Protection against **Electric Shock**

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This article is the second part of two that looks at summarising protective measures applied to special installations or locations defined in Part 7 of the 17th Edition of the IEE wiring Regulations (BS 7671:2008). In particular, this article looks at Sections 712 to 753.

One of the fundamental principles for electrical installations is protection for safety (Section 131) in which Regulation 131.2 Protection against electric shock requires protection to prevent a person or livestock coming into contact with live parts by the provision of basic protection (direct contact) as well as fault protection (indirect contact) to prevent an electric shock when an exposed conductive part becomes live due to a fault. The technical requirements of this principle are dealt with in Part 4 of the Regulations by Chapter 41 "Protection Against Electric Shock". This chapter highlights four protective measures that are generally permitted (Regulation 410.3.3);

- Automatic disconnection of supply (Section 411)
- Double or reinforced insulation (Section 412)
- Electrical separation for the supply to one item of current using equipment (Section 413)
- Extra –low voltage SELV and PELV (Section 414)

The application of one or more of these protective measures in an installation needs to take into account the external influence. Section 415 also gives requirements to provide additional protection by the provision of a residual current device (RCD) and supplementary equipotential bonding for certain conditions, including special installations or locations. For special installations or locations there are particular requirements for each Section that either supplement or modify the requirements of the protective measures defined in Chapter 41. Table 1 overleaf summarises the application of the above protective measures for the listed special installations or locations, highlighting the specific supplementary or modified requirements for a protective measure. In certain instances there are additional general requirements as well as additional protection (Section 415) requirements which enhance the protective measures.

In addition to the general protective measures already highlighted there is the protective measure of obstacles and placing out of reach (Section 417). It is worth highlighting that this is a protective measure that only provides basic protection and would only be applicable in installations that are restricted to skilled or instructed persons under the supervision of skilled persons. There are also other protective measures that are applicable in an installation that is controlled or under the supervision of

	Automatic Disconnection of Supply (411)	Double or Reinforced Insulation (412)	Electrical Separation –supplying single item of equipment (413)	Extra Low Voltage (414)	General Requirements and Additional Protection (415)
Solar photovoltaic (PV) power supply systems (712)	On the a.c side of the PV system, the PV supply cable is to be connected to the supply side of the protective device for automatic disconnection of circuits supplying current using equipment. Where the PV power supply system does not provide at least simple separation between the a.c side and d.c side, an RCD shall be installed for fault protection. This shall be a type B to IEC 60755 amendment 2. However the RCD is not required if the PV convertor is not able to feed d.c fault currents into the electrical installation.	Protection by the use of Class II or equivalent insulation shall preferably be adopted on the d.c side of the PV system.	General requirements of this Section apply if this measure is used.	Applying this measure means the nominal voltage Uo is replaced for a PV system by the open circuit voltage under standard test conditions $U_{oc\ STC}$ and is not to exceed 120V d.c. (Uoc STC is the voltage across an unloaded PV module, PV string, PV array, PV generator or on the d.c side of the PV inverter).	PV equipment on the d.c side of a PV system shall be considered to be energized, even when the system is disconnected from the a.c side.
Mobile or transportable units (717)	Automatic disconnection of the supply is to be provided by an RCD. Accessible conductive parts of the unit shall be connected via finely stranded main protective bonding conductors to the main earthing terminal within the unit. A TN-C-S system shall not be used to supply the unit, unless the installation will be under continuous supervision by skilled or instructed persons and the suitability and effectiveness of the earthing has been confirmed before any connection is made. An IT system can be provided with particular requirements (see Regulation 717.411.6.2)	General requirements of this Section apply if this measure is used.	General requirements of this Section apply if this measure is used.	General requirements of this Section apply if this measure is used.	Socket outlets intended to supply current using equipment outside the unit are to be protected by a 30 mA RCD with the characteristics specified in Regulation 415.1.1. An exception to this requirement is if the socket outlets are supplied with protection by SELV, PELV or electrical separation.
Electrical installations in Caravans and motor caravans (721)	Use of this measure requires a 30 mA RCD (complying with BS EN 61008-1 or BS EN 61009-1) with the characteristics specified in Regulation 415.1.1. The wiring system is to include a circuit protective conductor connected to the protective contact of the caravan supply inlet, exposed conductive parts of the electrical equipment and the protective contacts of the caravan socket outlets. Structural metallic parts which are accessible from within the caravan shall be connected via main protective bonding conductors to the main earthing terminal within the caravan. The use of a TN-C-S system is not permitted as a supply to a caravan.	General requirements of this Section apply if this measure is used.	Not permitted except for shaver socket outlets	General requirements of this Section apply if this measure is used.	Any part of a caravan installation operating at extra-low voltage is to comply with Section 414 (Protective Measure: Extra-low voltage provided by SELV or PELV). For extra-low voltage d.c power sources the nominal voltages of 12V, 24V and 48V are generally applicable. (48V is not to be exceeded). If a.c extra-low voltage is required the nominal rms voltages of 12V, 24V, 42V and 48V are generally applicable.
Temporary electrical installations for structures, amusement devices and booths at fairgrounds, amusement parks and circuses (740)	Where RCDs are used in a supply to an a.c motor they should be of the time delayed type (BS EN 60947-2) or S-type (BS EN 61008-1 or BS EN 61009-1) to prevent unwanted tripping. Where the type of system earthing is TN, a protective earthed neutral (PEN) conductor shall not be used downstream of the origin of the temporary electrical installation. An IT system shall not be used if an alternative is available. IT systems can be used for d.c applications if continuity of service is needed.	General requirements of this Section apply if this measure is used.	General requirements of this Section apply if this measure is used.	General requirements of this Section apply if this measure is used.	One or more RCDs not exceeding 300 mA are to be provided at the origin of the installation. The RCD is to incorporate a time delay (BS EN 60947-2) or be of the S-type (BS EN 61008-1 or BS EN 61009-1) to provide discrimination where final circuit RCDs are installed. Final lighting circuits, socket outlet circuits up to 32A and mobile equipment connected by means of a flexible cable or cord up to 32A shall be protected by 30 mA RCDs with the characteristics specified in Regulation 415.1.1. The supply to a battery operated emergency lighting circuit is to be connected to the same RCD protecting the lighting circuit. An RCD is not required for circuits protected by SELV or PELV, circuits protected by electrical separation or lighting circuits placed out of arm's reach provided they are not supplied by socket outlets for household or similar purposes or socket outlets according to BS EN 60309-1. In locations intended for livestock, supplementary bonding is required to connect all exposed conductive parts and extraneous conductive parts that can be touched by livestock. This is to include a metal grid if installed in the floor of the location. Extraneous conductive parts in, or on a floor e.g. reinforced concrete are to be connected to the supplementary equipotential bonding. It is recommended that spaced floors made of prefabricated concrete elements be part of the equipotential bonding. This is to erected and protected against mechanical stresses and corrosion.
Floor and ceiling heating systems (753)	An RCD with a rated residual operating current not exceeding 30 mA is to be used as a disconnecting device. For heating units without exposed conductive parts a conductive covering e.g. a grid with a spacing of not more than 30mm is to be provided above the floor heating elements or under ceiling elements and connected to the protective conductor of the electrical installation	General requirements of this Section apply if this measure is used.	Not permitted	General requirements of this Section apply if this measure is used.	A circuit supplying heating equipment of Class II construction or equivalent insulation requires additional protection by a 30 mA RCD with the characteristics specified in Regulation 415.1.1
Note:	A number of references are made to an RCD with the characteristics specified in Regulation 415.1.1. This describes the requirement for an RCD to have a rated residual operating current not exceeding 30 mA and an operating time not exceeding 40 ms at a residual current of 5 times the 30 mA rated residual operating current (e.g. trip in less than 40 ms at a residual current of 150 mA).				

Table 1 – Summary of the general protective measure requirements for Special installations or locations (712 to 753)

	Obstacles and placing out of reach (417)	Non-conducting Location (418.1)	Earth free local equipotential bonding (418.2)	Electrical separation – supplying more than one item of equipment (418.3)
Solar photovoltaic (PV) power supply systems (712)	Permitted	Not permitted on the d.c side of the PV installation	Not permitted on the d.c side of the PV installation	(Note 1)
Mobile or transportable units (717)	Not permitted	Not permitted	Not recommended	(Note 1)
Electrical installations in Caravans and motor caravans (721)	Not permitted	Not permitted	Not permitted	(Note 2)
Temporary electrical installations for structures, amusement devices and booths at fairgrounds, amusement parks and circuses (740)	Use of obstacles is not permitted. Placing out of arm's reach is permitted for electric dodgems, provided they operate at voltages not exceeding 50V a.c or 120V d.c and are electrically separate from the supply via a transformer or generating set.	Not permitted	Not permitted	(Note 1)
Floor and ceiling heating systems (753)	Not permitted	Not permitted	Not permitted	Not permitted
Note 1:	Although the use of this measure is not specifically restricted by a Regulation in Part 7 for this location this method of protection is not recognised for general application and is only to be applied where the installation is under the supervision of skilled or instructed persons so that unauthorized changes cannot be made.			
Note 2:	Although the use of this measure is not specifically restricted by a Regulation in Part 7 for this location there are specific restrictions in the use of electrical separation supplying only a single piece of equipment for this location that effectively restricts the use of this measure (refer to Electrical Separation for this specific location in Table 1).			

Table 2 – Specific protective measures applied to special installations or locations (712 to 753)

skilled or instructed persons (Section 418) to avoid unauthorized changes, these are:

■ Non-conducting location (Section 418.1)
■ Earth-free equipotential bonding (Section 418.2)
■ Electrical separation for the supply to more than one item of current using equipment (Section 418.3)
Each of these protective measures requires all electrical equipment to have basic protection in compliance with Section 416 along with specific requirements for each to provide fault protection.

Due to the nature of these types of protective measures there are a number of restrictions in relation to special installations or locations. Table 2 summarises the application of the above protective measures for the listed special installations or locations.

The IET Guidance Note 7 – Special Locations deals with special installations or locations. This is being aligned and updated to the 17th Edition and will provide additional guidance to the information provided here. ■