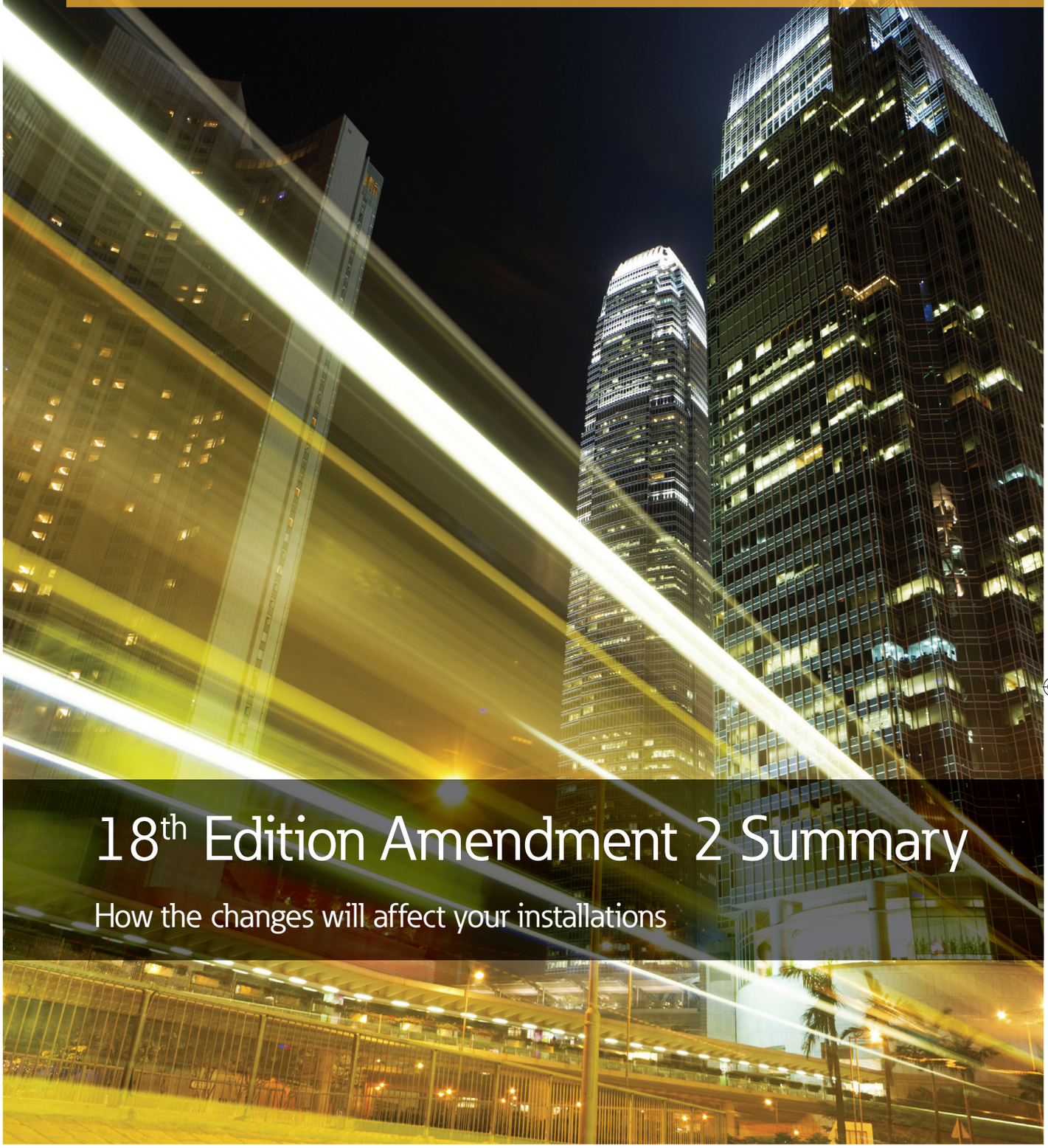
White Paper **WP003003EN**

Effective March 2022



18th Edition Amendment 2 Summary

How the changes will affect your installations

Powering Business Worldwide

Introduction

The BS7671 18th edition Wiring Regulations became mandatory in January 2019. As electrical installations and the devices protecting equipment, property and lives evolve, the Wiring Regulations are constantly updated hence the current edition has already seen a set of amendments (Amd 1) issued in February 2020 with a second set of amendments (Amd 2) issued in March 2022.

It's fair to say that the pace of technological change has if anything accelerated over the last few years and the most recent Amendment 2 reflects this with, as always, improved safety at the forefront but also the recognition that installations need to evolve to cover new requirements such as electric vehicle charging (covered in Amendment 1) and photovoltaic installations.

This whitepaper will cover not only some of the main changes in Amendment 2, but also offer the reasons why these changes are necessary and examine how the regulations have evolved, which might point the way for future revisions and new editions. Invariably what it recommends as best practice now, often become mandatory in the future.

For simplicity we will go through each change but group them according to subject rather than where they appear in the regulations, so for example all the changes relating to RCDs including "Risk Assessment of Sockets" will be in the same section of this report.

When will Amendment 2 become mandatory?

The first significant thing to note about Amendment 2 is the timeline and when the changes become mandatory.

Amendment 2:2022 to BS7671:2018 Requirements for Electrical Installations was issued on 28th March 2022. You can implement the changes from this amendment now, but the existing version (BS7671:2018=A1:2020) remains current until 27th September 2022 and you can apply either version until this date.

The most important thing to realise is the removal of any reference to "installations designed before". This means that after September 27th 2022 all installations must comply, even if you designed it before that date. This removes any ambiguity or uncertainty.

What changes will we be looking at?

In the following pages of this whitepaper, we will cover five of the main changes in Amendment 2 as outlined below:

411.3.3: Risk assessment of sockets

531: Changes in requirements for RCDs

421.1.7 Requirements for AFDDs

422: Precautions where particular risks of fire exist

433: Protection against transient over voltages

Brief outline of other changes

411.3.3 Risk assessment of sockets

Introduction

RCD protection of socket outlets became normal practice following the 17th edition of the Wiring Regulations from July 2008 onwards.

As a result, most modern installations have RCD protection of most if not all socket outlets via a distribution board or consumer unit. The most common solution is a split load board with twin RCDs to help minimise the effects of unwanted tripping, but installers use other configurations including the use of RCBOs to protect individual circuits.

The 18th edition then further strengthened this requirement in January 2019. Before then electrical designers and installers had the option of avoiding RCD protection if they labelled a socket outlet only for use with certain items. This option was removed in the 18th edition so that the installer should provide RCD protection unless there was a documented risk assessment showing that it was not appropriate.

Amendment 2 411.3.3 Risk Assessment of sockets

Amendment 2 to the 18th edition has further reduced the risk of electrocution as a result of earth leakage through the RCD protection of socket outlets. The relevant section in 411.3.3 now reads:

411.3.3 Additional requirements for socket-outlets and for the supply of mobile equipment for use outdoors

In AC systems, additional protection by means of an RCD with a rated residual operating current not exceeding 30 mA shall be provided for:

(i) Socket-outlets with a rated current not exceeding 32 A in locations where they are liable to be used by persons of capability BA1, BA3 or children (BA2, BA3)

(ii) Socket outlets with a rated current not exceeding 32 A in other locations and

(iii) Mobile equipment with a rated current not exceeding 32 A for use outdoors.

An exception to (ii) but not (i) or (iii) is permitted where a suitably documented risk assessment undertaken with the involvement of a skilled person (electrically) determines that RCD protection is not necessary.

Note: For the purpose of this exception, an ordinary person (BA1) instructed in the use of the installation does not become an instructed person (electrically) or cease to be an ordinary person. The documented risk assessment shall be provided with the appropriate electrical installation certificate.

How will this affect installations?

This means that all socket outlets in dwellings up to 32 A must have RCD protection. In other applications you can only omit RCD protection if a socket is only going to be used by a skilled person and you must also provide a fully documented risk assessment detailing why it is being omitted.

Clearly the intention of this amend is improved building safety to protect against electrocution as a result of an electrical fault. It also shifts the requirement for the RCD protection of socket outlets to who the anticipated user is rather than the location.

One consequence of using RCDs is that if you install the wrong type of RCD and/or the installation is badly designed, then the end user may face the issue of unwanted tripping or even the device not working at all. Amendment 2 deals with the selection of RCDs and RCBOs in section 531 to help overcome this issue – see below.

Section 531 – Changes in requirements for RCDs

Introduction

Before Amendment 2, section 531.3.3 stated that you may use type AC RCDs for general purposes. You then have to refer to NOTE 4 and NOTE 5 for further guidance on the correct use of RCDs for households and similar uses.

While you might have installed Type AC RCDs for many years, they can be ineffective in today's installations due to an element of DC residual current created by a lot of modern electrical equipment. In fairness without careful checking, you might not have realised that you were using these RCDs as they were often preinstalled in consumer units ready for installation.

While type AC RCDS are fine for equipment which is resistive, capacitive or inductive and fitted with passive electronic components, such as old tungsten lighting and electrical appliances that did not contain electronic equipment, today that is rarely the case. Most lighting is now based on LED technology which uses electronics and modern appliances such as washing machines or dishwashers focus on energy saving with measures such as speed control, which because of how they operate have an element of DC residual fault current.

This can lead to reduced protection from a Type AC RCD or at worst the Type AC RCD not operating at all. Indeed, many European countries have already banned the use of Type AC RCDs for general use.

What has changed in Amendment 2 section 531?

First there is an additional bullet point in 531.3.2 which deals with avoiding unwanted tripping as detailed below:

"(ii) the use of RCBOs for individual final circuits in domestic installations (see also Section 314)"

This is fairly self-explanatory in that a RCBO protects a single circuit so that if it does operate then it will only affect that circuit. Its inclusion, however, does indicate that electricians and designers should begin to consider the more widespread use of these devices in their installations.

The other change is in section 531.3.3 and the extract reads:

> Change in use of Type AC and Type A RCDs
>
> Type AC RCDs shall only be used to serve fixed equipment, where it is known that the load contains no DC components.
>
> **Note 1**: Examples of fixed equipment with a load current containing no DC components can include but not be limited to electric heating appliances and/or simple filament lighting, neither containing electronic components.
>
> **Note 2**: For guidance on the correct use of RCDs for household and similar use, see PD IEC/TR 62350.
>
> **Note 3**: Some typical fault currents in circuits comprising semiconductors are given in Annex A53, Figure A53.1.

What does this mean in practice?

In practice the simplest solution is to check and make sure that you are not using Type AC RCDs. You can still use them on certain circuits which are resistive, capacitive or inductive, examples include: simple filament lighting, an electric shower and an immersion heater.

In contrast Type A RCDs provide protection against residual sinusoidal currents and residual pulsating direct currents. This means that they can protect all the circuits listed above plus circuits that supply equipment containing active electronic components.

You should also be aware that there are a number of different types of RCD and that you may need to upgrade your specification according to what equipment will be on the circuit. For example, some energy efficient devices have high power electronics and frequency inverters for speed-controlled appliances such as some washing machines, dishwashers and tumble dryers. For this equipment the IET recommends using Type F RCDs which you can also use for the same circuits as those listed above.

If you are installing electric vehicle charging equipment, depending on the charging station selected, you may need to use either a type B RCD, a type A or a type F RCD. If a type A or F RCD is used then an RCD-DD device will also be required. And for photovoltaic system installations (see Section 712 – PV power supply systems of BS7671), depending on the inverter, you may need to use Type B RCDs.

Details of all these types of RCDs and where you should use them are in "BS 7671:2018 Types of RCD" in Notes 1, 2, 3 and 4.

For more information about the specification of RCDs take a look at the BEAMA RCD Handbook at: https://www.beama.org.uk/resourceLibrary/the-rcd-handbook---guide-to-the-selection-and-application-of-residual-current-devices.html.

643 – Verification of RCD performance

How you verify the performance of an RCD has also changed in Amendment 2.

The test has now changed from testing an RCD at a value of at least five times its rated residual operating current (5xIΔn) to testing at its actual residual operating current (IΔn) but with different disconnection times. The requirement now reads:

> Regardless of RCD Type, effectiveness is deemed to have been verified where an RCD disconnects within the time stated below with an alternating current test at rated residual operating current ($I_{\Delta n}$):
>
> - For general non-delay type, 300 ms maximum.
> - For delay 'S' type RCD, between 130 ms minimum and 500 ms maximum"
>
> This has changed for purely practical reasons because when there are certain load conditions on the RCD protected circuit, the old method of testing could lead to some test instrument erroneous results.

421.1.7 - Requirements for AFDDs

Introduction

Just like tightening the regulations on using RCDs, Amendment 2 has also focused on how the greater use of AFDDs, or Arc Fault Detection Devices, can improve safety.

This a good example of how new technology will help protect … "persons, livestock and property against fire caused by electrical equipment, against burns and against overheating, together with precautions where particular risks of fire exist." (Chapter 42 of Amendment 2 of the 18th edition.)

And fire caused by an electrical ignition is still a serious risk, we only have to remember the tragedy at Grenfell Towers where an electrical fault in a fridge freezer was the source of ignition.

While it is true that the number of fires in dwellings has reduced significantly over the last ten years, electrical faults are still one of the main causes and remain a serious issue.

According to the latest Government home office statistics in 2019/20 there were:

- 35,016 dwelling fires in the UK
- 12.1% of accidental dwelling fires caused by electrical distribution and leads
- A further 12.3% of accidental dwelling fires caused by "other" electrical appliances
- 285 fire related deaths in a dwelling

It is worth reflecting that AFDDs would help protect against fires caused by an arc due to faulty appliances and leads, and fires due to electrical distribution i.e. cabling, wiring or plugs.

Arcs can be caused by insulation defects in cables, crushed wires, damage to cables by impact, accidental penetration of nails and screws or by loose terminal connections. Other circuit protection devices, such as MCBs and RCDs will not detect electric arcs, whereas AFDDs will provide this additional protection.

What has changed in Amendment 2?

Before Amendment 2 section 421.1.7 - Requirements for AFDDs read:

> 421.1.7 Arc fault detection devices conforming to BS EN 62606 are recommended as a means of providing additional protection against fire caused by arc faults in AC final circuits.
>
> If used, an AFDD shall be placed at the origin of the circuit to be protected.

In practice most installations did not use AFDDs despite their obvious safety benefits. Amendment 2 now makes it a requirement, rather than a recommendation to protect final circuits supplying socket outlets in specific high-risk premises, with a recommendation to protect final circuits supplying socket outlets with a rated current under 32 A in other properties.

The new section now reads:

421.1.7 Arc fault detection devices (AFDD) conforming to BS EN 62606 shall be provided for single-phase AC final circuits supplying socket-outlets with a rated current not exceeding 32 A in:

- Higher Risk Residential Buildings (HRRB)
- Houses in Multiple Occupation (HMO)
- Purpose built student accommodation
- Care homes

Note: Higher Risk Residential Buildings are assumed to be residential buildings over 18 m in height or in excess of six storeys, whichever is met first. It is anticipated that in many areas higher-risk residential buildings will be defined in legislation which can be subject to change over time, as well as in risk management procedures adopted by fire and rescue services. Current legislation should be applied.

For all other premises, the use of AFDDs conforming to BS EN 62606 is recommended for single-phase AC final circuits supplying socket-outlets not exceeding 32 A.

Where used, AFDDs shall be placed at the origin of the circuit to be protected.

The use of AFDDs does not obviate the need to apply one or more measures provided in other clauses in this standard.

Note: For busbar systems conforming to BS EN 61439-6 and Powertrack systems to BS EN 61534, the AFDD may be placed at a location other than the origin of the circuit.

Clearly this is a sensible approach to safety which targets premises where a fire is more likely to have devastating effects. This measure will help protect against electrically ignited fires and makes it clear where you must use them – it removes any ambiguity and ultimately will save lives in the future.

And it's worth pointing out that although thankfully the number of fires is decreasing every year, we are as a nation building more high rise and high occupancy buildings where the potential consequences of a fire are more serious. And demographics are not on our side either as, in common with the rest of the developed world, we get older as a nation and are more likely to be living with one or more disabling conditions.[1] It is harder to alert people with disabilities about a fire and then evacuate them.

In light of these factors, fire prevention should remain high on our agenda and we should use new technology such as AFDDs as widely as possible. After all, what price would you put on saving even a single human life?

[1] https://www.un.org/development/desa/disabilities/disability-and-ageing.html

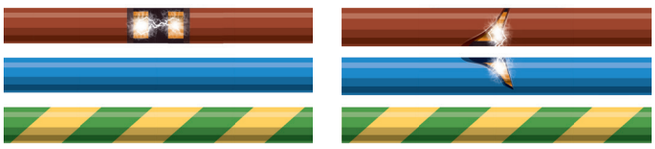
Types of Arc Fault and Protection

Arc fault currents typically occur at a nominal current or just below and are therefore hard to detect. Small arcs can grow over time as insulation is increasingly damaged by them.

Typical causes

Broken or squashed wires lead to an arc that continuously or intermittently burn and damage the insulation. Eventually this can lead to the ignition of a fire.

There are two types of arc current:



How an AFDD works

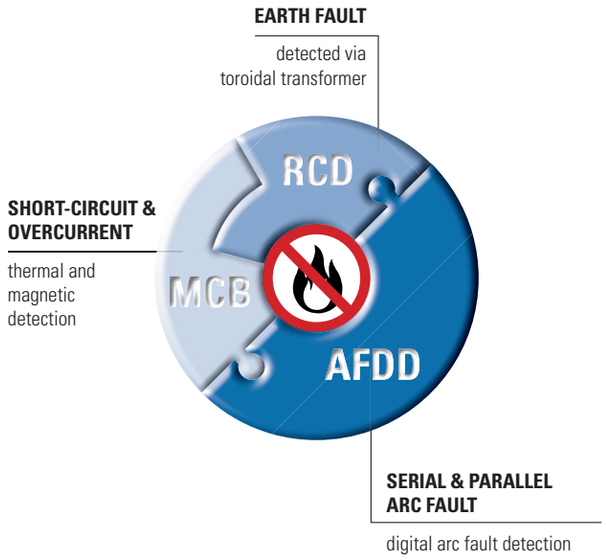
When an arc fault occurs, it has unique and readily identifiable characteristics. These are:

- High-frequency noise within the fault current and
- A breakdown of the fault current, close to the zero-crossing of the driving voltage

An AFDD monitors current signals and uses an algorithm in the integrated electronic circuit to ensure sensitive detection of fault currents, which indicates the presence of dangerous arc faults causing it to trip. They are also designed to recognise the 'normal arcing' generated by loads being switched such as from motors operating so you will not get unwanted tripping.

What is an AFDD+ device?

An AFDD+ is a new device that combines short circuit, fault current and residual current protection capability from RCBOs with an AFDD (arc fault detection device). An AFDD+ applies an algorithm in the integrated electronic circuit to ensure sensitive detection of fault currents, which indicates the presence of dangerous arc faults.



For more information about AFDDs we would suggest downloading BEAMA's "Guide to Arc Fault Detection Devices (AFDDs)" at https://www.beama.org.uk/resourceLibrary/beama-guide-to-arc-fault-detection-devices–afdds.html

422: - Precautions where particular risks of fire exist

There are also new recommendations where there are particular risks from fire in Amendment 2. Notably this has replaced the term "conditions for evacuation in an emergency" with "protected escape routes".

The proposed changes read:

- Electrical system designer/installer to provide details of the electrical system explaining associated services and testing and maintenance requirements.
- Specific requirements for "Protected escape routes".
- Cables or other electrical equipment shall not be installed in a protected escape route unless they are part of an essential fire safety or related safety system e.g. lighting, emergency lighting, or alarm systems.
- Specific requirements for cables in protected escape routes.
- Cables in escape routes shall be as short as practicable. Cables encroaching on escape routes shall not be installed within arm's reach unless they are provided with protection against mechanical damage likely to occur during an evacuation.

While you should read the recommendations in more detail, we suggest that you only install cables supplying safety related equipment in protected escape routes and where you do install cables, they should not be within arm's reach unless you have used appropriate mechanical protection.

This change simplifies section 422 by removing the conditions BD2, BD3 and BD4 that relate to occupation or ease of evacuation.

The amendment also removes any ambiguity as far as the designer/installer is concerned. Before amendment 2 it was a recommendation that they provide details for operating, testing and maintaining electrical systems relevant to fire safety to "responsible persons" now it is a requirement that they must do so.

Overall, this amendment improves fire safety for both occupants and emergency services.

443 – Protection against overvoltages

Another critical area that has come under the spotlight in Amendment 2 is the guidance on using surge protection devices. It became a requirement when the 18th edition was launched where to quote what the regulations previously stated:

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

1. Results in serious injury to, or loss of, human life or
2. Results in interruption of public services and/or damage to cultural heritage or
3. Results in interruption of commercial or industrial activity, or
4. Affects a large number of co-located individuals.

For all other cases, a risk assessment according to Regulation 443.5 shall be performed in order to determine if protection against transient overvoltages is required. If the risk assessment is not performed, the electrical installation shall be provided with protection against transient overvoltages, except for single dwelling units where the total value of the installation and equipment therein does not justify such protection.

What has changed?

Amendment 2 has updated the wording for overvoltage assessment and equipment. This is important because it changes the approach to the overvoltage assessment.

The relevant section now reads:

Primary areas now considered for the use of SPDs, where overvoltage could result in:

(i) Serious injury to, or loss of, human life.

(ii) Failure of a safety device

(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.

Protection against overvoltages shall be considered in the case of equipment likely to produce switching overvoltages or disturbances exceeding the applicable rated impulse voltage of equipment according to Table 443.2, e.g. where an LV generator supplies the installation or where inductive or capacitive loads (e.g. motors, transformers, capacitor banks), storage units or high current loads are installed.

This simplifies the requirements for SPDs by making it clear where you must use them, and for other applications also involves the building owner in making an informed decision about the risk of excluding them.

There is an ongoing debate about using SPDs but what can't be denied is that properties now have more equipment with sophisticated electronics that are vulnerable to damage from such surges.

And there are also some properties where such an overvoltage could cause a serious issue, such as in data centres and banks.

As outlined by the changed wording, it is not just lightning that causes transient overvoltages but also equipment such as generators, motors and transformers. It means that there is more need for surge protection and this trend is likely to continue.

Clearly there is a move to using more SPDs which will only grow in the future.

Brief outline of other changes in Amendment 2

Other significant changes in Amendment 2 reflect how modern installations are changing. Section 712 deals with the rise of renewable power generation using photovoltaic power supply systems and there is a new chapter 82 about "Prosumers LV Installations", which recognises that properties and other services may also contribute to electrical production

Section 712 – PV power supply systems

Amendment 2 has expanded Section 712 for PV power supply systems from 3 pages to 11 pages of text. It now covers different installation arrangements and specific requirements for

- Protection against thermal effects
- Protection against overcurrent
- Protection of PV string, sub-array, array and AC cable
- Protection against transient overvoltage
- Identification/notices and wiring systems
- Isolation and switching
- Earthing arrangements and protective conductors

New Chapter 82 – Prosumer's LV Installations

Recognising that an increasing number of customers now don't just consume electricity but also produce and store it, Amendment 2 has added a whole new chapter about "Prosumers Electrical Installation (PEI)".

Not only does the new chapter introduce the concept of a prosumer but it provides requirements for PEIs to achieve safe operation, sustainability and efficient use of energy when integrated into smart grids.

Clearly the installation of PV and energy storage systems and the customers producing and even supplying electricity is a massive topic in its own right. We will deal with this in a future publication.

In summary

Given the increasing pace of technological change, the Wiring Regulations must reflect this to ensure that installations remain safe, useful and able to meet evolving standards.

Some of the changes in Amendment 2 reinforce safety such as the risk assessment of sockets and the strengthening requirement for RCD use, while others are as a result of technological change.

Some of this technological change relates to the equipment in a modern property which contains increasingly complex electronic components so the devices protecting those circuits must evolve to meet different needs – a good example is with the selection of RCDs and also SPDs.

In other cases, technology provides new devices that further improve safety, with a good example being the protection offered by AFDDs against arc faults which are a major cause of fires.

Clearly when talking about technological change we cannot ignore how electrical installations themselves are changing. One growing trend is the increasing number of photovoltaic installations and Amendment 2 goes into far more depth about this and also reflects that customers now produce and even supply electricity with a new chapter detailing Prosumer Electrical Installations (PEIs).

Some final thoughts

If anything, technology is advancing more rapidly than ever and electrical installations will need to adapt to meet ever changing circumstances. And with these changes the Wiring Regulations must also adapt to ensure ongoing convenience and safety. Before you know it, there will be more amendments and then the 19th edition – watch this space.

Anyone who has studied the Wiring Regulations across different editions and amendments will notice that often what starts out as a recommendation becomes mandatory later on, so it is worth exploring all the changes and not only changing an installation to meet new requirements but also following Amendment 2's recommendations.

Notes

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