

PROTECTION AGAINST FIRE



We look at the requirements of Chapter 42 of the 17th Edition of the Wiring Regulations.

By Geoff Cronshaw

AMENDMENT number 1 of the 17th edition came into effect on 1 January 2012, and includes requirements for protection against thermal effects. The requirements are contained in Chapter 42 for the protection of persons, livestock and property against fire caused by electrical equipment, against burns and overheating and include precautions where particular risks of fire exist.

Protection against fire resulting from the electrical installation and the use of the electrical installation has been necessary since electricity was first introduced into buildings.

Protection against fire caused by electrical equipment

Regulation 421 requires measures to prevent electrical equipment from presenting a fire hazard to materials in close proximity to electrical equipment.

The regulation gives examples of causes of damage, injury or ignition, including:

- **thermostats, temperature limiters, seals of cable penetrations and wiring systems;**
- **overcurrent;**
- **insulation faults and/or arcs causing interference;**
- **harmonic currents;**
- **lightning strikes, see the IEC 62305 series.**

Special precautions are necessary for flammable dielectric liquids. Regulation 421.5 requires that where electrical equipment in a single location contains flammable liquid in significant quantity, adequate precautions shall be taken to prevent the spread of liquid, flame and the products of combustion.

IET Guidance Note 4 explains that the options available to the designer will depend on a number of things; for example, whether a single item or a number of items of equipment are involved, and whether the location is indoors or outdoors. The options include:

- **reducing the risk by partitioning the location with fire doors and sills;**
- **providing bunds or kerbs around items of equipment or, for larger items, a retention pit filled with pebbles or granite chips (the net capacity of the bund or retention pit when filled with pebbles or chips should exceed the oil capacity of the equipment by at least 10 per cent);**
- **providing a drainpit and flame arrestor;**
- **provision of automatic fire venting and/or automatic fire suppression or foam inlets and integration with the automatic fire detection and alarm system of the building, where appropriate;**
- **ramped floors;**
- **use of an outdoor location;**
- **blast walls between large items.**

Chapter 42 also contains requirements for fixed equipment. Regulation

421.4 requires that fixed equipment producing high concentrations of heat – for example, radiant heaters and high-intensity luminaires – must be at a sufficient distance from any fixed object or building element to ensure that, in normal conditions, the object or element is not subjected to a dangerous temperature.

Regulation 421.3 requires that where arcs or sparks may be emitted, for example in circuit-breakers or semi-enclosed fuses, the equipment shall be either:

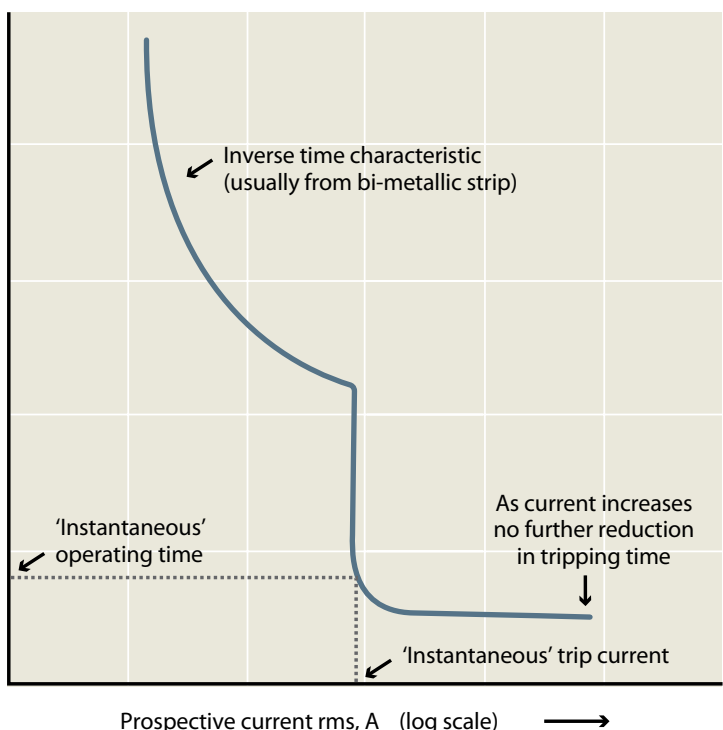
- **totally enclosed in arc-resistant material; or**
- **screened by arc-resistant material; or**
- **mounted so as to allow safe extinction of the emissions at a sufficient distance from material upon which the emissions could have harmful effects.**

Precautions where particular risks of fire exist

The requirements of this section fall under five headings: ➤

Time/current characteristic for miniature circuit breaker

Time, s
(log scale)



■ Selection and erection of installations in locations of national, commercial, industrial, or public significance

Requirements for electrical installations in locations of national, commercial, industrial or public significance were introduced into BS 7671:2008, the 17th Edition, when it was published in 2008, and this has been retained in amendment 1 of the 17th Edition. These are areas such as museums, national monuments, airports, railway stations, laboratories, computer- and data-storage centres, and archiving facilities. Regulation 422.6 requires compliance with Regulation 422.1 and consideration of a number of measures such as installation of cables with improved fire-resistance.

■ Requirements for fire-propagating structures

Some buildings with certain shapes may facilitate the spread of fire, e.g. high-rise, or forced ventilation where a chimney effect may exist. Chapter 42 contains

requirements to protect against these hazards.

■ Locations with risks of fire due to the nature of processed or stored materials

In condition BE2 (fire risk) Chapter 42 contains requirements for luminaires, enclosures, switchgear, cables, motors, heating appliances etc.

■ Requirements for locations with combustible constructional materials

Precautions should be taken so that electrical equipment does not pose an ignition hazard to walls, floors or ceilings to which it is in close proximity – by the adoption of appropriate design, installation methods and choice of electrical equipment. Distribution boards and accessory boxes for switches, socket-outlets, and the like, that are installed into or on the surface of a wall made from combustible materials should meet the requirements of the relevant product standard for temperature rise. Where this is not the case, the

equipment or accessory should be enclosed by non-flammable material of suitable thickness, taking into account the nature of the material being employed. Refer to Regulations 422.4.1, 422.4.3, and 422.4.4 for further details.

■ Emergency escape routes

In conditions BD2 (multi-storey buildings such as offices), BD3 (buildings open to the public, such as shopping centres and places of public entertainment), BD4 (high-rise buildings open to the public, such as hotels), wherever possible wiring systems should not encroach on escape routes and should in any case be as short as possible.

Future developments at international level

The Wiring Regulations (BS 7671) are based on international standards. Work is ongoing at international level to amend IEC 60364-42 to incorporate requirements for the installation of arc fault detection devices (AFDDs) to mitigate the risk of fire in final circuits of a

fixed installation due to the effect of arc-fault currents.

Arc faults

Arc faults can occur between line conductors and earth, or line conductors and neutral. Also, series-arc faults can occur, for example in a broken conductor or loose connection. These faults may result from insulation defects between live conductors, or live conductors and earth, leading to fault currents (parallel arcs), or broken or damaged conductors or poor terminal connections with increased resistance (serial arcs).

RCDs

It is recognised that RCDs can reduce the likelihood of fires associated with earth faults. For example, Section 705 of BS 7671 (Agricultural and horticultural premises) requires (Regulation 705.422.7) that, for the protection against fire, an RCD has a rated tripping current not exceeding 300mA.

An RCD is a protective device used to disconnect automatically the electrical supply when an imbalance is detected between live conductors. In the case of a single-phase circuit, the device monitors the difference in currents between the line and neutral conductors. If a line-to-earth fault develops, a portion of the line-conductor current will not return through the neutral conductor.

The device monitors this difference, operates and disconnects the circuit when the residual current reaches a preset limit, the residual operating current ($I_{\Delta n}$). An RCD on its own does not provide protection against overcurrents. Overcurrent protection is provided by a fuse or a circuit-breaker. However, combined RCD and circuit breakers are available and are designated RCBOs. Unwanted tripping of RCDs can occur when a protective conductor current or leakage current causes unnecessary

operation of the RCD. An RCD must be so selected, and the electrical circuits so subdivided, that any protective conductor current that may be expected to occur during normal operation of the connected load(s) will be unlikely to cause unnecessary tripping of the device.

Overcurrent protective devices – circuit breakers

Whilst RCDs can detect earth faults, because there is no leakage current to earth, they cannot reduce the risk of electrical fire due to series or parallel arcing between live conductors. Also, it is understood that the impedance of the series-arc fault reduces the load current, which will keep the current below the tripping threshold of the circuit-breaker. It is therefore worthwhile looking briefly at the operation of a typical commonly-used circuit breaker.

There are many types of circuit breaker available, the most common being the thermal magnetic circuit breaker. Miniature circuit breakers (MCBs) should comply with BS EN 60898 entitled 'Circuit-breakers for Overcurrent Protection for Household and Similar Installations'. The scope

identifies that MCBs are designed for use by an uninstructed person. The maximum rated current permitted is 125A.

Thermal trip

A thermal bi-metallic trip is used to protect against overload currents. The bimetallic or thermal sensing element deflects mechanically as current passes through it. The higher the overcurrent, the greater the deflection.

At a predetermined point, the element will actuate a tripping mechanism, open the contacts and disconnect the circuit. This action is represented by the inverse time characteristic (curved section) of the circuit breaker (see graph on facing page). The Standard BS EN 60898 refers to $1.45 I_n$ (the rated current or current setting of the protective device) as the conventional tripping current which must open the circuit breaker contacts within the conventional time. This is defined as one or two hours.

Magnetic characteristics

The magnetic characteristics of BS EN 60898 circuit breakers are fixed. Devices with a common nominal current rating are available in three different types. A letter preceding the nominal current rating e.g. B20 for a 20A type B circuit breaker denotes the type of device. The letters B, C, or D relate to the magnetic trip setting or characteristic curve.

The sensing component of the circuit breaker is constructed using a coil or solenoid, which is designed to operate the tripping mechanism when the overcurrent reaches a set magnitude. This magnetic component is specifically designed to deal with fault currents. The letter B, C, or D represents a multiple of I_n . When the current rises to this multiple value, the magnetic trip operates instantaneously to open the contacts.

Conclusion

To summarise, it is recognised that RCDs can reduce the likelihood of fires associated with earth faults. However, whilst RCDs can detect earth faults they are not able to reduce the risk of electrical fire due to series or parallel arcing between live conductors – because there is no leakage current to earth.

Also, it is understood that the impedance of a series arc fault reduces the load current, which will keep the current below the tripping threshold of the circuit-breaker and therefore the circuit-breaker may not operate to disconnect the circuit.

For this reason work is ongoing at present at

international level to amend IEC 60364-42 to incorporate requirements for the installation of AFDDs to mitigate the risk of fire in final circuits of a fixed installation due to the effect of arc fault currents.

Important

Please note this article only gives an overview of the requirements of section 42 of the 17th Edition of the Wiring Regulations (BS 7671). For more information refer to section 42 of BS 7671:2008 incorporating Amendment 1. Also, it is important to point out that this future development work is still at a very early stage of development in IEC and therefore may not become an international standard. ❄



Combined RCD and circuit breakers are available



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