



FAIRGROUNDS, AMUSEMENT PARKS AND CIRCUSES

by Mark Coles

THIS ARTICLE looks at Temporary Electrical Installations for Structures, Amusement Devices and Booths at Fairgrounds, Amusement Parks and Circuses – a proposed new Section for BS 7671:2008, 17th Edition of the *IEE Wiring Regulations*.

Currently, there is no Part or Section of BS 7671:2001(2004) covering such installations but information can be found in IEC 60364-7-740 and HD 60364-7-740.

The proposed Section 740 of BS 7671:2008 is based on the CENELEC Harmonised Document HD 60364-7-740, of which, the UK is to incorporate the technical intent of that standard.

(Please note that Regulations and Sections quoted within this article are from the proposed BS 7671:2008 and may be subject to change).

The Scope of Section 740

Section 740 recognises that some installations are exposed to many differing and onerous circumstances, as they are frequently installed, dismantled, moved to a new location then installed and operated again.

To compound problems, such installations can be exposed to the elements, open to the general public, house animals and livestock and be operated as a place of work. The equipment must function without compromising safety, therefore, the installation has to be fit for purpose and be designed to cope with ever-changing conditions.

The permanent electrical installation, from which the temporary system is supplied, or the building in which the temporary system is housed, is excluded from the scope, nor does the scope apply to the

internal electrical wiring of machines (see BS EN 60204-1).

Electrical Supplies

The nominal supply voltage of temporary electrical installations in booths, stands and amusement devices should not exceed 230/400 V ac or 440 V dc. Supplies can be obtained from a number of sources:

- from the public network, i.e. the DNO
- generators, i.e. those mounted on trucks owned by the touring event
- from privately owned supplies, i.e. a local factory with sufficient spare-capacity

There can be any number of electrical sources supplying the temporary system and it is of paramount importance that line-and-neutral conductors from different sources are not interconnected. Where the supply is obtained from the DNO any instructions given must be adhered to.

Supplies obtained from the DNO would preferably be TN-S but this isn't always possible. A TN-S system has the neutral of the source of energy connected with earth at one point only, at, or as near as is reasonably practicable, to the source of supply. The consumer's main earthing terminal is typically connected to the metallic sheath of the distributor's SWA service cable.

Where the available supply is TN-C-S, the supply should not be used in that form, i.e. a TT system should be created. The reason is that the ESQCR prohibits the use of a TN-C-S system for the supply of a caravan or similar construction.

Where continuity of service is important, IT systems may be used for dc applications only.

Protection against electric shock

At the origin of each electrical supply, to all or part of the installation, an RCD, with a rated residual operating ►

◀ current not exceeding 300 mA, is to be installed to provide automatic disconnection of supply. As there will be further RCDs downstream of this point, this RCD should be of the S-type, complying with the requirements of BS EN 61008-1 or BS EN 61009-1 and incorporate a time delay in accordance with BS EN 60947-2, to provide discrimination with further RCDs protecting final circuits.

For supplies to ac motors, RCDs should be the time-delayed or the S-type where necessary to prevent unwanted tripping.

The protective measure of protection by obstacles is not permitted on this type of installation, however, placing out of arm's reach is acceptable for electric dodgems – more of which later.

Additional protection

All final circuits in the installation, e.g. lighting, socket-outlets rated up to 32 A, mobile equipment connected by a flexible cable and rated up to 32 A are to be protected by an RCD having a rated residual operating current not exceeding 30 mA. The requirement for additional protection relates to the increased risk of damage to cables within an installation of this nature.

Lighting circuits incorporating emergency luminaires, with self-contained batteries for example, should be protected by the same RCD protecting that lighting circuit.

This requirement for additional protection does not apply to:

- SELV or PELV circuits – this measure alone is deemed to be a protective measure in all situations
- circuits protected by electrical separation
- lighting circuits placed out of arm's reach – provided they are not supplied by socket-outlets, i.e. those manufactured to BS 1363 or BS EN 60309-1; luminaire supporting couplers or plug-in lighting distribution units excepted



Supplementary bonding

Particular care must be taken in areas where livestock are housed as they are sensitive to small potential differences. To minimise potentials, supplementary bonding should be installed to connect all exposed-conductive-parts and extraneous-conductive-parts that can be touched by livestock.

Where a metal grid is laid in the floor, or extraneous-conductive-parts are accessible, they should be included within the supplementary bonding of the location. It is important to note that animal excrement and urine is very corrosive and so all supplementary bonding connections should be enclosed in a suitable enclosure.

THE INSTALLATION

Wiring systems

Conduit, cable trunking and ducting, tray and ladder systems can be used but must, of course comply with the manufacturer's instructions; the following standards apply:

- conduit systems BS EN 61386 series
- cable trunking systems/cable ducting systems BS EN 50085 (particular parts only)
- tray and ladder systems BS EN 61537

Cables

All cables should be fire rated and meet the requirements of

BS EN 60332-1-2. Cables of type H07RNF or H07BN4-F (BS 7919) together with conduits complying with BS EN 61386-23 are deemed to satisfy this requirement. Cables should have a minimum rated voltage of 450/750 V, except that, within amusement devices, cables and cords having a minimum rated voltage of 300/500 V may be used. Where cables are buried in the ground, the route should be marked at suitable intervals and be protected against mechanical damage.

Electrical connections

Joints should not be made in cables except where necessary as a connection into a circuit. Where joints are made, these should be either using connectors in accordance with the BS 7671, the manufacturer's instructions or the connection should be made in an enclosure with a degree of protection of at least IP4X or IPXXD. Where strain can be transmitted to terminals the connection should incorporate cable anchorage(s).

External influences

Electrical equipment should have a degree of protection of at least IP44.

Switchgear and controlgear

Switchgear and controlgear should be placed in cabinets which can be opened only by the use of a key or a tool, except for those parts designed and intended to be operated by ordinary persons.

Isolation

It is a requirement that every electrical installation of a booth, stand or amusement device has its own means of isolation, switching and overcurrent protection, these devices should be readily accessible. There are similar requirements for supplies to amusement devices. Additionally, each distribution circuit should be provided with its own readily accessible and properly identified means of isolation. A device for isolation should

disconnect all live conductors – line(s) and neutral conductors.

Examples of devices used for isolation are:

- circuit-breaker
- RCD
- plug and socket arrangement

Luminaires

Every luminaire and decorative lighting festoon-chain should have a suitable IP rating and be securely attached to the structure or support intended to carry it. Its weight should not be carried by the supply cable, unless it has been selected and erected for this purpose.

Luminaires and decorative lighting festoon-chains mounted less than 2.5 m, i.e. arm's reach, above floor level or could be otherwise accessible to incidental contact, should be firmly fixed, sited and guarded to prevent risk of injury to persons or ignition of materials. Access to the fixed light source should only be possible after removing a barrier or an enclosure, which should only be possible by the use of a tool. Lighting festoon-chains should use H05RN-F (BS 7919) cable or equivalent, they may be used in any length provided the overcurrent protective device in the circuit is correctly rated.

Luminous tube, sign or lamps with an operating voltage higher than 230 V/400 V a.c., e.g. neon signs, are to be installed out of arm's reach or be adequately protected from accidental or deliberate damage. A separate circuit should be used which should be controlled by an emergency switch. The switch should be easily visible, accessible and marked in accordance with the requirements of the local authority.

Luminaires in shooting galleries and other sideshows where projectiles are used should be suitably protected against accidental or deliberate damage.

When transportable floodlights are used, they should be mounted so that

the luminaire is inaccessible to non-instructed persons. Supply cables should be flexible and have adequate protection against mechanical damage.

Safety isolating transformers and electronic converters

Safety isolating transformers should comply with BS EN 61558-2-6 or provide an equivalent degree of safety. Each transformer or electronic converter should incorporate a protective device which can be manually reset only; this device should protect the secondary circuit.

Safety isolating transformers should be mounted out of arm's reach or be mounted in a location that provides equal protection, e.g. in a panel or room that can only be accessed by a skilled or instructed person, and should have adequate ventilation. Access by competent persons for testing or by a skilled person competent in such work for protective device maintenance should be provided.

Electronic converters should conform to BS EN 61347-2-2.

Enclosures containing rectifiers and transformers should be adequately ventilated and the vents should not be obstructed when in use.

Plugs and socket-outlets

An adequate number of socket-outlets should be installed to allow the user's requirements to be met safely. In booths, stands and for fixed installations, one socket-outlet for each square metre or linear metre of wall is



generally considered adequate. Socket-outlets dedicated to lighting circuits placed out of arm's reach should be labelled according to their purpose. When used outdoors, plugs, socket-outlets and couplers should comply with BS EN 60309-2, or where interchangeability is not required, BS EN 60309-1.

FIRE RISK

Luminaires and floodlights

Luminaires and floodlights should be fixed so that a focusing or concentration of heat is not likely to cause ignition of any material.

Electric motors

An electric motor which is automatically or remotely controlled and which is not continually supervised should be fitted with a manual reset protective device against excess temperature.

ELECTRICAL EQUIPMENT

Electrical supply to devices

At each amusement device, there should be a connection point readily accessible and permanently marked to indicate the following essential characteristics:

- rated voltage
- rated current
- rated frequency

Electric dodgems

Electric dodgems should only be operated at voltages not exceeding 50 V a.c. or 120 V d.c. The circuit should have an electrical separation from the electrical supply by means of a safety isolating transformer in accordance with BS EN 61558-2-4 or a motor-generator set.

Low voltage generating sets

It is very important that all generators are located to prevent danger and injury to people through inadvertent contact with hot surfaces and dangerous parts. The electrical equipment associated with the ►

◀ generator should be mounted securely and, if necessary, on anti-vibration mountings.

Where a generator supplies a temporary installation, forming part of a TN, TT or IT system, care should be taken to ensure that the earthing arrangements are adequate and, in cases where earth electrodes are used, they are considered to be continuously effective. In reality this means that the drying of the ground, in summer, or freezing of the ground, in winter, should not adversely affect the value of earth fault loop impedance for the installation.

The neutral conductor of the star-point of the generator should, except for IT systems, be connected to the exposed-conductive-parts of the generator.

INSPECTION AND TESTING

The temporary installation

The electrical installation between its origin and any electrical equipment should be inspected and tested after each assembly on site. Internal electrical wiring of roller coasters, electric dodgems, etc., are not considered as part of the verification of the electrical installation. In special cases the number of the tests may be modified according to the type of temporary electrical installation.

The HSE offers guidance on the inspection and testing of the temporary electrical installation in the publication HSG 175 – *Fairgrounds and Amusement Parks: Guidance on Safe Practice*. The document is the result of work carried out by the Fairgrounds and Amusement Parks Joint Advisory Committee (FJAC) which has worked for over 25 years to continually improve standards and the exchange of information. Fairgrounds and amusement parks have been shown to be relatively safe compared to such activities as driving a car or riding a bicycle but there have been a small number of serious accidents involving the general public and employees.



Amusement devices

The Scope of Section 740 does not cover amusement devices but, in law, there is still a requirement to ensure that the devices are fit for use.

The Amusement Device Safety Council (ADSC) is the policy making body for safety, self regulation and technical guidance in the UK amusement industry. This committee, in partnership with HSE, develops the policy for, and oversees the Amusement Device Inspection Procedures Scheme (ADIPS). ADIPS is the fairground and amusement park industry's self regulated safety inspection scheme which registers competent ride inspectors and the rides they inspect.

The purpose of the scheme is to promote and improve fairground and amusement park safety through rules and procedures relating to the annual inspection of the amusement devices. It is supported by industry associations who require that their members use ADIPS.

ADIPS is also available to any operator of amusement devices as it demonstrates 'best practice' and their compliance with the Health and Safety at Work (etc) Act.

Further information

The following standards and publications have been referenced in this article or will provide further reading on the subject:

- BS 1363** – 13 A plugs, socket-outlets and adaptors
- BS 7919** – Electric cables. Flexible cables rated up to 450/750V, for use with appliances and equipment intended for industrial and similar environments
- BS EN 50085** – Cable trunking and cable ducting systems for electrical installations
- BS EN 60204-1** – Safety of machinery. Electrical equipment of machines. Specification for general requirements
- BS EN 60309-1** – Plugs, socket-outlets and couplers for industrial purposes. General requirements
- BS EN 60309-2** – Plugs, socket-outlets and couplers for industrial purposes. Dimensional interchangeability requirements for pin and contact-tube accessories
- BS EN 60332-1-2** – Tests on electric and optical fibre cables under fire conditions. Test for vertical flame propagation for a single insulated wire or cable. Procedure for 1 kW pre-mixed flame
- BS EN 60947-2** – Low-voltage switchgear and control gear. Circuit-breakers
- BS EN 61008-1** – Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs). General rules
- BS EN 61009-1** – Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs). General rules
- BS EN 61347-2-2** – Lamp controlgear. Particular requirements for d.c or a.c. supplied electronic step-down converters for filament lamps
- BS EN 61386** – Conduit systems for cable management. General requirements
- BS EN 61537** – Cable management. Cable tray systems and cable ladder systems
- BS EN 61558-2-6** – Safety of power transformers, power supply units and similar. Particular requirements for safety isolating transformers for general use
- IEC/HD 60364-7-740** – Electrical installations of buildings – Part 7-740: Requirements for special installations or locations – Temporary electrical installations for structures, amusement devices and booths at fairgrounds, amusement parks and circuses
- HSG 175** – Fairgrounds and Amusement Parks: Guidance on Safe Practice ISBN 978-0-7176-6249-4
- ADIPS** – www.adips.co.uk

Thanks to Ken Morton of the HSE. ■