their installations are safely operated and maintained in a safe condition. They should follow good standards of safety, ensuring that bad habits and complacency do not undermine continuing improvements.

Installers have a professional responsibility to ensure that design, operation, and maintenance are carried out to a safe standard. They are often the only electrically competent persons involved on site and work should be undertaken in a safe way for the protection of themselves and others affected. No assumptions can be made that someone else will solve any deficiencies. For example, children, elderly, or vulnerable people may be involved who may not react in an expected way.

If something is not right, it must be made clear to those responsible. The control of the installation can be complex, particularly for modification, refurbishing and handover. From the outset it is essential that the control of the installation is absolutely clear. Only one party
can be in control of any part of the installation at any time. If necessary, special procedures to cover the work should be developed with all those responsible for, or involved in, the work. Live working must be justified to comply with the regulations and should be very much the exception. Records are important.

All people who are exposed to electrical risk should be safe. Walking past or ignoring potential danger can have serious consequences. After an incident, prior action could have prevented the feeling of guilt, and all that pain, suffering, and sometimes grief.

For more guidance, the ‘Code of Practice for Electrical Safety Management’ can be purchased via the IET’s website, at https://shop.theiet.org/code-of-practice-for-electrical-safety-management-2nd-edition

This blog was kindly written by Bill Bates and Bill Tubey, the trainers of our ESM course taking place in May and October this year.
What does Electrified Heat actually mean?

‘Net zero’, ‘decarbonization’ and ‘electrification’ are just some of many current buzzwords and phrases in the built environment. What do they mean, and how do they impact on electrical installations in particular? Looking at the bigger picture, the climate is changing. To mitigate the impacts of this, it is apparent that we all need to reduce our demands on the planet and be more considerate to natural resources. Business as usual is not an option, but the solutions are not necessarily straightforward either.

Electrified heat is cited as a way forward, but what does that actually mean? The IET has produced the IET Guide to Implementing Electrified Heat in Domestic Properties to provide insight to the issues and guidance on the solutions from industry leaders.

We need to reduce carbon emissions, especially in buildings: electrical designs and installations can help with the right strategy. However, it is important to remember that it needs careful assessment and informed design choices before cables, equipment and controls are installed. Other considerations should include energy efficiency control measures and correctly assessing maximum demand and load diversity.

Lighting, especially in commercial and public buildings, adds to energy demands, however, the use of LED luminaires and deployment of automatic controls can alleviate that aspect. Increasing uptake of electric vehicles will add to energy consumption and may need load management, possibly coupled to smart metering. Small power loads often have relatively short term requirements with either directly monitored use or their own automated controls that limit energy consumption.

The largest persistent energy demand in buildings are space heating and water heating. There is a lot of discussion about the electrification of heat, including the deployment of heat pumps. So, what is the electrification of heat and what are the implications? What are the impacts on new building designs? What are the impacts on retrofit installations?

We have always had some forms of electrical powered heat. Point of use water heaters at sinks, back up electrodes for immersion tanks on gas heated water systems and electrical element storage space heaters run on overnight cheaper tariffs are all examples of legacy technologies that are still used. The inherent efficiency of these systems is typically less than 100%.

Heat pump technology is hardly new and is an adaptation of refrigeration based technology. It harvests heat energy from a renewable source, for example the ground (GSHP) or air (ASHP), and either uses it immediately as space heating or stores it in a medium for later use as domestic hot water or space heating.

Refrigeration is the means to harvest the heat, but it is electricity that drives the system. There are benefits to this approach: for every unit (kWh) of electricity “invested” there can be a “return” of 3 kWh.
or more in heat energy. This efficiency is referred to as the ‘coefficient of performance’ (CoP). This CoP varies throughout the year. For ASHP, in the summer months, a CoP of 4.5 is feasible, during the winter it will perhaps reduce to 2.2. The average over the whole year will typically be in the range of 2.8 to 3.0.

A word of caution though, simply swapping out an old gas or oil boiler for a heat pump system is not always advisable. There are a number of considerations and the IET Guide to Implementing Electrified Heat in Domestic Properties provides a number of insights into those areas:

- **Fabric**: heating is there to make us comfortable and replaces the heat loss in a building. Improving the fabric of the building reduces those losses irrespective of the fuel type used on a building. Better fabric means stable thermal comfort, less heating to maintain that comfort, less input power and therefore a lower electricity bill. IET Guide to Implementing Electrified Heat in Domestic Properties has some worked examples of heat loss calculations.

- **Heat pump types**: one size does not fit all. To provide a solid understanding of how to deploy heat pumps the IET Guide provides information on the refrigeration cycle, on the various components of a heat pump system, the types of heat pumps, refrigerants, operation conditions, correctly sizing the systems and associated efficiencies.

- **Hot water**: electrification of domestic hot water (DHW) is a proven technology. Using heat pumps for hot water production can also be very successful and offers significant energy efficiencies when compared to fossil fuel systems (gas or oil).

- **Space heating**: there are several types of direct electrically powered space heating. Heat pumps add to the available types of systems and the IET Guide describes the pros and cons of them all. On some systems zoning the heating will allow for specific areas to be tailored to suit different uses.

- **Electrical supplies**: direct electrified heat is an area that is fully understood. Implementation of heat pumps needs some additional thought to understand the implications of winter CoP and how that can affect the electrical installation’s maximum demand when there will be coincidental seasonal demands, such as increased use of lighting. Constraints on electrical supplies are a risk but can be mitigated. Designs for new builds may have challenges, but can be resolved. Designs for retrofit installations may need additional thought, but there are solutions available in most cases. The IET Guide provides insight into these issues and explanations on dealing with DNO applications and smart grids. Headline commentary on the integration of PVs, EVs and energy storage is also included, although there is separate IET guidance and Codes of Practice available for more in depth information in those areas.

- **Business case**: new technologies might be perceived as disruptive and there will be clients who need a business case to ensure the correct decisions are made, even for domestic installations. The IET Guide provides key insights on drivers for change, pros and cons, stakeholders, energy costs, capital costs, serving costs, carbon factors. There is guidance on simple financial evaluations and worked examples too.

- **Future perspectives**: the landscape for heating is changing. In large conurbations heat as a service is an option. The IET Guide provides some analysis of the future for electrified heat, how it may be applied and the implications that may have. Developments of multi-storey residential estates are already using central energy centres that, in turn, provide connections to heat interface units (HIU) in individual apartments. Heat pumps are now being used as the source for the energy centres in a number of new developments.

Electrified heat is here to stay and is set to be a major player in new installations of all shapes and sizes, either through communal systems or smaller individual installations. Fossil fuelled gas and oil boilers will be phased out following on from recent central government declarations.
Electrified heat has a role to play in retrofit too, provided the installation is correctly designed, sized adequately and installed where the heat pump can work effectively. The author has monitored his own retrofitted DHW ASHP for more than 6 years. The previous gas boiler required circa 6900 kWh of gas energy per annum to provide hot water. The DHW ASHP requires circa 1200 kWh per annum of electrical energy which provides around 3500 kWh of heat energy. Even with fluctuating energy prices that represents a cost saving and a significant saving on the equivalent carbon emissions too.

The IET *Guide to Implementing Electrified Heat in Domestic Properties* provides a holistic and practical overview of the requirements, implications and benefits of electrified heat.  
Readers may also be interested in the IET’s new factfile entitled *Decarbonising the built environment*