

IET Wiring Regulations 18th Edition

BS 7671:2018

Life Is On

Schneider
Electric

Learning outcomes

- 1 Review some of the main changes within the IET Wiring Regulations 18th Edition BS 7671:2018
- 2 Understand the technology of Residual Current Devices (RCDs), where to use them and their main benefits
- 3 Explore Arc Fault Detection Devices (AFDDs), where to use them and what their main benefits are
- 4 Understand the technology of Surge Protection Devices (SPDs), where to use them and their main benefits

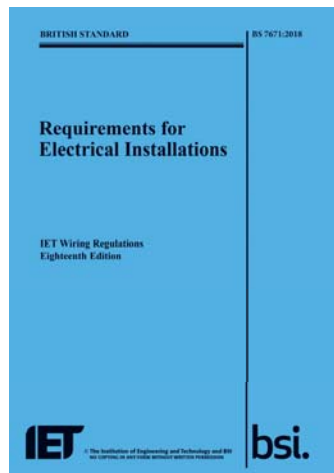


Key dates of the IET Wiring Regulations 18th Edition BS 7671:2018

2018



18th Edition published
1st July 2018



2019

18th Edition enforced
1st January 2019

All installations designed after
31st December 2018
are required to comply



Requirements of the 18th Edition:

Regulation 411.3.3 has been revised and now applies to socket-outlets **rated up to 32A** and also mobile equipment up to 32A for use outdoors. (*max 30mA*)

There is still an exception to omit RCD protection where, other than for an installation in a dwelling, a documented risk assessment determines that RCD protection is not necessary. However, the exception for a specific (labelled or otherwise) suitably identified socket outlet for the connection of a particular item of equipment has been removed.

New Regulation 411.3.4 requires **RCD additional protection** for all AC final circuits supplying luminaires in domestic (household) premises. (*max 30mA*)

Regulation 531.3.3 outlines the guidance on selection of different types of RCDs.



Considerations for compliance:

- Risk assessments (according to Regulation 411.3.3) justifying the omission of RCD protection must be adequate, otherwise client and electrical installation designer could be left open to liability in the event of an incident at a later date
- 536.4.3.2 - While 63A RCCBs can still be used in consumer units, a study must be conducted by the installer around the diversity factor
- If there is any doubt, an RCCB equal to the upstream protective device should be installed
- For localised protection:
RCD protected wiring devices could also be considered for localised protection



Requirements of the 18th Edition:

A new Regulation 421.1.7 has been introduced recommending the installation of arc fault detection devices (AFDDs) to provide additional protection against fire caused by arc fault currents in AC final circuits of a fixed installation.

The regulation gives the following examples of where such devices can be used:

- Premises with sleeping accommodation
- Locations with a risk of fire due to the nature of processed or stored materials, i.e. BE2 locations (e.g. barns, wood-working shops, stores of combustible materials)
- Locations with combustible constructional materials, i.e. CA2 locations (e.g. wooden buildings)
- Fire propagating structure, i.e. CB2 locations
- Locations with endangering of irreplaceable goods (e.g. museums, galleries)



Considerations for compliance:

- It is possible that upcoming reports from recent incidents in the industry could have an impact on this **advisory** regulation, if it is determined that such incidents could have been avoided if AFDDs had been installed
- AFDDs should not be considered as the sole measure – **circuit design, equipment verification, installation practice and maintenance** are all part of reducing potential risks in electrical circuits
- Circuits should be designed accordingly to cater for load requirements and be supported by manufacturers guidance.



Requirements of the 18th Edition:

Section 443, Protection against transient overvoltages of atmospheric origin or due to switching, has been redrafted.

The AQ criteria (conditions of external influence for lightning) for determining if protection against transient overvoltage is needed are **no longer included** in BS 7671.

Instead, new Regulation 443.4 requires that protection against transient overvoltages to be provided where the consequence caused by overvoltage:

- a) results in **serious injury to, or loss of, human life** (e.g. hospitals)
- b) results in **interruption of public services** or **damage to cultural heritage** (e.g. bus stations)
- c) results in **interruption of commercial or industrial activity** (e.g. banks)
- d) affects a **large number of co-located individuals** (e.g. blocks of flats)

For all other cases, a **risk assessment** according to Regulation 443.5 **has to be performed** in order to determine if protection against transient overvoltage is required (except for single dwelling units where the total value of the installation and equipment therein does not justify such protection). If no risk assessment is performed, protection must be installed.

Considerations for compliance:



- Lightning is still a risk, but the regulations now recognise that the applications most typically impacted by electrical surges are those located **near to sites with large switching loads**, such as wind farms and industrial applications
- The risk assessment to determine if protection is needed for both residential and commercial applications involves a calculated risk level (CRL) formula, for which the installer must have knowledge of the final 1km of cabling. **If the CRL is less than 1000, protection is required**
- That said, SPDs can be justified in virtually all residential applications because the **combined cost of equipment at risk will far outweigh the cost of additional protection**



Requirements of the 18th Edition:

The scope of Regulation 521.10.202 (previously Regulation 521.11.201), which requires wiring systems to be supported such that they will not be liable to premature collapse in the event of a fire, has been extended.

This is a significant change as the Regulation now requires **fire resistant supports** to be used **throughout the installation** and not just in escape routes, to ensure wiring systems are supported against premature collapse in the event of a fire.



Considerations for compliance:

- There are no applications excluded from this regulation; in installations of all types of premise – trunking, conduit and cabling fixed to surfaces of the building or attached to cable support systems must all have **fire-resisting supports** in place to avoid premature collapse.
- Whilst **not** every fixing must be metal, the installer must ensure that there is an **adequate number** in place to support against premature collapse in the event of fire, expected to be around 25% as a **supplementary** measure.



Requirements of the 18th Edition:

This is a new appendix that provides recommendations for the design and erection of electrical installations, including installations having local production and storage of energy, for optimising the overall efficient use of electricity.

The recommendations within the scope apply for new and modifications of existing electrical installations. Much will not apply to domestic or similar installations.

It is intended that this appendix is read in conjunction with BS IEC 60364-8-1, when published in 2018.





Residual Current Devices

Technical overview, applications and benefits



What is a Residual Current Device (RCD)?

An RCD is a device that is designed to provide protection against electrocution or electrical fires by cutting off the flow of electricity automatically when it senses a 'leakage' of electric current from a circuit.

Figure 1.

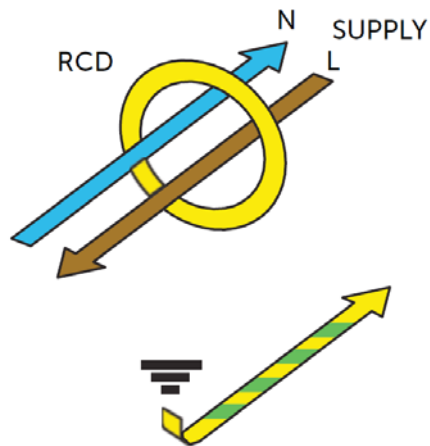
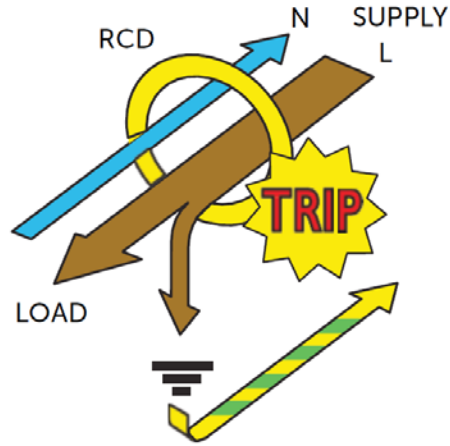
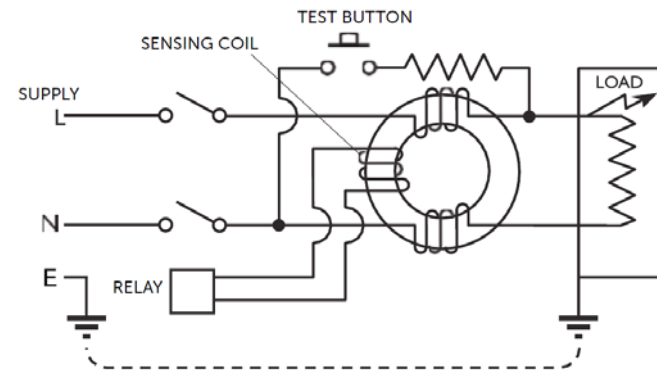


Figure 2.



Schematic of an RCD



Types of Residual Current Devices (RCDs) & Applications

RCCB

Residual Current Circuit-Breaker without Integral Overcurrent Protection



- Not designed to give protection against overloads and/or short-circuits.
- Provides residual current protection.
- Must always be used in conjunction with a fuse or circuit-breaker.

RCBO

Residual Current Circuit Breaker with Overcurrent Protection



- Protection against overloads and/or short-circuits and residual current protection.
- Can be used independently of any other overcurrent protective device within its rated short-circuit capacity.

SRCD

Socket-Outlet Residual Current Device



- Socket outlet with an integral residual current device that automatically switches the main circuit to open at a predetermined value of residual current.

FCURCD

Fused Connection Unit with Residual Current Device



- Fused connection unit with an integral residual current device that automatically switches the main circuit to open at a predetermined value of residual current.

Source: The RCD Handbook. BEAMA Guide to the selection and application of Residual Current Devices (RCDs) July 2018

Types of Residual Current Devices (RCDs) & Applications continued

CBR

Circuit-Breaker
incorporating Residual
Current Protection



- Provides overcurrent protection and incorporates residual current protection either integrally or by combination with a residual current unit which may be factory or field fitted.

IC-CPD

In-Cable Control and
Protective Device for
mode 2 charging of
electric road vehicles



- An RCD (≤ 30 mA) and control device integrated into a mode 2 charging cable for electric vehicle charging. (BS EN 62752:2016)

MRCDD

Modular Residual Current
Device



- Device(s) comprising a current sensing means and a processing device designed to detect and to evaluate the residual current and to control the opening of the contacts of a current breaking device.

Source: The RCD Handbook. BEAMA Guide to the selection and application of Residual Current Devices (RCDs) July 2018

Fire Protection with RCDs

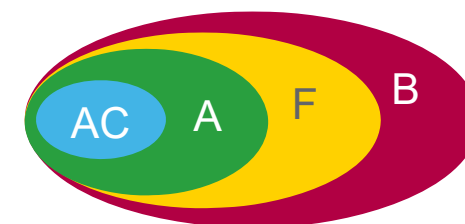
- Electricity is major cause of accidental fires in UK homes – over 20,000 electrical fires each year.
- Statistics from 2013/14 attribute 12% of fires to electrical distribution.
- These statistics demonstrate that electrical fires occur and can cause injuries, deaths and damage or destroy significant amounts of property.
- Household electricity supplies are fitted with fuses or circuit-breakers to protect against the effects of ‘overcurrents’.
- RCDs provide additional protection against the effects of earth leakage faults which could present a fire risk.



Source: The RCD Handbook. BEAMA Guide to the selection and application of Residual Current Devices (RCDs) July 2018; Department for Communities and Local Government, Fire Statistics 2011/12

RCD Technologies

Type	AC	A	F	B
I fault				
Waveforms from standard	50Hz 	class A 0° 0°+6mA DC 90° 135° 	Signal dials 10Hz+50Hz+1kHz 	Continuous smooth Three-phase Double alternate Biphase 150Hz 400Hz 1000Hz
Segments	 Residential Tertiary Industry	 Residential Tertiary Industry	 Residential Industry	 Industry PV Installations Electric Vehicles
RCD Applications	Immersion heater Oven/Hob – resistive elements Electric Shower Tungsten & Halogen lighting	1ph with electronic components Single phase invertors Class 1 IT and Multimedia Appliances - washing machine, not freq controlled e.g. d.c. or universal motor • Lighting controls - dimmer switch and home and building electronic systems LED drivers • Induction hobs • EV charging - smooth DC fault current is less than 6 mA	Frequency controlled equipment / appliances – inc some washing machines, dishwashers and driers e.g. containing synchronous motors*, • Some class 1 power tools • Some air conditioning controllers using variable frequency speed drives. Type F is also suitable for Type AC and Type A applications.	Three phase electronic equipment typically: Inverters for speed control, UPS Electric Vehicle charging : smooth DC fault current is > than 6mA Photo voltaic Power Electronic Converter Systems (PECS) typically: • industrial machines • cranes Type B is also suitable for Type AC, Type A and Type F applications.



B Type must provide all functionalities of AC / A / F / and DC protection



Arc Fault Detection Devices

Technical overview, applications and benefits

What is an Arc Fault Detection Device?

- UK electrical fires are still unacceptably high.
- Use of overcurrent and residual current protection has vastly reduced the risk and consequence of electrical fires.
- However, due to their characteristics, electric arcs in cables and connections cannot be detected by fuses, circuit breakers (e.g. MCBs, MCCBs) or by Residual Current Devices (RCDs), such electrical arcing can cause fires.
- Modern technology makes it possible to detect dangerous arcs and thus to protect installations.
- Arc Fault Detection Devices (AFDDs) disconnect the circuit's electricity supply when it detects the presence of dangerous electrical arcs, thus preventing the outbreak of fire.



What does an AFDD do?

An AFDD monitors electric arcs that occur in cables and connections that may cause a fire. These arcs are the result of localised cable deterioration or loose connections.

It is used for three types of situations that can result in a fire:

1. **Parallel arc:** insulation problems between two live conductors that cause a resistive short-circuit, too weak to be detected by a circuit breaker and with no earth leakage that would be detected by an earth-leakage protection device.



2. **Series arc:** a damaged conductor or connection that causes part of the current to pass into its carbonised insulation due to a local rise in temperature,

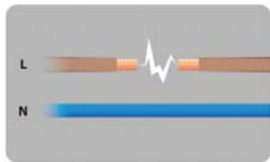


3. **Overheating** of electronic components in loads, when exposed to an overvoltage for several seconds.

Source: BEAMA Guide to Arc Fault Detection Devices (AFDDs) Second Edition – July 2018



Types of Arc Fault



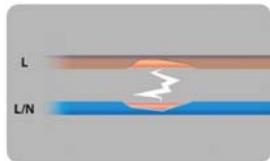
a) Series arc fault current

Originates from

- Damaged (e.g. crushed, broken, etc) cables
- Loose connections

A series arc is in series with a load and at a lower level than a parallel arc. The series arc fault characteristics result in the rms value of current and I^2t being too low to operate a fuse or MCB.

Protection is provided by AFDDs.



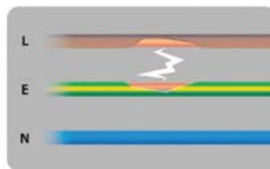
b) Parallel arc fault current (L-N)

Originates from :

- Fault between L-n
- High impedance due to damaged insulation, fault current is too low to trip other protection devices

Parallel arc fault characteristics (including short duration high peak currents) result in rms, i^2t and peak time values that are generally too low to operate protective devices such as fuses or MCBs.

Protection is provided by AFDDs.



c) Parallel arc fault current (L-E)

Originates from :

- Fault between L-E
- High impedance due to damaged insulation, fault current is too low to operate circuit breakers or fuses

Protection is provided by RCDs and AFDDs.

Requirements of the 18th Edition:

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The regulation gives the following examples of where such devices can be used:

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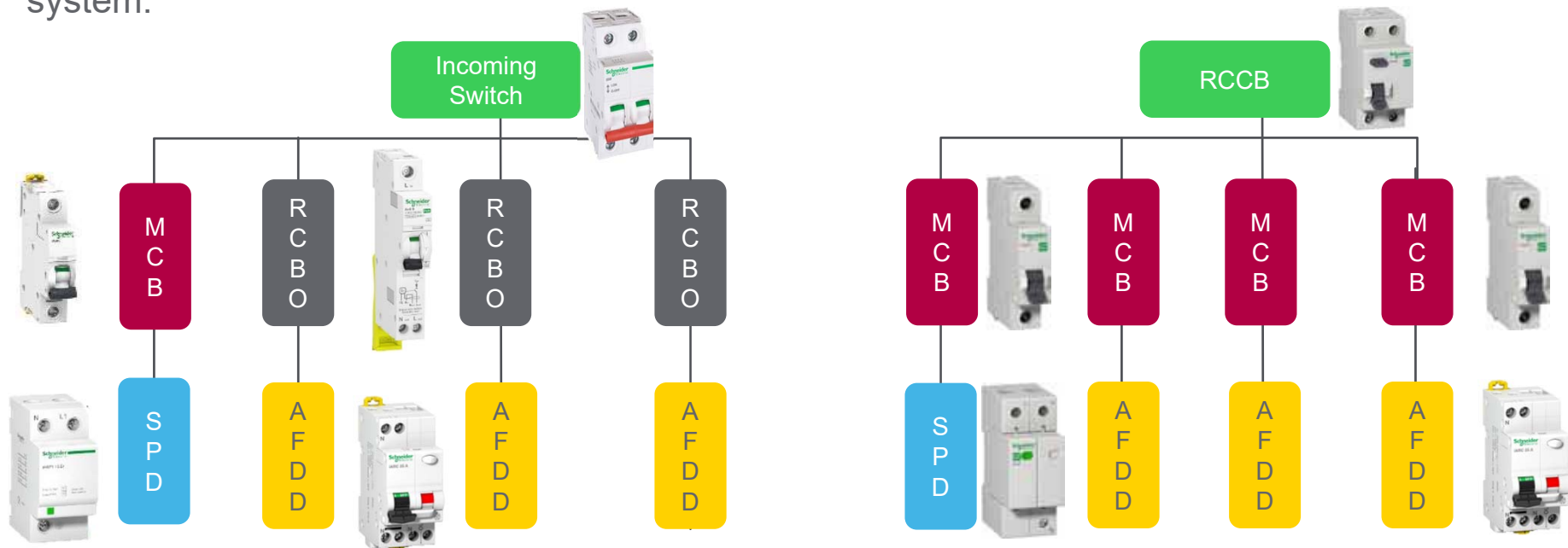
Considerations for compliance:

- It is possible that upcoming reports from recent incidents in the industry could have an impact on this **advisory** regulation, if it is determined that such incidents could have been avoided if AFDDs had been installed
- AFDDs should not be considered as the sole measure – **circuit design, equipment verification, installation practice and maintenance** are all part of reducing potential risks in electrical circuits
- Circuits should be designed accordingly to cater for load requirements and be supported by manufacturers guidance.



Configuration of Arc Fault Detection Devices

AFDDs are not intended to be used as a sole means for protection. They are to be used in conjunction with other protective devices to form a complete safe circuit protection system.



Source: BEAMA Guide to Arc Fault Detection Devices (AFDDs) Second Edition – July 2018

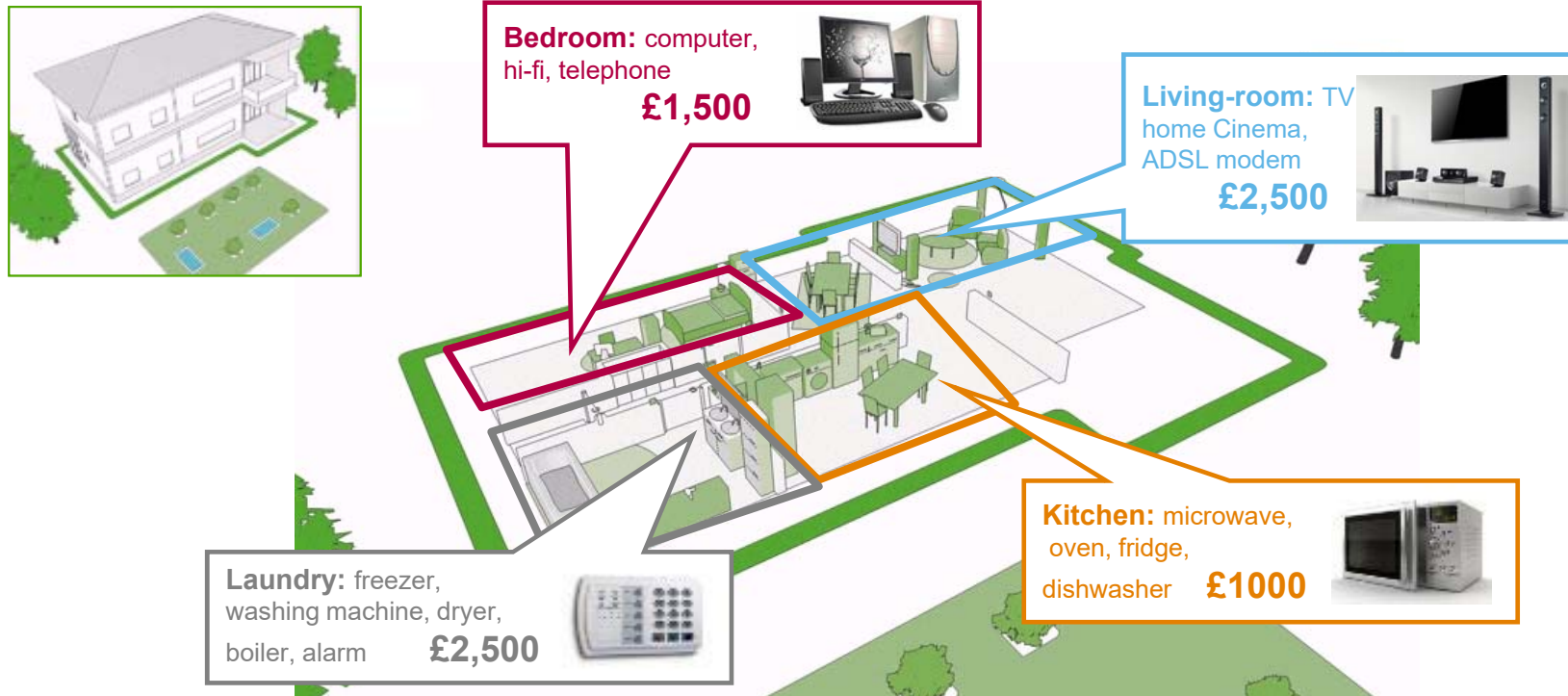


Surge Protection Devices

Technical overview, applications and benefits

The danger of power surges on equipment

➤ **90%** of sockets with power sensitive equipment + **Overvoltage** can result in damage



Electrical surges

The electrical network is subject to **power cuts and voltage fluctuations** for example:

- Weather, trees, damage to cables
- Power utility switching etc

Electrical transients can also be generated from internal sources such as **inductive load switching**



Grid Challenges

- There is a **rapidly-growing number of clean technologies accessing the grid** including solar panels, wind turbines, EV technologies
- **Renewable energy is intermittent** for e.g. if the wind isn't blowing, no power is produced from wind turbines
- **Electricity surges into the grid can damage appliances or even cause outages**

Electrical surges coming from lightning in the UK

Tornado and Storm Research Organisation (TORRO) revealed that United Kingdom, Ireland and surrounding seas typically experience **200,000 – 300,000 lightning each year**

Lightning Map – Netweather using ATD lightning detector system from the **Met Office**

Lightning Map - ATD



Welcome to the UK lightning map on Netweather, updated every 15 minutes and using the ATD lightning detection system from the Met Office. This system offers the most accurate lightning detection available for the UK. For live 5 minute updates, combined radar and lightning detection views and many more additional features take a look at [Netweather Extra](#).



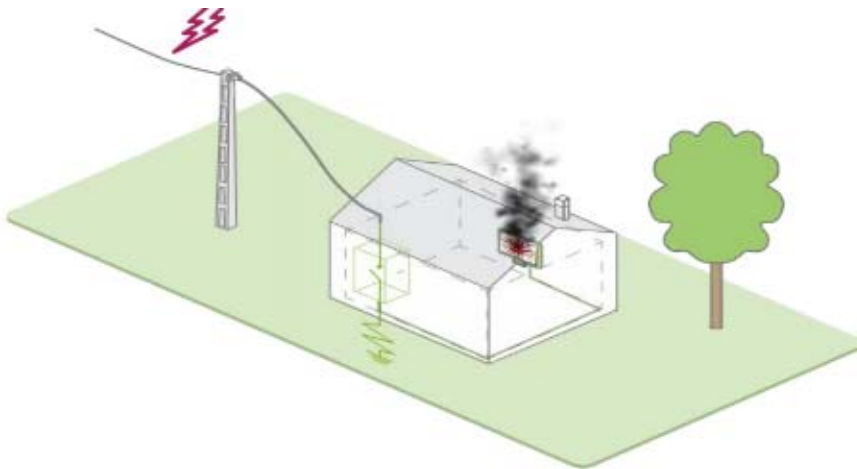
4889 lightning detected in this month
11/06/2018



Lightning and its consequences

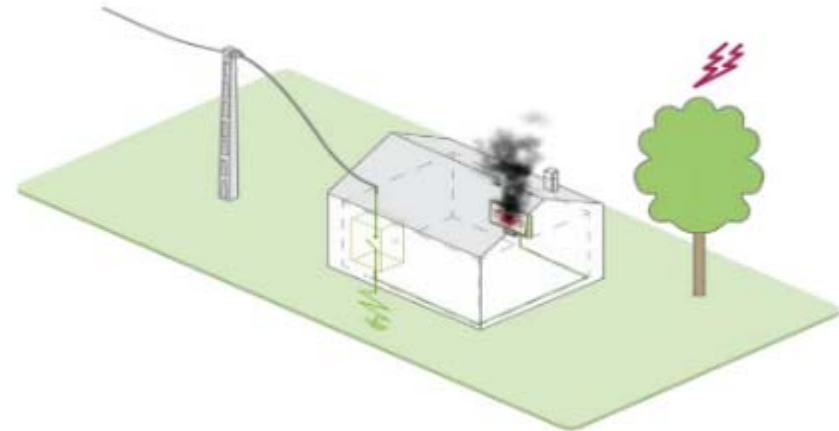
Direct

A **direct lightning strike** to a power distribution line generates **surge of energy** which might **destroy all pieces of electronic equipment**.



Indirect

Indirect lightning strike is a very common phenomenon where the overvoltage travels through the ground and causes damages to equipment.

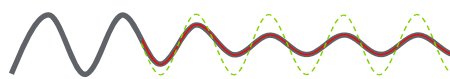


Typical electrical disturbances in power distribution network

Undervoltage

230/400V

Less than 230V -10%



Outage

230/400V

Loss of phase



Transient overvoltages

Surges or transient overvoltages are short duration, high magnitude voltage peaks which can damage or even destroy equipment

Lightning: $U_n \times 20$

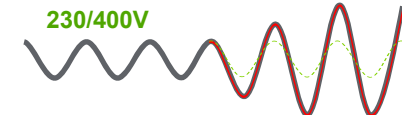
Overvoltage generated by operations: $U_n \times 5$




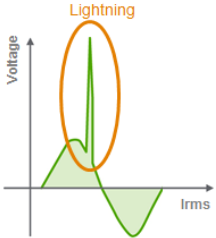

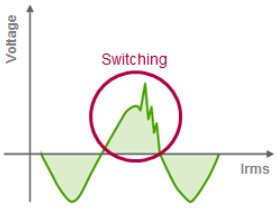
Temporary overvoltages

230/400V

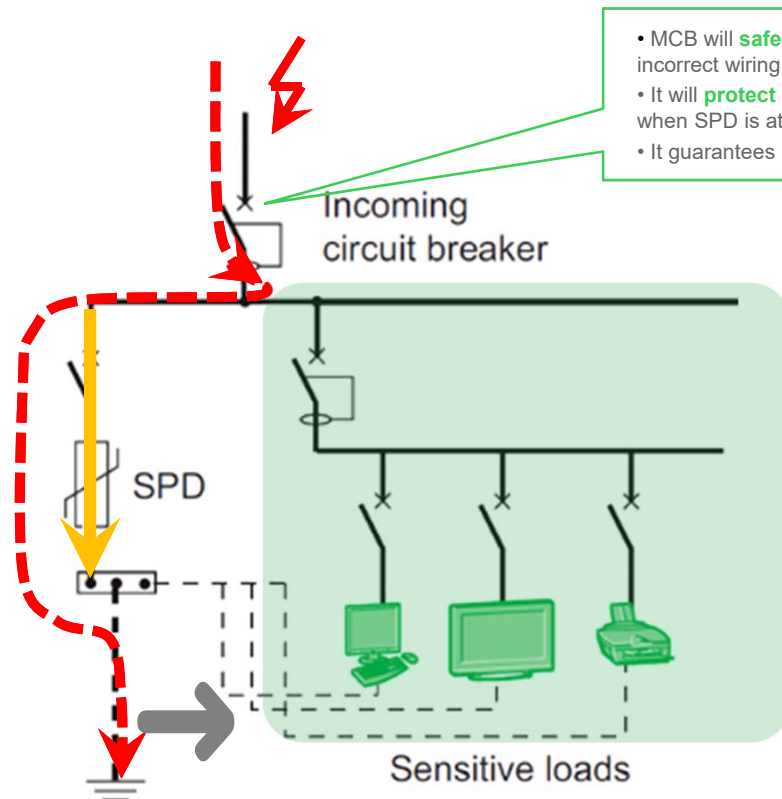
400V instead of 230V



Transient overvoltages (surges)

<p>Lightning</p>  <p>Atmospheric surges</p>		<p>Ultra-rapid transient phenomenon. Unit of measurement = $kV/\mu s$ Highly destructive energy</p>
<p>Switching</p>  <p>Industrial surges</p>		<p>Repetitive phenomenon leading to premature aging. Malfunction which may even result in permanent damage.</p>

How does Surge Protection work?



- **Connected in parallel** to the incoming breaker - **SPD has high impedance**
- Once the overvoltage appears, the **impedance of the device decreases** allowing the **surge current to travel through the SPD**, bypassing sensitive equipment.

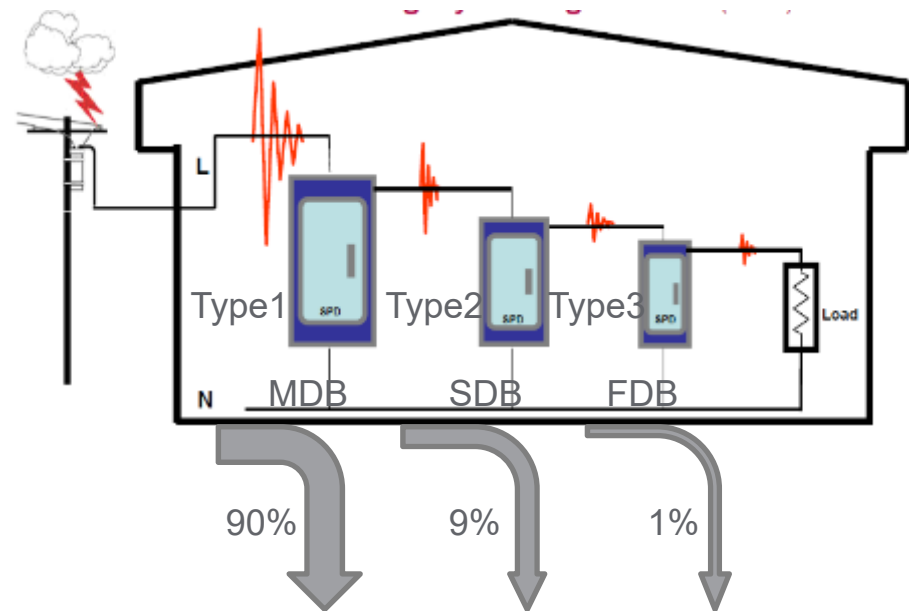
➔ **Use SPDs to protect equipment**

Types of protective devices to be used basing on lightning risk

SPD Type 1: when the building is fitted with a lightning protection system (lightning rod) and there is a high risk of direct strike. It absorbs a very large quantity of energy;

SPD Type 2: recommended to all incoming DB, it absorbs residual overvoltages;

SPD Type 3: provides "fine" protection to sensitive equipment. If load is more than 10m away from the incoming SPD, the SPD type 3 must be installed (close to the loads).



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Considerations for compliance:



- The focus has moved from lightning to **switching overvoltage**
- Lightning is still a risk, but the regulations now recognise that the applications most typically impacted by electrical surges are those located **near to sites with large switching loads**, such as wind farms and industrial applications

The risk assessment to determine if protection is needed for both residential and commercial applications involves a calculated risk level (CRL) formula, for which the installer must have knowledge of the final 1km of cabling. If the CRL is less than 1000, protection is required

- That said, SPDs can be justified in virtually all residential applications because the **combined cost of equipment at risk will far outweigh the cost of additional protection**



CRL Calculation



The CRL is found by the following formula: $CRL = f_{env} / (L_p \times N_g)$

where:

- f_{env} is an environmental factor and the value of f_{env} shall be selected according to Table 443.1
- L_p is the risk assessment length in km
- N_g is the lightning ground flash density (flashes per km² per year) relevant to the location of the power line and connected structure (see Lightning flash Density N_g map of UK in Figure 443.1)

The risk assessment length L_p is calculated as follows:

$$L_p = 2 L_{PAL} + L_{PCL} + 0.4 L_{PAH} + 0.2 L_{PCH} \text{ (km)}$$

where: L_{PAL} is the length (km) of low-voltage overhead line;
 L_{PCL} is the length (km) of low-voltage underground cable; 
 L_{PAH} is the length (km) of high-voltage overhead line;
 L_{PCH} is the length (km) of high-voltage underground cable 

The total length ($L_{PAL} + L_{PCL} + L_{PAH} + L_{PCH}$) is limited to 1 km, or by the distance from the first overvoltage protective device installed in the HV power network (see Figure 47) to the origin of the electrical installation, whichever is the smaller

Summary of SPD impacts in the 18th Edition

- Regulations now recognise that the **applications most typically impacted by electrical surges in the UK** are those **located near to sites with large switching loads** such as wind farms and industrial applications.
- **Lightning is still a risk**, particularly in the East of the country
- The **risk assessment** to determine if protection is needed for both residential and commercial applications involves a **CRL (calculated risk level) formula**
- **SPDs can be justified in virtually all residential applications** because the combined cost of equipment at risk will far outweigh the cost of additional protection.

Questions?

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