Learning outcomes

1. Review the main changes within the IET Wiring Regulations 18th Edition BS 7671:2018 relating to Surge Protection Devices (SPDs)

2. Understand what are surges

3. What is the impact of surge and the consequences?

4. How to select the correct surge protection device for the right application
Key dates of the IET Wiring Regulations 18th Edition BS 7671:2018

18th Edition published 1st July 2018

18th Edition enforced 1st January 2019

All installations designed after 31st December 2018 are required to comply.
Requirements of the 18th Edition:

Use of the AQ criteria (conditions of external influence for lightning) for determining if protection against transient overvoltage is needed is no longer included in BS 7671. Instead, new Regulation 443.4 requires protection where 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 must be performed to determine if protection against 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:

- 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

To find out more and view the source of this information, click here: BEAMA
The danger of power surges on equipment

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

- **Living-room:** TV, home Cinema, ADSL modem
  - £2,500

- **Bedroom:** computer, hi-fi, telephone
  - £1,500

- **Kitchen:** microwave, oven, fridge, dishwasher
  - £1,000

- **Laundry:** freezer, washing machine, dryer, boiler, alarm
  - £2,500
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**
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.

<table>
<thead>
<tr>
<th>Strikes Today</th>
<th>Last 7 Days</th>
<th>This Month</th>
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<tbody>
<tr>
<td>12</td>
<td>166</td>
<td>4889</td>
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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**
Lightning: Un x 20
Overvoltage generated by operations: Un x 5

**Temporary overvoltages**
230/400V
400V instead of 230V

_Surges_ or transient overvoltages are short duration, high magnitude voltage peaks which can damage or even destroy equipment.
## Transient overvoltages (surges)

### Lightning

- **Atmospheric surges**
- **Switching**

  **Lightning**
  - Ultra-rapid transient phenomenon.
  - Unit of measurement = kV/µs
  - Highly destructive energy

  ![Lightning Graph](image)

  ![Switching Graph](image)

  **Switching**
  - Repetitive phenomenon leading to premature aging.
  - Malfunction which may even result in permanent damage.

  ![Switching Graph](image)
Transient overvoltages (surges)

Surges sometimes are hardly noticeable – they have multiple consequences on electronic equipment and installations. In many cases it can cause a halt in operation, loss of data or interrupted manufacturing process. The users have a difficulty to determine the cause.

Consequences:

• Surge can **destroy electronic components**, even vaporise conductors.
• **Noise on analog signals** that generate false indications (e.g. wrong temperature)
• Possibility of **data loss** or change in memory
• **Lower transmission speed** due to repetition
• **System reset**
How does Surge Protection work?

- **Connected in parallel** to the incoming breaker - SPD has high impedance
  - MCB will *safely* trip in case of incorrect wiring
  - It will *protect* the installation when SPD is at end of life
  - It guarantees *safe* maintenance

- 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 rode) 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).
The CRL is found by the following formula:

\[ \text{CRL} = \frac{f_{env}}{L_p \times N_g} \]

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 Ng map of UK in Figure 443.1)

The risk assessment length \( L_P \) is calculated as follows:

\[ L_P = 2 \times L_{PAL} + L_{PCL} + 0.4 \times L_{PAH} + 0.2 \times L_{PCH} \text{ (km)} \]

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.

Source: BEAMA Surge Protection Guide  July 2018
Summary of SPD impacts in the 18th Edition

- The focus of Section 443 has moved from specifically lightning to also include switching overvoltage.

- Lightning is still a risk, particularly in the East of the country.

- 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.

- 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.