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Code of practice for temporary electrical systems for entertainment and related purposes

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Foreword

Publishing information

This British Standard is published by BSI and came into effect on 31 August 2011. It was prepared by Technical Committee CPW/4, *British standards for imaging*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 7909:2008, which is withdrawn.

Relationship with other publications

This British Standard should be read in conjunction with BS 7671:2008+A1:2011, and it expects temporary electrical systems to adhere to its fundamental principles.

Where this British Standard requires performance criteria to be met, the requirements in this British Standard take precedence over those in related standards.

Information about this document

This is a full revision of the standard, which incorporates changes that result from the changes made to BS 7671:2008+A1:2011. The following principle changes have been introduced:

- earlier editions of BS 7671 required an Electrical Installation Certificate (EIC) and Periodic Inspection Report (PIR); BS 7671:2008+A1:2011, Chapter **61**, requires an Electrical Installation Certificate (EIC) and introduces the Electrical Installation Condition Report (EICR), which replaces the PIR. The likely presence of either a PIR or EICR for an existing installation has been included;
- the responsibilities of suppliers for the provision of equipment have been more positively stated in **4.5**;
- additional information about cable types has been added in **7.3**;
- the records, results and certificates in **9.3** have been updated to take account of updates made to Annex G, including updated certificates and procedures;
- the information on standards applicable to RCDs and RCD types in Annex E has been updated;
- additional information about supplies provided for temporary distributions at venues has been added in Annex F;
- the information on standard connections for 16-pin and 19-pin connectors used for lighting applications has been updated.

This British Standard deals with the creation and operation of temporary electrical distributions and systems required for events in entertainment and other related industries. The range of electrical equipment involved is broad and is frequently supplied by a variety of specialist facilities and services providers under separate hire agreements.

The staff for such events bring a considerable range of skills; they might be employees of the facilities and services providers, or sole traders or freelance people hired under varied and separate agreements. Each event brings together different facilities and people and requires management arrangements to be in place and understood. Clause **4** of this British Standard outlines the management arrangements and expects the appointment of a person responsible for the temporary electrical systems to be created for the event.

The person responsible for the temporary electrical system needs to understand the equipment and procedures developed for such events as these differ considerably from those used for permanent installations. It is important to recognize these differences and the need for the safety guidance recommended. The electrical supplies required range from that available from a domestic socket-outlet, to significantly larger supplies obtained from direct connection to public or private electricity suppliers' systems or from mobile generating sets.

Considerations of portability limit the size and weight of units, and time and other constraints prevent the use of conventional fixing methods. Tight schedules, adverse weather and late changes of plan are routine problems. The reusable equipment developed for these circumstances is accepted as providing proper standards of safety if used correctly and this British Standard is intended to provide overall guidance for these circumstances.

There is a huge variety of events and activities in the entertainment and related industries, ranging from very simple to highly complex, that require the use of temporary electrical systems. The main body of the standard gives recommendations for all temporary electrical systems; Clause **5** deals with the simpler temporary systems only.

The principle clauses each deal with a different aspect of work; many contain references to other clauses or BS 7671 that have a direct bearing on the detail being considered.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately knowledgeable and experienced people, for whose use it has been produced.

BSI permits the reproduction of Figures F.2, G.1, G.2, G.3, H.1 and H.2 of BS 7909:2011. This reproduction is only permitted where it is necessary for the user to work or record findings on the figure during each application of the standard.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This British Standard gives recommendations for the management, design, setting-up and operation of temporary electrical systems using low voltage a.c. electricity, for the entertainment and similar or related industries. Mobile and transportable units with electrical installations that are used in these industries are also covered.

This British Standard gives recommendations for the provision of a safe and suitable temporary electrical system for an event and the duties and work to implement this.

NOTE 1 Each aspect of the work could be under the control of a different person responsible.

This British Standard gives guidance on matters of common interest to producers, production companies, event organizers and managers, freelance people, facilities and services hire companies, equipment hire companies, equipment manufacturers, electrical consultants, electrical installation contractors, distributors, suppliers of electricity, venues, local authorities and those responsible for safety.

The systems covered by this British Standard operate at low voltage as defined in BS 7671:2008+A1:2011 and supply equipment normally operating at 230 V a.c. or 400 V a.c. 50 Hz. Electricity at low voltage can be taken from an existing installed electrical system, the public supply, privately owned supplies or from mobile or portable generators. Direct current supplies are outside the scope of this British Standard.

NOTE 2 It is expected that all electrical equipment, switchgear units, distribution units and cables used for work covered by this British Standard are manufactured to the appropriate product standards, and that the temporary electrical systems and their use are designed, set-up, supervised, operated and removed by suitably competent persons. It is also expected that responsibility for such temporary electrical systems is taken by a suitably competent person referred to as the person responsible.

NOTE 3 All equipment forming the temporary electrical system is expected to be delivered to site as pre-assembled units that have been tested and are known to be safe and suitable for use. This does not preclude the manufacture on site of simple units that might be necessary; though this is the exception and not the rule.

*NOTE 4 In many situations temporary electrical distributions are intimately associated with mobile and transportable units. In such cases, see BS 7671:2008+A1:2011, Section **717**, for further information.*

*NOTE 5 This British Standard may be applied to temporary electrical distributions at exhibitions and fairgrounds; see BS 7671:2008+A1:2011, Sections **711** and **740**, respectively for specific information for these activities. Specialized documents related to exhibitions are published by the Association of Event Venues [1].*

NOTE 6 Specialized documents related to theatres and places of entertainment are published by the Association of British Theatre Technicians [2].

NOTE 7 This British Standard does not offer guidance for hazardous locations where expert advice needs to be sought.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 4533-102.9, *Luminaires – Part 102: Particular requirements – Section 102.9: Specification for photo and film luminaires (non-professional)*

BS 4533-102.17, *Luminaires – Part 102: Particular requirements – Section 102.17: Specification for luminaires for stage lighting, television, film and photographic studios (outside and indoor)*

BS 4363, *Specification for distribution assemblies for reduced low voltage electricity supplies for construction and building sites*

BS 5266-1, *Emergency lighting – Part 1: Code of practice for the emergency lighting of premises*

BS 5499-10, *Safety signs, including fire safety signs – Part 10: Code of practice for the use of safety signs, including fire safety signs*

BS 6500, *Electric cables – Flexible cords rated up to 300/500 V, for use with appliances and equipment intended for domestic, office and similar environments*

BS 7375, *Distribution of electricity on construction and building sites – Code of practice*

BS 7430:1998, *Code of practice for earthing*

BS 7671:2008+A1:2011, *Requirements for electrical installations – IET Wiring Regulations – Seventeenth Edition* [1)]

BS EN 12193:2007, *Light and Lighting – Sports lighting*

BS EN 50172 (BS 5266-8), *Emergency escape lighting systems*

BS EN 60529:1992+A2:2000, *Specification for degrees of protection provided by enclosures (IP code)*

BS EN 60598-1, *Luminaires – Part 1: General requirements and tests*

BS EN 60598-2 (all sections), *Luminaires – Part 2: Particular requirements*

BS EN 61439 (all parts), *Low-voltage switchgear and controlgear assemblies*

BS EN 61558-2-6, *Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V – Part 2.6: Particular requirements and tests for safety isolating transformers and power supply units incorporating safety isolating transformers*

BS EN 61984, *Connectors – Safety requirements and tests*

PAS 51, *Guide to industry best practice for organizing outdoor events*

[N1] IET, *Guidance Note 6: Protection against overcurrent*. IET Publications [1)], 2009.

[N2] HEALTH AND SAFETY EXECUTIVE, *The event safety guide. A guide to health and safety and welfare at music and similar events* (HSG195). HSE Books 1999.

[N3] IEE, *Code of practice for in-service inspection and testing of electrical equipment*. IET Publications, 2007.

[N4] IET, *Guidance Note 3: Inspection and testing*. IET Publications [1)], 2008.

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1) This was originally published by the IEE but is now published and available from the IET: www.theiet.org.

[N5] HEALTH AND SAFETY EXECUTIVE, *Maintaining portable and transportable electrical equipment* (HSG107). HSE Books, 2004.

[N6] IET, *Guidance Note 8: Earthing and bonding*. IET Publications, 2007.

[N7] HEALTH AND SAFETY EXECUTIVE, *Electrical Safety of Independent Low Voltage a.c. Portable and Mobile Generators and Connected Systems* (OC482/2). HSE Books.

3 Terms and definitions

For the purposes of this British Standard, the definitions given in BS 7671:2008+A1:2011 apply, together with the following.

NOTE Some of the definitions in this British Standard are simplified to assist the general reader.

3.1 activity

occasion or part of an event where a temporary electrical system is used

*NOTE See **3.22**.*

3.2 cable splitter unit (CSU)

unit that enables a temporary distribution cable to be split into two or more outgoing circuits without further circuit protection

*NOTE See **B.4**.*

3.3 carry-in

where relatively small amounts of equipment are carried into a location and set-up for use on a temporary basis

NOTE The equipment requires less than 6 kVA of power and is typically used for recording or editing of broadcast material. The expression "radio carry-in" describes a method of working in the radio industry; this method might apply to other areas of work.

3.4 central distribution unit (CDU)

portable distribution unit providing a means of functional switching, contactor control and/or protection of a number of outgoing circuits

*NOTE 1 See **B.3**.*

NOTE 2 Central distribution units, intake switch units and final distribution units can be constructed as composite units in any combination. Central distribution units might include dimmers and other power-processing or controlling devices.

3.5 circuit protective conductor (CPC)

protective conductor connecting exposed-conductive-parts of equipment to the main earthing terminal

NOTE A CPC is included with the line and neutral conductors to all parts of a temporary distribution.

3.6 Class I construction

equipment in which protection against electric shock does not rely on basic insulation only, but which includes means for the connection of exposed-conductive-parts to the CPC in the temporary distribution

3.7 Class II construction
equipment in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions such as supplementary insulation are provided, there being no provision for the connection of exposed metalwork of the equipment to a protective conductor, and no reliance upon precautions to be taken in the temporary distribution

NOTE 1 See BS EN 61140.

NOTE 2 Class II appliances may incorporate means for maintaining the continuity of protective circuits, provided that such means are within the appliance and are insulated from conductive accessible parts by supplementary insulation. Class II equipment has a double square symbol and is identified with the Class II mark: ⧈.

3.8 Class III construction
equipment in which protection against electric shock relies on a supply at Separated Extra Low Voltage (SELV) and in which voltages higher than those of SELV are not generated

NOTE See BS EN 61140.

3.9 competence (competent person)
sufficient technical knowledge, relevant skills and practical experience for the nature and complexity of the duty to be undertaken and able to prevent danger and injury to themselves and others

NOTE In the context of this British Standard, competence is associated with the knowledge, skill and experience to deal with the electrical and/or related managerial matters that might arise at any time during the progress of the event. The environments in which temporary distributions are used are often subject to change, therefore a competent person is able to identify hazardous conditions and implement appropriate control measures. A competent person is aware of their limitations.

3.10 current-using equipment
equipment which converts electrical energy into another form of energy such as heat, motive power, light or signals, etc.

3.11 dimmer
device for varying the power supplied to a luminaire, thus varying the light output

3.12 disconnector
mechanical switching device which in the open position conforms to the requirements for isolation

NOTE 1 This is the preferred term for a device that used to be referred to as an isolator.

NOTE 2 Disconnectors are not designed to make or break load current.

3.13 discrimination
design arrangements to ensure that the overcurrent protection or RCD nearest to a fault operates before any other protective device

NOTE Correctly arranged discrimination ensures the appropriate protective devices operate. It is the overcurrent or residual current device immediately upstream of the cause of the problem that operates so that no other circuits are affected. See also ***E.2.5*** *and* ***E.3.3****.*

3.14 distribution(s)
NOTE See ***3.59****, temporary electrical distributions.*

3.15 distributor/distribution network operator (DNO)

organization that operates a network that distributes electricity to separate consumers

NOTE 1 Such organizations are referred to as "distributors" in the Electricity Safety, Quality and Continuity Regulations (ESQCR) [3] and the Electricity Supply Regulations (Northern Ireland) 1991 [4]. In this British Standard DNO indicates "distributor" as used in ESQCR [3].

For instance, an organization or person can be a DNO where they own an industrial site on which they provide and control the means of distributing electricity to a number of separate individual units on that site, or where they own a commercial or domestic premise, such as a shopping mall, block of offices or flats, which are occupied as separate individual units and to which they provide and control the means of distributing electricity to each unit.

NOTE 2 When information about a main distribution to a consumer is needed, the Electricity Networks Association can provide maps and contact information [2)] about the DNOs that serve Great Britain and Northern Ireland.

3.16 diversity

allowance made in calculation of system or circuit capacity that predicts that the maximum available load is not connected simultaneously

3.17 earthing arrangements

defines the electrical system

*NOTE Where a generator is used as the source of supply under certain circumstances, it might not be necessary to connect this source to the general mass of Earth (see **7.4.2.3** and **C.5.2**). In this case the earthing arrangement relates to the connections between the generator output, the generator's earthing terminal, the generator's chassis and the CPC of any connected distribution. Earthing arrangements that might be encountered when considering temporary electrical systems used at events are given in **3.17.1**, **3.17.2**, **3.17.3**, **3.17.4** and **3.17.5**.*

3.17.1 TN-C

system in which neutral and protective functions are combined in a single conductor throughout the system

NOTE The ESQCR [3] and the Electricity Supply Regulations (Northern Ireland) 1991 [4] prohibits the use of TN-C in a consumer's installation.

3.17.2 TN-S

system having separate neutral and protective conductors throughout the system

3.17.3 TN-C-S

system in which neutral and protective functions are combined in a single conductor in the distributor's network and then separated in the consumer's part of the system

*NOTE BS 7671:2008+A1:2011, Section **7**, introduces the fact that the majority of installations that are TN-C-S in form are supplied from a protective multiple earth (PME) source and have a protective earth derived from the PME source (see **3.49**). Within this British Standard, wherever TN-C-S supply is referred to, it is considered to have been obtained from a PME source and arranged in this way.*

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2) This can be found at http://energynetworks.squarespace.com/ena-members/ and http://energynetworks.squarespace.com/electricity-distribution-map.

*TN-C-S supplies in this form experience the greatest problems and potential safety issues in the event of a PEN failure in the main PME distribution. Situations exist where a TN-C-S supply has its protective earth connected to structural steel or concrete reinforcement that forms the building's foundations or to earth electrodes in intimate contact with the general mass of Earth. This situation is described in **C.4.3**, item 4.*

3.17.4 TT

system having one point of the source of supply directly earthed, the exposed-conductive-parts of the installation being connected to earth electrodes electrically independent of the earth electrodes of the source

3.17.5 IT

system having no direct connection between live parts and Earth, the exposed-conductive-parts of the electrical installation being earthed

3.18 electrical environment

geographical area in which an electrical system exists and its characteristics wherever assessed are substantially constant

*NOTE The area outside a building, a garden for example, is considered to be a different electrical environment from that within the same building. The area within touching distance around a metal columned street light is an electrical environment. The area within a vehicle with onboard generator is an electrical environment; the area within touching distance of this same vehicle is a different electrical environment from that within the vehicle and that around the street light (see also **C.2**).*

3.19 electromagnetic interference (EMI)

undesirable electrical and/or magnetic energy, which can be radiated, conducted or induced in a system and that causes interference with the normal operation of equipment

*NOTE Matters of electromagnetic disturbance or EMI in permanent installations are dealt with in BS 7671:2008+A1:2011, Chapter **44**, Section **444**.*

3.20 entertainment industry

all branches of theatre, opera, concerts, touring shows, music festivals, pop concerts, ballet, pageants, public or private spectacles or events, fashion shows, corporate and business events, sporting events, broadcast activities, news gathering, etc., staged as live performances for an immediate audience or for the production of film, television, video or sound recorded material

NOTE 1 Events such as county shows, jamborees and similar are also covered under this heading.

NOTE 2 Entertainment events might also be staged at fairgrounds and exhibitions and might be subject to additional specialist regulations.

3.21 equipotential bonding

electrical connection maintaining various exposed-conductive-parts and extraneous-conductive-parts at substantially the same potential

*NOTE See also **3.47**.*

3.22 event

occurrence that is an entertainment, such as a sporting, commercial or business occasion, public or private festival or pageant, where temporary electrical systems are used

*NOTE This also includes any work that requires systems associated with the broadcasting or recording of the occurrence as educational, entertainment or newsworthy material (see also **3.1** and **3.20**).*

3.23 event manager

individual who carries overall responsibility for the event, including all aspects of bringing together the staff, equipment and facilities required for the event and the safe and smooth running of the event, including its set-up, operation and removal

NOTE 1 In the context of this British Standard the event manager's role specifically includes the appointment of a senior person responsible to oversee any temporary electrical systems that might be required.

NOTE 2 The event manager, for example, can be a producer, promoter, event manager/organizer, news editor, project manager, production manager or other similar person.

3.24 exposed

likely to be affected by adverse environmental conditions

NOTE Environmental conditions include natural or man-made conditions, such as weather, moisture, humidity and dust.

3.25 facilities

constituent parts of an event that are needed so that the event can be mounted and run

NOTE 1 Such facilities involve electricity and might include staff (wet hire) or might be without staff (dry hire).

NOTE 2 Facilities or services for instance include catering, hospitality, rest areas, welfare or first aid, toilets, wardrobe, make-up, staging, offices, workshops, trading units and similar. Facilities directly associated with the supply, distribution or use of electricity as a core part of the event are included, such as suppliers of generators, electrical distributions, television, radio, communications, public address and sound systems; lighting systems of all types and electrically operated lifting systems and stage machinery. Where appropriate these are referred to specifically.

3.26 facilities providers

individuals or organizations that provide facilities or services to events

3.27 facilities vehicles

vehicles used by facilities providers to make the facilities or service offered available to the event

NOTE Such vehicles, including transportable units used by facilities providers, often have installed electrical systems supplied from a local or onboard generator or from the temporary distribution.

3.28 final distribution unit (FDU)

portable distribution unit supplied from a central distribution unit or intake switch unit and provides sub-circuit protection and switching for a number of outgoing circuits

*NOTE See **B.5**.*

3.29 freelance

person who is not permanently employed, but is engaged on a short-term or fixed-term employment to provide services in a personal capacity

3.30 indoor use

use limited to locations where protection against the effects of detrimental environmental conditions deleterious to insulation and electrical safety is ensured

3.31 ingress protection (IP) classification system
internationally agreed classification system that defines degrees of protection against solid objects, dust and liquids

NOTE See BS EN 60529:1992+A2.

3.32 installation
items not part of a temporary electrical system and permanently fixed in a position from which they are not intended to be removed

3.33 installed electrical system (installed system)
system that is permanently fixed in position and not intended to be removed

NOTE 1 Installed electrical systems are not covered by this British Standard. Such installations are part of the infrastructure of premises, buildings and mobile or transportable units, etc. covered by BS 7671:2008+A1:2011.

NOTE 2 Existing installed electrical systems might have been designed to earlier editions of BS 7671. This does not necessarily mean that they are unsafe for use nor does it mean that they do not conform with the Electricity at Work Regulations 1989 [5].

3.34 instructed person
individual adequately advised, or supervised by skilled persons, to avoid dangers that electricity can create

3.35 intake switch unit (ISU)
switchgear designed for connection between the source of temporary supply and the remainder of the temporary electrical system providing means of isolation and switching

*NOTE The ISU has one or more outgoing circuits (see note to **3.4** and **B.2**).*

3.36 keyed single pole connector (KSPC)
single pole connectors that incorporate a key index device

NOTE 1 There are five different key arrangements that define a connector for duty as E, N, L1, L2 or L3.

*NOTE 2 The moulded shell carries an alphanumeric marking related to its circuit duty. The shells are available in colours appropriate to circuit duty, but some variation in colour related to circuit duty exist so complete reliance on colour alone is unwise. The key indexing and alphanumeric marking is always correct to circuit duty no matter what shell colour is present. Several manufacturers produce KSPCs that follow the same logic and are interconnectable according to circuit position (see also **3.55, 7.3.4, A.4** and **F.3.5.3**).*

3.37 kilovolt amps (kVA) and kilowatts (kW)
units that indicate the ability of a supply to provide energy or the amount of energy consumed by current-using equipment

NOTE kVA is the product of supply voltage and current flowing. kW is the useful power delivered. This takes into account any power factor present due to the current and voltage of the circuit being out of phase. In an a.c. electrical system the useful power delivered is typically less than the product of supply voltage and current flowing. The kVA rating is preferred as its use in calculations result in a more accurate prediction of current flow.

3.38 load-side
part of a connector or system used to distribute electricity to a load (current-using equipment)

3.39 location

site where an event takes place that requires a temporary electrical system

NOTE A location might also be referred to as a site or venue.

3.40 low voltage (a.c.)

voltage exceeding 50 V a.c. but not exceeding 1 000 V a.c between conductors, or 600 V a.c. between conductors and earth

3.41 mobile and transportable units

vehicles, trailers, similar mobile units and transportable cabins and huts, etc., which have permanent electrical installations

NOTE For instance, mobile or transportable units such as broadcast technical vehicles, catering units, wardrobe or make-up units, toilets, facilities vehicles, mobile or portable site offices, workshops, welfare, emergency, trading units, and transport units with installed low voltage electrical systems. (See BS 7671:2008+A1:2011, Section ***717****, see also* ***3.33****, Note 2, and IET Guidance Note 7 [6].)*

3.42 open-tails

cable assembly used to connect a temporary distribution to a source of supply that is typically in the form of a switched fuse

NOTE Open-tails are short lengths of single or multi core cable that are correctly terminated usually in a single pole or multi pole connector at one end; at the other end each bare conductor has a crimped ferule or lug to suit the termination at the switched fuse. The termination of bare conductors directly onto busbars constitutes an addition to the fixed installation (see ***7.3.4.4*** *and BS 7671:2008+A1:2011, Regulation* ***132.16****).*

3.43 outdoor

unprotected environment where conditions deleterious to insulation and electrical safety are probable

3.44 performance lighting

lighting equipment for the purpose of lighting the event or activity for the required artistic effect

NOTE Performance lighting is also known as production lighting.

3.45 person responsible

person who takes responsibility for any temporary electrical system(s) used for an event or activity, reporting to the event manager

NOTE 1 The competence of a person responsible needs to be sufficient and suitable for the complexity of the temporary electrical system and event involved, see ***3.9****.*

NOTE 2 Where larger, more complex temporary electrical systems are involved, work may be spilt into manageable parts, each under the control of a person responsible. In this case, the person responsible reports to a senior person responsible, who takes overall responsibility of all the temporary electrical systems involved and reports to the event manager, see ***3.9****.*

3.46 power-processing

range of equipment, usually electronic, which is used to smooth, correct or manipulate electrical supplies to the equipment

NOTE This covers equipment such as uninterruptable power supplies (UPS), inverters, dimmers, variable speed motor controllers and switched mode power supplies.

3.47 protective equipotential bonding
electrical connection maintaining various exposed-conductive-parts and extraneous-conductive-parts at substantially the same potential for the purposes of safety

3.48 protective earth and neutral conductor (PEN)
conductor combining the functions of both protective conductor and neutral conductor

NOTE In the context of this British Standard a PEN conductor only exists as a conductor of a PME distribution that is part of a DNO's domain. The presence and performance of a PEN conductor as part of a PME distribution can have an effect on the design and use of a temporary system.

3.49 protective multiple earthing
earthing arrangement, found in TN-C-S systems, in which the supply neutral conductor is used to connect the earthing conductor of an installation within a premises with Earth

NOTE 1 Attention is drawn to the Electricity Safety, Quality and Continuity Regulations 2002 (ESQCR) [3] and the Electricity Supply Regulations (Northern Ireland) 1991 [4] for details on PME.

NOTE 2 In the context of this British Standard a PME arrangement only exists as a distribution that is part of a DNO's domain. The presence and/or use of a supply derived from a PME arrangement can have a significant effect on the design and use of a temporary system.

3.50 residual current device (RCD)
mechanical switching device or association of devices intended to cause the opening of the contacts when the residual current attains a given value under specified conditions

NOTE 1 See Annex E.

NOTE 2 An RCD without integral overcurrent protection is defined as an RCCB, and an RCD with integral overcurrent protection as an RCBO.

3.51 safety lighting
lighting provided to ensure the safety of all persons on the site in the absence of adequate illumination

NOTE Part of a safety lighting system classified as emergency lighting can be provided with independent power supplies and wiring to reduce the risk of danger resulting from failure of the main system.

3.52 seamless back-up generation
use of two or more compatible generators synchronized together and supplying a load so that the supply to the load is maintained if one of the generators failed

3.53 services
input to an event provided by hired personnel (see also **3.25**)

3.54 set-up, setting-up
process of creating a temporary electrical distribution or system

NOTE Within the industry this might also be referred to as "rigging", "installing", "fit-up", "get-in" or similar expressions.

3.55 single pole connectors
high current connectors where each individual connector carries only one conductor of the circuit

*NOTE 1 These are used as connectors for circuit conductors where the current exceeds 125 A. The preferred type is the KSPC, although there are other types known as BAC and CamLok, which are not keyed. These different types of connector are not inter-connectable across types (see also **3.36** and **7.3.4**).*

*NOTE 2 BAC single pole connectors exist in 150 A and 400 A types. In use BAC connectors are arranged so that the supply-side connector has the appearance of a male contact with an insulating tip that conforms to BS EN 60529:1992+A2, IPXXB finger test. The load-side connector has the appearance of a female contact, which is open and does not conform to IPXXB. BAC connectors have rubber based black outer shells. They may be used in any conductor of a circuit; they need to be marked for circuit duty when incorporated into a temporary distribution. BAC connectors are manufactured to an obsolete standard BS 5550-7.5.4 (see also **7.3.4**).*

*NOTE 3 CamLok single pole connectors are used up to 400 A. In use CamLok connectors are arranged so that the supply-side connector has the appearance of a female contact which is open and does not conform to BS EN 60529:1992+A2, IPXXB finger test. The load-side connector has the appearance of a male contact and does not have an insulating tip and does not conform to IPXXB. CamLok connectors have rubber based outer shells that exist in a variety of colours. It cannot be guaranteed that the correct colour for circuit duty is available; therefore care is needed when using CamLok connectors in a temporary distribution. Some CamLok connectors are used in the UK. Equipment brought into the UK by foreign touring shows often use CamLok single pole connectors (see also **7.3.4**).*

3.56 skilled person
individual with relevant training and experience to identify, assess and avoid dangers that electricity can create

3.57 supplementary equipotential bonding conductor
conductor maintaining various exposed-conductive-parts and extraneous-conductive-parts at substantially the same potential

NOTE In certain situations or places of increased shock risk, supplementary equipotential bonding is required.

3.58 supply-side
part of a connector or system used as a source of electricity

3.59 temporary electrical distribution (temporary distribution)
all switchgear, distribution units, dimmers and similar equipment, protective devices, cables, connectors and metering equipment, etc. that forms the means of supplying electricity to all parts of an event

NOTE There can be a main distribution and several sub-distributions or several independent distributions provided by separate facilities providers.

3.60 temporary electrical system (temporary system)
all switchgear, generators, distributions units, dimmers and similar equipment, cabling, connectors, protection, and measuring devices and current-using equipment including mobile and transportable units that are required for an event

NOTE 1 There can be a main system and several sub-systems connected or several independent systems provided by one or more facilities provider.

NOTE 2 Some examples of temporary systems are given in Annex D, Figure D.1, Figure D.2 and Figure D.3.

3.61 venue

premises specifically adapted for the hosting of events of all sizes, such as theatres, concert halls, sports stadia, show grounds, exhibition halls, arenas and similar

NOTE Sometimes referred to as a location or site.

4 Management of an event and supply of equipment for temporary electrical systems

4.1 Management of the event

Every event or activity should have someone with overall responsibility for the management and safe execution of the work necessary to create and run that event or activity.

NOTE 1 Depending upon the nature of the event or activity, this person might be a producer, news editor, event manager/organizer, promoter, project manager, production manager or other similar person. This person is referred to as an event manager for the purposes of this British Standard; see ***3.23****.*

The event manager should ensure that a person is appointed to accept the overall responsibility for all temporary electrical systems required for the event. This senior person responsible should have sufficient and suitable competence to deal with the size and complexity of the work involved, which can vary considerably, see **4.3**.

NOTE 2 No matter what the size or complexity of the work, health and safety legislation applies, particularly the Management of Health and Safety at Work Regulations 1999 [7], the Provision and Use of Work Equipment Regulations 1998 [8] and the Electricity at Work Regulations [5]. Events require many different facilities, services and people to safely function together in an environment that is often owned or occupied by others who might not be directly associated with the event. It is of fundamental importance that the event manager and all persons responsible understand the need for co-operation and co-ordination between all parties associated with the event at the premises involved, see the Management of Health and Safety at Work Regulations 1999, Regulations 11 and 12 [7].

4.2 Outlining the parameters of the event

The event manager should provide an outline of the type, size and aims of the event, where and when it is to be held and how it is to be managed.

NOTE 1 An event might require single or multiple, separate temporary electrical systems of varying complexity with more than one electrical environment.

The outline of the event should provide this information and also the responsibilities of others working directly with the design, provision, setting-up or use of distribution or current-using equipment.

The anticipated number of supplies and how they are to be provided, used and managed should be discussed at an early stage with the senior person responsible.

NOTE 2 The complexity increases with the number of electrical environments, each with its electrical supply and associated temporary system supplying the units and facilities related to that sector of the event. In reality, environments probably overlap each other, the different temporary systems come close together and earth referenced signal cables might be connected between electrical equipment from different electrical environments. These situations mean that protective bonding between temporary systems and electrical environments is required.

The person responsible for the electrical system should be sufficiently competent to understand and manage its use; examples can be found in Annex D, Figure D.1, Figure D.2 and Figure D.3 with the related commentary.

4.3 Responsibility for the temporary electrical system(s)

The senior person responsible should have sufficient and suitable competence to enable them to ensure the safety in all respects of any temporary electrical system in all conditions that can reasonably be predicted to occur.

Where large or multiple temporary electrical systems are involved, consideration should be given to splitting the work into manageable parts or sub-systems, with each part or sub-system having a separate person responsible for the temporary electrical system involved, reporting to the senior person responsible (see **3.45**, **5.1**, **5.2**, **6.1**, **7.1.1**, **8.1**, **8.2** and **9.2**). Each separate person responsible should have sufficient and suitable competence to enable them to ensure the safe use of the temporary system(s) they are responsible for.

Every person responsible should know and understand the requirements of the event or activity and the extent of their own responsibility (see also Clause **5** and **6.1**).

NOTE 1 The small/simple form of temporary electrical system is typically supplied from a single installed electrical system using 13 A or 16 A connectors, where the total power used does not exceed 6 kVA.

*NOTE 2 The large/complex forms of temporary electrical systems include all those that do not clearly fall within that described in **4.3**, Note 1. Systems small or large that are not simple might include those:*

- *with supplies obtained from one or more installed sources and/or generators;*
- *used in complex ways, including supplying mobile or transportable units;*
- *used at locations that involve other electrical environments;*
- *used in association with various permanent or temporary structures;*
- *used by or in the presence of performers, crew members, audience, guests or the public in varying numbers.*

*The range of large/complex work is considerable and might involve one or more interrelated electrical systems and multiple separate temporary systems. The work can involve a significant number of electrical crews and crew members. There can also be issues related to the location, environment, weather, or other people who might be affected by the use of electricity (see Clause **6**).*

4.4 Early planning

Early in the planning of the event, the event manager and the senior person responsible should discuss and agree (see **3.45**, **5.2**, **5.3**, **6.1**, **6.2**, **6.4** and **6.5**) the following:

a) the arrangements for procuring equipment;

b) the arrangements for providing any crew required;

c) the amount of power required and how it is obtained.

4.5 Provision of equipment

4.5.1 Supply of equipment for events

NOTE 1 It is a frequent requirement that temporary electrical systems are set-up for use with the minimum of delay and that it is possible for changes to be made easily and safely and the temporary system removed rapidly. The recommendations in this British Standard aim at achieving this effectively and safely.

A simplified inspection and testing routine is permitted for temporary electrical systems set-up for events, where each of the following conditions should be met.

a) Equipment should be supplied in the form of tested complete stock items that can be plugged together at the location to form the temporary electrical system required.

b) Equipment should be delivered to the event in a safe and serviceable condition and within a valid period, having passed a formal inspection and test.

c) Evidence should be provided to show that the equipment has passed the formal inspection and test. The evidence should include relevant dates that show the period of validity.

NOTE 2 This evidence might be provided by a suitable "tested" label applied to the equipment or by printed or electronic certificate clearly referring to the equipment concerned.

d) Equipment should be suitable for use in the manner for which it was manufactured.

e) Mobile and transportable units with an electrical installation should be within a valid period having passed a formal inspection and test. The inspections and tests should be done in accordance with BS 7671:2008+A1:2011, Chapter **61** (see also **3.33**, Note 2). The Electrical Installation Certificate and most recent Periodic Inspection Report (PIR) or Electrical Installation Condition Report (EICR) [3] should be available and also the mobile or transportable unit should be provided with evidence that these formal inspections and tests are valid.

If the conditions in a) to e) are not fulfilled, the equipment should be subjected to a formal inspection and test before use.

The name of the owner or supplier should be shown on the equipment.

4.5.2 Responsibilities of owners or suppliers of equipment

NOTE 1 The equipment provided can be owned by a person or organization employed on the event or by one or more others who supply the equipment under a hire agreement or contract for use at the event.

NOTE 2 The supplier of the equipment might provide specialist labour to set-up and operate the equipment. Such labour needs to be suitably competent for the work involved, whether they are permanently employed or freelance.

The owners or suppliers of equipment should ensure the conditions contained in **4.5.1** are met as failure to meet these conditions causes additional formal inspection and testing to be carried out on site, causing unnecessary delay.

Where owners or suppliers provide specialist labour to set-up or operate the equipment, the owners or suppliers should ensure that any such labour provided understand their duty at the event and are competent to undertake the work involved.

[3] Earlier versions of BS 7671 (see **3.33**, Note 2) require an Electrical Installation Certificate and PIR, BS 7671:2008+A1:2011, Chapter **61**, requires an Electrical Installation Certificate and introduces the EICR in place of the PIR.

5 Small/simple events and activities requiring up to 6 kVA

*COMMENTARY ON Clause **5***

The following processes are applicable to small/simple events and activities that have temporary electrical systems typically using a maximum of 6 kVA from single phase supply installed and used within a building. The supply would usually be derived from 13 A or 16 A socket outlets.

5.1 General

Events and activities requiring small/simple temporary electrical systems involve a small number of people and the conditions in the vicinity of the location should not impose complications on the management of the temporary electrical system.

Where practicable, Class II insulated equipment should be used to reduce the risk of electrical shock.

NOTE 1 Examples of simple activities include: small photographic shoots, small TV interviews and documentary work, radio carry-ins, temporary locally set-up editing facilities, small conferences, small theatrical performances and similar.

*NOTE 2 It is possible that certain separate parts of a larger event might fall within the scope of a simple activity covered by Clause **5**, in which case the person responsible would be directed by the senior person responsible for all the temporary electrical systems of the larger event.*

5.2 Person responsible

The person responsible for the small/simple temporary electrical system should have sufficient and suitable competence to manage the system involved. If the work is outside their known competence, they should state this and not accept the work.

The person responsible should understand their responsibilities and that a risk assessment should be carried out, and also that a site survey might be necessary. They should have the following information:

a) the date, time and location of the event;

b) details of local and environmental conditions that might be encountered;

c) the number of people who might be involved or affected by the temporary system, including performers, crew and any public etc;

d) whether any animals might be involved;

e) where electrical supplies are to be obtained from;

f) how much equipment is needed and how it is procured.

In the event of a problem arising with the temporary electrical system or the installed electrical system at a location, the person responsible should have quick and effective access to assistance from an electrically skilled person who has sufficient and suitable competence to deal with the problem (see Clause **4** and **5.1**, Note 2).

5.3 Planning the small/simple temporary electrical system

Where necessary, while planning the system, a diagram to show how it is set-up should be prepared and the equipment required should be listed.

NOTE 1 This assists in determining exactly what is needed, the power required and the ease with which the system can be managed or changed.

With a clear idea of what is required the following should be carried out.

a) Prior agreement should be sought on whether the owners or occupiers of the location are prepared to supply the power required. In the cases where the owners or occupier supply electricity, agreements should be reached to determine which of their sockets and other electrical equipment is used. Owners or occupiers can insist that evidence is provided that the temporary electrical system being set-up is safe and suitable. All relevant test information along with a diagram (if required) of the temporary system should be made available at all times.

   NOTE 2 It is advisable to agree with the location owner or occupier what state the installed electrical system is to be left in upon completion of the event.

b) It should be ascertained what electrical equipment is currently in use at the location. There should not be any unwanted interaction between the temporary system and the permanently installed equipment and one should not compromise the operation of the other in any way.

c) Check that the source of supply is safe and suitable to use; this should include as a minimum a visual inspection of the socket outlets to be used, a polarity check and an assessment of earth fault loop impedance. If the source fails the visual inspection, polarity or earth loop impedance checks, it should not be used.

   *NOTE 3 There are plug-in devices commercially available that check polarity and earth fault loop impedance (see **G.1** and **G.2**).*

d) The location of the protective devices for the source of supply used should be established and that access should be possible at all times in case of urgent need.

5.4 Risk assessments

Risk assessments relating to the particular use of electricity for the event should be undertaken by the person responsible for the temporary electrical system. These should then be given to the event manager at a sufficiently early time to allow any risks that have been identified to be resolved, either by removing the risk or ensuring that it is minimized and controlled.

Risks should be constantly monitored, re-assessed and acted upon as the event or activity develops.

5.5 Supplying and checking equipment

The suppliers of equipment should ensure it is supplied in a safe and serviceable condition (see **4.5**).

The person responsible for the temporary electrical system should ensure that the equipment selected for use:

a) has evidence of being within a valid period after passing a formal inspection and test;

b) is safe, serviceable and suitable for the purpose and conditions that exist;

c) is visually inspected for damage before use.

Equipment failing any of these checks should not be used.

5.6 Setting-up a small/simple temporary electrical system

Every temporary distribution should be protected by an RCD with a rated residual operating current ($I_{\Delta n}$) not exceeding 30 mA and an operating time not exceeding 40 ms at a residual current of 5 $I_{\Delta n}$, which should be placed at the socket providing the supply so that all circuits supplied from this source are protected.

The test or "T" button on the RCD should be pressed with the electricity supply switched on. The RCD should operate and switch off the supply. If the RCD does not operate, it should be removed and replaced with a correctly functioning device.

When the temporary distribution has been set-up, the following things should be checked (see **G.1** and **G.2**):

a) each circuit is set-up as planned;

b) each socket outlet of the temporary distribution has correct polarity and acceptable earth fault loop impedance;

c) the equipment that requires a supply has been connected and is switched on one at a time;

d) the connected equipment functions correctly;

e) any instructions have been given to those who are using the temporary electrical system or are affected by its use.

The event or activity should only proceed when the temporary electrical system has passed all the required checks and is confirmed as safe for use. Any equipment found to be faulty at inspection or during use should be removed from service and labelled as faulty with an indication of the problem.

If at any time the installed electrical supply fails or in some way shows that it is unsafe or not suitable for use, work should be stopped and the conditions re-assessed. If there are indications that the system is unsafe for use, the advice of a suitably skilled person should be sought (see **5.10**).

5.7 Changes to the system

The person responsible should ensure that if any changes to the temporary electrical system are required, the relevant circuits should be isolated and the following actions should be carried out:

a) disconnect the parts of the distribution where changes are to be made;

b) visually inspect any new equipment needed prior to connection;

c) re-assess the risks and apply corrective actions, if required (see **5.4** and **5.5**);

d) set-up in the new arrangement;

e) check it is safe to reconnect the temporary electrical system to the supply;

f) power should be restored and the system tested as required and confirmed as functioning correctly before work is resumed.

5.8 Leaving the system unattended

5.8.1 General

If at any time the temporary electrical system is to be left unattended, the person responsible should decide whether the supply should be isolated and the system secured against use by unauthorized persons. The temporary system should be re-checked to ensure that it is safe before re-energizing.

5.8.2 Person responsible leaving the system

If the person responsible for the temporary electrical system leaves the location while the system is still in use or energized, then a suitable deputy should be appointed. The deputy should have sufficient and suitable competence to control the use of the system in the form that it is in.

NOTE It is advisable that the appointed deputy is able to contact the person responsible in case of need.

5.9 Removing the system

When the event or activity has been completed, the temporary electrical system should be dismantled in a safe manner. Equipment should be packed for return to the supplier and any faulty equipment should be labelled and notified to the supplier.

5.10 Problems with the installed electrical system

If the installed electrical system at a location has been found to be unsafe, the owners or occupiers should be made aware of the problem and a recommendation made that their electrical system be inspected by a suitably competent person.

If there are electrical problems with the installed system at the location caused by the people and/or work associated with the event, then appropriate correction of these should be agreed. The person responsible for the temporary electrical system should arrange for the problems to be investigated by a suitably competent person and an agreed arrangement for correction of the problems put into action [see **5.3**, a)].

6 Large/complex events and activities requiring in excess of 6 kVA

6.1 Responsibility

6.1.1 Person responsible

*NOTE 1 A senior person responsible has overall responsibility for all the temporary electrical system(s). The size and complexity of the event might require the work to be split into smaller parts or sub-systems, with a separate person taking responsibility for each part or sub-system and answering to the senior person responsible (see **4.3**).*

Any person taking responsibility for large/complex temporary electrical systems should be trained and experienced in all aspects of the control and use of temporary electrical systems and competent to perform the work required (see Clause **4** and **9.2**).

NOTE 2 Persons responsible for temporary electrical systems need suitable competence and might be Crew Chiefs, Chief Electricians, Gaffers, Best Boys, Production Electricians, Engineering Managers, Sound Supervisors, Unit Managers, Communications Engineers, Project Managers, Site Managers, Technical Managers, Lighting Directors, Lighting Designers or Directors of Photography.

If the size and complexity of an event requires the work to be split into smaller parts or sub-systems, a senior person responsible should be appointed. The senior person responsible should have the skills to manage and control the crew and all aspects of the work they undertake. The role should include responsibility for all people and equipment involved and any effect that the temporary electrical system(s) might have on others. Any person taking responsibility for large/complex temporary electrical systems should know and understand the following:

a) the date, time and location of the event;

b) details of local and environmental conditions that might be encountered;

c) the extent of the work under their control and its requirements, including a site survey where necessary;

d) the competence of those under their control;

e) the number of people who might be involved or affected by the temporary system(s), including performers, crew and any public;

f) whether any animals might be involved;

g) the amount of power required and how the supply is to be obtained;

h) the electrical issues that might affect any mobile or transportable units with electrical installations;

i) the equipment needed and how it is to be provided.

6.1.2 Allocation of responsibility

Where a temporary electrical system(s) is split into smaller parts or sub-systems, the senior person responsible should ensure that the design, provision, distribution, co-ordination and control of the system at the location are assigned to suitably competent people.

All parties should agree on the allocation of responsibilities.

A person should not accept any duty they know to be outside of their competence.

The senior person responsible, any other person(s) responsible and the event manager should agree which of the following are included as part of their duties:

a) retaining any records, drawings, agreements, etc. that might be needed for the temporary electrical system;

b) arranging for the electrical supplies required;

c) checking the safety and suitability of the electrical supplies;

d) designing the temporary electrical system(s) involved;

e) selecting and obtaining the equipment required;

f) ensuring the equipment required is safe and fit for purpose;

g) assessing and controlling the risks affecting temporary electrical system(s) throughout the event and providing risk assessments as required (see **6.3**);

h) setting-up and testing the temporary electrical system(s);

i) controlling the operation of the system and any changes that might be needed;

j) removing the temporary electrical system(s) and restoring the location to a condition that was agreed with the owners or occupiers before the event or activity.

6.1.3 Principle responsibilities

6.1.3.1 General

The principle responsibilities given in **6.1.3.2**, **6.1.3.3**, **6.1.3.4**, **6.1.3.5** and **6.1.3.6** should be undertaken either separately or in combination.

6.1.3.2 System design

Designs for large/complex temporary electrical systems should include:

a) analysis of the production requirements including the foreseeable duration of the event;

b) investigation and assessment of expected site conditions;

c) consideration of the electrical characteristics of the supply;

d) consultation with relevant authorities and experts;

e) calculation of electrical details to ensure safety and suitability;

f) calculation of weight and loading details as required for structural design and erection purposes;

g) provision of lists of equipment required;

h) specification of non-standard set-up procedures;

i) specification of system tests, test methods and limiting parameters, including those required for emergency backup systems;

j) guidance on foreseeable emergency procedures.

6.1.3.3 Site work

Site work should include:

a) assessment of actual site conditions, including electrical environments;

b) understanding the design specifications and special requirements;

c) liaison with other parties on site;

d) provision of supplies and temporary distributions for the set-up and removal processes [see also **6.1.3.6**, b)];

e) proper application of standard erection and removal procedures;

f) provision of satisfactory workmanship;

g) co-operation with persons responsible for testing and operating the temporary electrical system.

6.1.3.4 Testing and certification

The verification and testing procedures for large/complex temporary electrical systems should include:

a) relevant inspection and testing, including re-inspection and retesting as necessary;

b) special safety checks required by the design specification;

c) recording of test results and evaluation of safety implications;

d) initiating any remedial action required;

e) provision of appropriate written certification that the system is safe for use;

f) test the emergency, safety and back-up systems.

6.1.3.5 Operation

The operation of a large/complex temporary electrical system should include:

a) energizing and controlling the system to the event requirements within the design limitations;

b) provision of competent staff to keep the temporary system in good condition;

c) prevention of tampering and damage to the temporary system, by performers, other technical and non-technical personnel, and members of the public;

d) dealing with unforeseen production requirements safely;

e) dealing with emergencies, including operational checks of emergency, safety and backup systems;

f) ensuring that temporary electrical systems remain safe when not in active use, whether energized or not.

6.1.3.6 Removal of equipment

The safe removal of equipment should include:

a) co-operation with others to produce a work plan;

b) provision of supplies required for the removal process, see **6.1.3.3**, d);

c) notifying when circuits have been isolated so that disconnection and removal can proceed according to the work plan;

d) safe isolation and removal of all temporary cables and switchgear, etc. from the site;

e) inspection of equipment that is to be re-used, under the same agreement, at another site without return to the supplier;

f) setting aside and marking suspect or faulty equipment for repair and retesting;

g) restoration of all alterations and modifications to the location to an agreed standard;

h) notifying the location owner or occupier that the site and all permanent installations have been left safe.

6.2 Electrical supply

6.2.1 Supplies required

NOTE Supply can be obtained by connection to an installed supply at a location, from a generator or from a DNO.

Electrical requirements as outlined in BS 7671:2008+A1:2011, Regulations **132.2** and **313.1**, should be discussed and agreed between the senior person responsible, the event manager and the supply providers early in the planning.

The supply requirements should include the following details:

a) the maximum demand in kVA;

b) the number of phases, current per phase, power factor and harmonic content for the anticipated load;

c) the earthing arrangements of all supplies that might be used for the event, or be involved with the event via earth referenced signal cables, or the planned or casual interconnection of protective conductors;

   NOTE It is important to know whether the supplies to be used are TN-S, TN-C-S or TT and whether the main earthing terminal at a location is connected to earth rods, tapes, mats or conductive structural reinforcement forming the foundations. This information might affect the design and operation of the temporary system (see Annex C).

d) the seamless back-up requirements where generators are used;

e) the earthing arrangements for generators (see Annex C);

f) the overload and residual current protection at the supply;

g) the prospective short circuit current rating;

h) the earth fault loop impedance at the supply terminals;

i) the connection and disconnection dates;

j) the metering, tariff or charges;

k) the most suitable positions for connection to the supply;

l) the method of connecting the temporary electrical system to the supply;

m) the responsibility and procedure for safe connection, operation and disconnection;

n) the precautions to be taken by the users and/or the suppliers;

o) the maintenance and standby arrangements;

p) the possibility of the temporary electrical system extending into other electrical environments;

q) the mechanical protection of temporary connections and cables;

r) the existence of any hazardous environments [see **6.3**, e) and **8.12**].

The results of these agreements should be recorded and provided for those designing, setting-up, testing and operating the temporary electrical system.

6.2.2 Electrical supplies from installed sources

NOTE Many venues such as exhibition halls, sports stadia, theatres, and similar premises have permanent connection points to supply electricity for temporary systems as part of the offered facilities.

If a venue plans to provide permanent connection points to electrical supplies for a temporary electrical system(s), the supply should be arranged in a convenient manner to enable the connection of temporary distributions (see Annex F for details).

6.3 Risk assessments

The person responsible for the temporary electrical system should prepare a risk assessment, to be given to the event manager, which covers the provision, setting-up, operation and removal of the system. The results of the risk assessment should be communicated to all relevant people and incorporated into the planning and design of the temporary electrical system.

All significant hazards related to the temporary electrical system and its use should be considered, including the following:

a) weather conditions, including the possibility of lightning;

b) the effects that lighting might have on nearby transport routes including aircraft;

c) time of day;

d) the presence of the general public, including children, people with special needs or animals;

e) hazardous environments, such as mines, petroleum installations, processes producing flammable dust or explosive materials (see **8.12**);

f) the presence of overhead or underground power cables or other utilities;

g) the presence of water;

h) the length of time the temporary electrical system is due to exist;

i) possible mutual EMI effects between the temporary electrical system and any permanent electrical installations;

j) medical areas and locations (see **8.13** and **C.4.5**);

k) movement of vehicles;

l) agricultural locations;

m) interaction of electrical environments resulting from the use of generators, installed supplies, sources of renewable energy such as photovoltaic panels and sources other than 230/400 V at 50 Hz.

There should be a continuous assessment of risks that might occur or change as the event develops. Any hazards should be removed or minimized and controlled and the event manager kept informed.

6.4 Equipment

6.4.1 General

Equipment should be delivered to the location in a safe and serviceable condition with evidence of valid formal inspection and test. The person responsible should ensure this evidence is checked before the equipment is used (see **4.5**, **8.4** and **9.4**).

6.4.2 Specialist equipment

Where specialist equipment is accompanied by a technician, operator or crew, they should be fully advised of their responsibilities in relation to the temporary electrical system and their duties within the event as a whole.

6.4.3 Specific electrical requirements

Where equipment with unusual or specific electrical characteristics are used, the requirements of the equipment and its supplies should be discussed with the equipment providers prior to the design of any temporary system.

*NOTE Such equipment can include variable speed lifting equipment, high power discharge lighting, mobile or transportable units and broadcast technical vehicles. BS 7671:2008+A1:2011, Section **717**, deals with aspects of mobile and transportable units.*

6.5 Crew

Regardless of the process used for selecting crew to staff the temporary electrical system, details of the work involved should be discussed and agreed between the event manager, senior person responsible and person(s) responsible where applicable.

Crew members might have varying skills and experience, so the person(s) responsible should fully consider the competence and suitability of potential crew members before accepting them.

7 Design and instructions for temporary electrical systems

7.1 Design

7.1.1 General

The design of each temporary electrical system should meet the requirements of the event and take account of the supplies to be used and the conditions present at the location, including physical and environmental conditions and potentially hazardous sites.

The person designing the temporary electrical system should ensure all requirements are properly met and recorded. The design details and any special requirements including tests should be provided to the person responsible for the temporary electrical system.

The temporary electrical distribution should conform to the relevant requirements of BS 7671. The equipment forming the temporary distribution should conform to Annex A and be selected taking account of the features given in Annex B.

Effective site communications should be considered as a part of the planning and design process.

7.1.2 Principles of the temporary distribution

The conductors used in all parts of the temporary distribution including those within ISUs, CDU, FDUs and similar distribution or control units should be arranged so that the conductors forming Line, Neutral and CPC at any particular circuit position all have the same cross-sectional area.

NOTE 1 This allows for typically available, flexible cables and connectors to be used and the various distribution units that might be designed and built for use in temporary distributions to have a consistent and predictable current rating. The use of undersized or oversized conductors at any particular circuit position removes this consistency and understanding.

Wherever three-phase and neutral overcurrent protective devices are used they should be four-pole devices interlocked so that all poles open together. There should be overcurrent sensing on all four conductors.

NOTE 2 This is to take account of the probability that there is likely to be a neutral current that is greater than any phase current due to harmonics and lack of phase balance in temporary distributions covered in this British Standard.

7.2 Electrical supplies

7.2.1 Source of supply

The source of supply should be verified as safe and suitable for use. The earthing arrangements of the supply should be identified so that the design can take account of any particular requirements that might be necessary (see Annex C). Evidence of the most recent formal inspection and test of the source of supply should be made available and checked by the person responsible.

A means of isolation controlled by the person responsible should be provided as close to the point of supply as practicable.

NOTE 1 For most temporary distributions the first isolation unit is an intake switch unit (ISU).

The protective measures at the source of supply and the rating of the cabling to the ISU should be compatible and conform to BS 7671 (see also **3.33**, Note 2, and **7.3.4.4**).

*NOTE 2 For further information on RCDs at the source of supply see **7.6** and Annex E.*

Where the source of supply does not have suitable overcurrent protection for the cable feeding the first ISU then the ISU should be positioned so that the length of this cable does not exceed 3 m. Where suitable protection is provided, longer runs of cable may be used and the design should take these factors into account (see **8.8.2**).

If low voltage supplies other than 230/400 V or 50 Hz are required, they should be supplied by a transformer or separate generator. Any intended departure from this British Standard needs special consideration by the designer and should be noted in the Completion Certificates. The resulting degree of safety of the temporary system should not be less than that obtained by compliance with this British Standard (see Annex G).

7.2.2 Generators as a source of supply

NOTE 1 Mobile or static generators can be used if a permanent electrical installation is inadequate or unavailable, or if there are operational advantages to run from an independent electrical supply.

NOTE 2 Generators can be used to supply all or part of the power required and are available at 230 V single-phase or 400 V three-phase and neutral operating at 50 Hz.

If operation outside of these parameters is required, this should be discussed with the generator supplier.

NOTE 3 For a large/complex temporary electrical system, or where a seamless back-up is required, two or more generators can be paralleled through suitable synchronizing and protective switchgear. In special circumstances, interconnection with the public or a private network or a private installed supply can be arranged. Specific discussion and agreement with the DNO (i.e. the network operator) or private supplier is necessary. Attention is drawn to the ESQCR [3] and the Electricity Supply Regulations (Northern Ireland) 1991 [4] and BS 7671:2008+A1:2011, Section ***551****.*

Where a generator is used, careful consideration should be given to the way the supply is earthed (see **7.4.2** and Annex C).

7.2.3 Responsibility for connection to a supply

NOTE 1 Connection to the source of supply can be via suitable connectors of the appropriate rating, cables terminated at a switched fuse or directly to busbars (see also ***7.3.4****).*

Agreement should be reached between the owner of the source of supply and the person responsible for the temporary electrical system as to who makes the connection and any tests that are required for the temporary system before connection.

NOTE 2 The event as a whole can have more than one connection to a permanently installed source or connections to two or more different installed sources or generators or any combination of these.

Line or neutral conductors from different supplies should not be interconnected unless specifically designed to do so through an appropriate electrical interface, such as a generator synchronization panel. Particular care should be taken when considering interconnection between CPCs from different supplies or earth referenced signal cables between equipment fed from different supplies (see **7.4**, Annex C and Annex D).

Connection to exposed conductors should only be carried out with the circuit disconnected from the source of supply and secured so that it cannot be accidentally re-energized.

7.3 Cables and connectors

7.3.1 General

All cables for temporary distributions should be terminated with connectors of rating equivalent to that of the cable (for single pole connectors see **7.3.4.2**, Note 2). The protective device for any circuit should always have a rating suitable for the cable, connectors and equipment it is intended to protect.

Where connections to a switched fuse are required, open-tails should be used only if correctly terminated in an appropriate connector to supply the distribution that follows. In this case the open-tails should be correctly coloured and bear correct alphanumeric markings to reduce the chance of misconnection to the source of supply.

The cables used for temporary distributions should always have neutral and protective conductors of the same cross-sectional area as each of the line conductors.

The design of the temporary distribution should meet the required voltage drop and disconnection times, therefore the selection of cable ratings and the protective devices should take account of:

a) all environmental conditions likely to be present;

b) grouping or routing of cables that might give rise to excessive increases in conductor temperature;

c) the loads that are likely to be connected;

d) the length of cable run.

Estimation of maximum loads should also take into account:

1) the likelihood of significant lack of phase balance;

2) the presence of harmonics causing increased neutral current in multi-phase distributions;

3) the likelihood that neutral current might exceed the line current as a result of 1) and 2);

4) the possibility of the connection of additional current using equipment.

NOTE 1 The rating of cables in three-phase systems that have high neutral currents due to harmonics is covered in BS 7671:2008+A1:2011, Regulations ***523.6.3*** *and* ***524.2.2*** *and in Appendix 4,* ***5.5****. Poor phase balance combined with high harmonic content can lead to excessive neutral current (see* ***7.1.2*** *and* ***A.1****).*

Multiple cables electrically connected in parallel should not be used to achieve increased delivery of energy.

NOTE 2 Strict requirements for overcurrent protection when using parallel cables are given in BS 7671:2008+A1:2011, ***434.4*** *and* ***523.7****; further information is given in IET Guidance Note 6: Protection against overcurrent [N1].*

Where single pole connectors and cables are used, the running of such cables should ensure that they are kept close together to minimize EMI effects (see **8.8.1**).

NOTE 3 Matters of electromagnetic disturbance or EMI in permanent installations are dealt with in BS 7671:2008+A1:2011, Chapter ***44****, Section* ***444****.*

7.3.2 Identification of conductors and single pole connectors

Conductors and single pole connectors should be clearly marked and coloured in accordance with Table 1, as appropriate.

Table 1 **Marking of conductors and single pole connectors**

	Earth	**Neutral**	**Line 1**	**Line 2**	**Line 3**
Alphanumeric mark	**E**	**N**	**L1**	**L2**	**L3**
After 31 March 2006	Green/Yellow	Blue	Brown	Black	Grey
Before 31 March 2006 [A)]	Green/Yellow	Black	Red	Yellow	Blue

A) These outdated colours are still in use in some places.

Single pole connectors should be keyed according to purpose so the chance of misconnection is removed. If the single pole connectors do not have a keyed index, they should be clearly marked and coloured (see **7.3.4**).

Care should be taken to ensure the correct connection of open-tails to terminals at a switched fuse or busbars as these could show outdated colours.

NOTE The comparison of old colours to new colours is shown in Table 1.

The coding or colouring for the temporary distributions should be in accordance with BS 7671:2008+A1:2011, Table 51.

Colours alone should not be used on cables to denote ownership or length, as they are easily confused with circuit function. Ownership and length should be shown using text or symbols.

7.3.3 Cables

All cables for the temporary distribution should be multicore except for circuits above 125 A where single core cables are usually provided for portability (see **A.4** for further details of single core cables).

NOTE 1 Cables with armour protection are not usually necessary if appropriate measures to ensure mechanical protection have been taken.

Cables should be flexible and of suitable conductor size and mechanical strength for their intended duty as follows.

a) Cables for use indoors only should be PVC or rubber insulated and sheathed in accordance with BS 6500 (H05RN-F or equivalent), with a voltage designation of not less than 300/500 V (ordinary duty flexible, as defined in BS 7540-1).

b) Cables for use outdoors and in general use should be rubber insulated and sheathed in accordance with BS 7919 (H07RN-F or equivalent), with a voltage designation of not less than 450/750 V (heavy duty flexible, as defined in BS 7540-1) and resistant to abrasion and water.

NOTE 2 Thermoplastic cables are not designed for use outdoors. For example, cables known as 'arctic blue', 'SY' are thermoplastic and are not suitable for use outdoors.

A simple visual inspection of a connector-cable combination might not provide clear evidence of its current rating; only cables carrying the cross-sectional area (csa) information on their sheath should be used. If this information is not present, the csa should be marked on the cable.

Only cables where the specification can be verified should be used.

All multicore cables used for temporary distribution should have line, neutral and CPC conductors present and correctly terminated throughout the entire distribution. Cables of different ratings should only be connected through a distribution unit providing suitable overcurrent protection for all the downstream cables.

Identification of conductors should conform to BS 7671:2008+A1:2011, Table 51.

Any cables liable to come into contact with high temperature luminaires should conform to BS 4533-102.17.

7.3.4 Connectors

7.3.4.1 General

With the exception of connecting open-tails to a source of supply, all temporary electrical connections on site should be made using plugs, sockets and cable couplers appropriate for the current and voltage and prevailing site conditions in accordance with Table 2.

Connectors not given in Table 2 should conform to BS EN 61984.

Plugs, sockets and connectors conforming to BS EN 60309-2 should be used in accordance with the recognized voltage colour code and mandatory keyway positions.

Table 2 **Connector types**

Application	Typical use	Standards
Low power ≤20 A	Local distribution for single items of equipment such as luminaires, audio equipment, cameras, multicore cables for multiple lighting circuits, etc.	BS 1363 A (UK domestic 13 A plugs and socket outlets) [A)] BS EN 60320-1:2001+A1 (IEC 10 A connectors) [A)] BS 546 (15 A round pin plugs and socket outlets) [A)] BS EN 60309-2 for plugs, socket outlets and connectors (such as Ceeform connectors) Multipole connectors should conform to BS EN 61984 [B)] or other product specific standards if available [C)]
Medium power >20 A ≤125 A	Power distribution and supplies to higher current-using equipment	BS EN 60309-2 for plugs, socket-outlets and connectors having a current rating up to and including 125 A (Such as Ceeform connectors)
High power >125 A	Main power distribution [D)]	BS EN 60309-1 for connectors up to 250 A BS 5550-7.5.4 (BAC connectors) [E)]

[A)] These should not be used outdoors.

[B)] BS EN 61984 is a connector safety standard; it does not specify any specific connector type.

[C)] Details of the 19-pin and 16-pin connector circuit configurations for lighting are shown in Annex H.

[D)] The essential safety requirements of BS EN 60309-1 should be followed. There are no international product standards for connectors such as CamLok, KSPCs or other connectors rated above 250 A (see **7.3.4.2**).

[E)] BS 5550-7.5.4 is an available but obsolete standard for BAC connectors.

The choice of connectors for any use should not permit the interconnection of circuits that are not compatible. Care should be exercised with connectors brought into the UK by touring shows and productions from other countries, as the detailed circuit functions of these can be different to those used in the UK.

7.3.4.2 Single pole connectors

Wherever single pole connectors are used they should be of the KSPC type, keyed for their circuit function, coloured in accordance with BS 7671:2008+A1:2011, Table 51 and carry the relevant alphanumeric markings. Single pole connectors should be arranged so that the supply-side connector is of the male contact type and the load-side connector is of the female contact type. Both supply-side and load-side connectors should pass a BS EN 60529:1992+A2, IPXXB finger test.

*NOTE 1 KSPC are unusual as the contact part of the supply-side connector has a male appearance and the contact part of the load-side has a socket or female appearance. The load-side (socket/female contact) KSPC connectors exist in two versions, one version satisfies IPXXB, the other does not (see **F.3.5.3** and Figure **F.1**).*

*NOTE 2 For single pole connectors, a simple visual inspection of a connector-cable combination might not provide clear evidence of its current rating. It is possible to have a connector-cable combination where the cable has a lesser current rating than that of the connector (see **A.4**).*

If single pole connectors are used that are not key indexed for their circuit function, great care should be taken to ensure that they are clearly marked and coloured to the arrangement set out above to avoid polarity connection errors.

Temporary distributions utilizing any type of single pole connectors should not be energized while in a partly assembled state as exposed live parts might become accessible. No type of single pole connectors should be connected or disconnected on load and should be protected from accidental disconnection.

Single pole connectors should provide protection conforming to at least IP44 when fully connected in normal use.

7.3.4.3 Connections for open-tails

Where conductors are terminated into the fixed installation stranded bare conductors should be finished with the appropriate termination.

7.3.4.4 Connection to busbars

Connection to busbars is not a preferred method but if it is used, there should be close co-operation with the owners of the supply and the design should take this into account (see **8.6.6**).

Connections to permanently installed busbars constitute an extension to that installation and should conform to BS 7671:2008+A1:2011, Regulation **132.16**, including verification, testing and certification to BS 7671:2008+A1:2011, Part 6.

Such connections, including those on generators with busbars, should only be made by a person with a level of competence suitable for this work using the correct terminations and tools to ensure a safe and effective connection.

7.4 Earthing and bonding

7.4.1 General

All parts of the temporary distribution should have a CPC as an integral part of all distributions that supply equipment.

All CPCs should be connected to the main earthing terminal associated with the source of supply that is being distributed; the only exception to this is the final connection to Class II insulated current-using equipment, which does not require a circuit protective conductor.

Current-using equipment constructed to Class II insulation requirements should be used in preference to Class I or Class III equipment as Class II insulation significantly reduces the risk of electrical shock.

*NOTE 1 Safety isolating transformers may be used to supply items of equipment where the electrical safety of such equipment cannot be ascertained (e.g. performers equipment); see also **8.9.7**, b).*

*NOTE 2 For the supply of more than one item of current using equipment from a single safety isolating transformer see BS 7671:2008+A1:2011, Regulation **418.3**.*

7.4.2 Generator earthing

7.4.2.1 General

NOTE 1 Generator earthing is the connection of the neutral or star point to the general mass of Earth, which can be achieved by the use of an earth electrode and/or connection to the main earthing terminal of any installed system of a premises associated with the generated output.

The earthing of generator(s) and temporary systems used in the entertainment industry can be complex and therefore should be in accordance with Annex C.

Earthing for temporary mobile generators should follow the guidance in BS 7430:1998, Clause **17** and BS 7671:2008+A1:2011, Section **551**. The neutral/star point terminal of the generator should be connected to the main earthing terminal, generator chassis and to the outgoing CPC.

*NOTE 2 Historically the practice of earthing generators was commonplace. This practice, though not required in every instance, can be beneficial (see **C.5** and **7.4.2.3**).*

NOTE 3 Placing a plate under the wheels of the generator vehicle does little more than provide a discharge path for static electricity.

7.4.2.2 Generator earthing required

Generator earthing should be used where the generator is a switched alternative to a supply from an installed system of a premises or where the output of the generator is used in the electrical environment of such a permanently installed system (see **C.5** and Annex D).

*NOTE The practice of using a generator as a switched back-up to an installed system of a premise is unusual in the applications covered by this British Standard and if employed close liaison with the owners of the installed supply is needed. Attention is drawn to ESQCR, Regulation 21 [3], the Electricity Supply Regulations (Northern Ireland) 1991 [4] and BS 7671:2008+A1:2011, Section **551** for switched alternative sources of energy (see also **C.5.4.4**).*

Where a generator is within or in the vicinity of another electrical environment, such as a building's installed electrical system or that associated with another source, there is the possibility of casual contact between the CPCs and exposed or extraneous-conductive-parts of the different systems; the protective earthing of the systems should be connected together (see **7.4.3**).

7.4.2.3 Generator earthing not required

Where a generator supplies a temporary electrical system that is electrically separated from all other electrical systems, a connection from the generator to the general mass of Earth is not essential, however, if this method of supply is used, extreme care should be taken to ensure that there is no intended or casual interconnection with any other electrical systems, such as via earth referenced signal cables, CPCs, exposed or extraneous-conductive-parts.

Where items of equipment supplied from different generators are intentionally or casually interconnected by earth referenced signal cables, then the main earthing terminals of the generators should be interconnected (see **7.4.3**).

7.4.2.4 TN-C-S or PME supplies and mobile and transportable units

Where mobile and transportable units are supplied from a permanently installed TN-C-S arrangement or are interconnected via earth referenced signal cables either intentionally or casually, the procedures set out below should be followed as appropriate.

*NOTE 1 There are safety implications which arise when connections are made to a TN-C-S installed system that is derived from a PME source and uses the earthing facility provided by this source (see **C.4.3**). In the UK, mobile and transportable units are viewed as caravans in relation to ESQCR, Regulation 9.4 [3] and the Electricity Supply Regulations (Northern Ireland) 1991 [4]. BS 7671:2008+A1:2011, Regulation **717.411.4** deals with this issue.*

a) The temporary electrical system should not be connected unless under the supervision of a competent person in accordance with BS 7671:2008+A1:2011, Section **717**, and Annex C.

b) The earthing arrangement of the permanently installed system should be determined. If this is not possible it should be assumed to be TN-C-S.

c) The earthing arrangement of the permanently installed system should be confirmed as suitable and effective.

d) Where the supply is obtained from a permanently installed source, the supply cable should be verified as suitable. An earth fault loop impedance measurement should be taken at the incoming terminals of the mobile or transportable unit prior to energizing the unit's installed system.

e) Where the mobile or transportable unit is arranged so that its installed system is electrically separate from the incoming supply (using simple separation and an internal TN system), there should be no connection to the means of earthing of the permanently installed TN-C-S source (including by casual interconnection of earth referenced signal cables). In this case, consideration should be given to the possible need for deploying an earth electrode. The design and related instructions should reflect the decision taken.

f) Where the supply is obtained from a permanently installed TN-C-S system and the means of earthing of this source is used, an earth electrode should then be deployed; this limits the hazards associated with a PEN (see **3.48**, **C.3** and **C.4.3**) failure.

NOTE 2 Where the permanently installed system is confirmed as TN-S or TT the deployment of an earth rod can be beneficial, though it might not be essential.

g) Where signals are passed between equipment that is supplied from different electrical sources, the transmission of signals should, where possible, avoid the use of earth-referenced cables, such as by using fibre optics.

The procedures outlined in items a) to g) should be carefully considered and carried out and the design of the temporary electrical system and the related instructions should be clear.

The risks that can arise should be properly assessed for each specific situation and event. The design and related instructions should take into account the risk assessment for each activity.

7.4.3 Interconnection of earthing systems

Where exposed conductive parts associated with or connected to different electrical supplies are simultaneously accessible, they should be connected to the same earthing system either individually, in groups or collectively.

The sizing of such conductors should be in accordance with BS 7671:2008+A1:2011, Chapter **54**. The position of this interconnection should be a design consideration and the rating of the conductors should be appropriate to the maximum load being supplied at the position chosen to make the interconnection.

The CPC in any part of the temporary electrical system should not be disconnected to prevent hum or other signal degradation.

7.4.4 Protective bonding

Main and supplementary bonding conductors should conform to **8.7.6** and BS 7671:2008+A1:2011, Section **544**.

Where a temporary system enters a different electrical environment, specific care should be taken as there might be a difference in potential of exposed conductive parts dependent upon the earthing arrangements of the different supplies involved (see Annex C and BS 7671:2008+A1:2011, Regulations **411.3.1.1** and **415.2**).

*NOTE 1 Developments at the event might lead to the protective bonding and earthing arrangements being reconsidered (see **6.3**).*

*NOTE 2 For the discharge of static electricity and lightning protection see Clause **11**.*

7.5 Overcurrent protection for temporary systems

Each section of a temporary system should have appropriate overcurrent protection.

The type and rating of fuses or circuit breakers within a temporary system should take account of the prospective short circuit current, the discrimination required and characteristics and current rating of the circuit they are protecting (see Annex A and Annex B).

If the design of the temporary system allows diversity on any circuits, this should be specified and recorded and those testing the distribution on site should be informed.

7.6 RCDs in temporary systems

NOTE 1 RCDs rated at 30 mA or less have traditionally been seen as the device to protect people and animals, they also perform a valuable circuit protective function to disconnect the supply from a circuit where fault current is insufficient to operate an overcurrent device. Information on the various types of RCD and their application is given in Annex E. Their presence in distribution units is dealt with in Annex A and Annex B.

Where long cable runs are used, care should be taken to ensure that the earth fault loop impedance does not become excessive and affect the fault clearance times required for the protective devices.

The designer should ensure that the most appropriate RCDs are used in the temporary distribution being planned. The following matters should be taken into account (see **8.9.7**, **8.9.8**, **9.8.4** and **10.7**).

a) Final circuits should be protected by an RCD, with a rated residual operating current ($I_{\Delta n}$) not exceeding 30 mA and an operating time not exceeding 40 ms at a residual current of 5 $I_{\Delta n}$, in accordance with BS 7671:2008+A1:2011, Regulation **415.1.1**. No more than six final circuits should be protected by a single RCD. The operation of an RCD should not introduce a hazard. For example, multiple circuits, such as working, safety or emergency lighting, should not be supplied from one single RCD where its operation could result in a hazard.

b) Some electronic equipment can introduce higher residual currents than expected and cannot be supplied from an RCD rated at 30 mA; the suppliers of such equipment should be consulted before the design of the distribution to such equipment is finalized and the type of RCDs selected (see **7.10**).

   NOTE 2 Such equipment can include outside broadcast technical vehicles and in some instances, control equipment for luminaires and lifting equipment.

c) Consideration should be given to the choice of RCD according to the circuit position and duty. Discrimination should be achieved so that only the circuit containing the fault is de-energized (see Annex E).

d) Distorted waveforms with d.c. components can be created by electronic equipment so Type A RCDs should be selected wherever possible. Certain electronic control units, such as those for variable speed lifting equipment can use non-sinusoidal pulse-width modulated currents and therefore Type B RCDs should be considered in the supply; manufacturer's recommendations should be followed.

e) Where the use of an RCD bypass is being considered within the temporary distribution, a risk assessment should be performed before any bypass is instigated. When the risk assessment has demonstrated that the use of a bypass is acceptable the bypass should only be set under the specific control of the person responsible for the temporary distribution. The RCD should be returned to the protective state immediately, after the reason for the bypass has been resolved (see **8.9.8** and **10.7**). Consideration should be given to the use of an RCD bypass facility in FDUs that automatically resets the bypass circuit on removal of power so that the RCD is returned to the protective state [see **B.5**, i)].

f) Where an adjustable RCD is provided at the source of supply, and is in the control of the provider, agreement should be reached with the responsible person on who sets the device and what values should be used.

g) Where the source of supply is protected by an RCD that is more sensitive than is acceptable for the temporary system being planned, agreement should be reached with the owners of the supply to either replace it with a more suitable device or remove the device from the circuit. In this circumstance the ISU should be fitted with an RCD of suitable rating or an adjustable RCD set to appropriate values for residual operating current and delay.

h) Residual current monitors permanently monitor any leakage current in the downstream system; these devices only give an audible or visible warning and should only be used under supervision of a person competent to interpret the warnings and take appropriate action if necessary.

*NOTE 3 Such devices are not intended to provide protection against electric shock (see BS 7671:2008+A1:2011, Regulation **538.4**).*

7.7 Equipment forming the temporary electrical system

*NOTE 1 See **4.5** and **6.4** for further recommendations on the provision of equipment.*

The distribution equipment should be constructed in accordance with Annex A and provide the appropriate functions (see Annex B).

Distribution equipment selected for use should have the following features:

a) safety and suitability for purpose in the conditions predicted;

b) flexibility in application for repeated use, i.e. to allow easy substitution of units for specific duties as required;

c) suitability for transport, storage and handling;

d) robustness in construction to resist damage;

e) suitability for use in the expected weather conditions.

Equipment designed for use indoors should not be used outdoors without additional protection against external influences [see BS EN 61439 (all parts)]. Equipment should conform to the IP categories given in Table 3.

Table 3 **Minimum IP protection (with all covers in place)**

Place of use	**IP category**
Electrical equipment generally	IP2X
Barriers with equipment to which non-skilled persons have access	IP2X, IPXXB
SELV/PELV equipment	IP4X, IPXXD
Electrical connections, e.g. junction boxes	IP4X, IPXXD
Equipment located outdoors	IP44
Equipment in contact with water	IPX8

NOTE 2 The requirements of the IP Code are given in BS EN 60529:1992+A2.

If any part of the temporary electrical system is to be used in a situation where it might be taken underwater or submerged, specialists in the supply and use of such equipment should be consulted.

7.8 Machinery

Parts of the temporary electrical system intended to supply electrically powered machinery should be designed to take account of possible hazards that can arise from the unexpected loss or return of supply, wrong-direction movement or stalling due to mechanical overload or under-voltage.

For three-phase motors, a correct and reliable phase sequence should be provided. Users and suppliers of machinery should advise the temporary system designer of short and long-term electrical loading and any other special requirements.

NOTE Attention is drawn to the Supply of Machinery (Safety) Regulations 2008 [9], in particular provision of all machinery system switchgear, no-volt protection, phase loss and phase sequence protection and all control functions and guard arrangements.

7.9 Luminaires

Luminaires for connection to the temporary distribution should conform to BS EN 60598-1 and the appropriate parts of BS EN 60598-2, BS 4533-102.17 or BS 4533-102.9.

NOTE Switch-on surge for lamps might exceed running current. This is rarely a problem if luminaires are properly maintained, used for their intended purpose and the temporary distribution supplying them is correctly designed.

7.10 Electronic equipment used for control and power-processing

Designers should take account of the characteristics for all electronic units used for control and power-processing when designing sub-circuit overcurrent protection and earth fault disconnection.

NOTE 1 Electronic equipment used for control and power-processing include such devices as dimmers, motor controllers, audio-visual equipment, UPS, inverters and switched mode power supplies, etc.

In practice, such devices should be supplied by the manufacturer/supplier with integral fuse or circuit-breaker protection suitable for normal conditions of use. The manufacturer/supplier should be consulted to obtain the characteristics of the protective devices used.

NOTE 2 Interpretation of the measured values of earth fault loop impedance requires knowledge of the nature and characteristics of the source of supply. Caution needs to be observed when verifying systems incorporating power-processing equipment such as UPS, inverters or similar electronic control devices.

7.11 Sub-systems for associated services

If a facilities provider is supplied from the temporary electrical distribution, an agreement should be made with the person responsible for the temporary system and supply requirements allowed for in the design. It should be provided at an agreed point from a distribution unit with the means for isolation and incorporating overcurrent and RCD protection. Agreement should be reached between the provider of this supply and the facilities provider on matters of suitability and safety of the facilities' electrical equipment.

Connection to the facilities provider's equipment should be through a plug and socket from the range given in **7.3.4**.

7.12 Protection against unauthorized use

Wherever it is possible that electrical equipment could be tampered with or operated by unauthorized people, the temporary electrical system should be protected by either a suitable locked enclosure, by barriers or guards, effective supervision, human intervention or a combination of these, dependent upon the location and the conditions present (see **8.8**, **8.9.3**, **10.1**, **10.3** and **10.4**).

7.13 Safety systems

7.13.1 Communications systems

The provision of communication systems for the control of work on site and emergencies should be included in the design considerations.

7.13.2 Supplies for safety services

Consideration should be given to providing suitable supplies, where required, for safety systems such as: fire detection and warning systems, including voice evacuation (in accordance with BS 5839); emergency lighting systems (in accordance with BS 5266-1); working lights; and site communications infrastructure (see **8.9.6** and **10.5**).

NOTE See HSG 195 [N2] and PAS 51.

7.13.3 Warning signs

Where required, warning signs related to the presence or use of electricity should be provided.

NOTE 1 For example, where cables are suspended overhead or buried, in areas designated for electrical equipment, on generators or on the electrical equipment itself.

Safety signs should conform to BS 5499-10.

NOTE 2 Attention is drawn to the Health and Safety (Safety Signs and Signals) Regulations 1996 [10] for information on warning signs.

7.14 Weather conditions

NOTE The effect of sun on distribution units, cables and equipment can easily increase temperatures to a point above that at which they can operate correctly. Dark coloured units are particularly prone to temperature rise due to solar gain if not placed in the shade.

Possible weather conditions should be taken into account when designing the temporary electrical system (see **8.8.2**, **8.11** and **11.1**).

Distribution units and connectors in cable runs should not be placed in a gutter, gully or depression serving as a drain or elsewhere that might fill with water. Care should be taken to ensure that connectors are not subject to water ingress due to the position in which they have been placed.

7.15 Removal of temporary electrical systems

The design and instructions for any temporary electrical system(s) should include any requirements that are needed to ensure that the temporary system(s) can be safely removed. The process of removal should also include any work that might be required to leave the location in the condition agreed with the owners or occupiers [see **6.1.2**, j), **6.1.3.3**, d), **6.1.3.6**, b), **6.3** and **8.16**].

8 Work on site

8.1 General

Work on site should be under the control of the person responsible for the temporary electrical system on which the work is to be carried out. That person should be fully aware of their responsibility as set out in Clause **6** and of the details of the design as set out in Clause **7**.

The work on site should be carried out in accordance with the design and any related instructions as set out in Clause **7**.

NOTE Attention is drawn to the relevant health and safety legislation and statutory regulations.

8.2 Responsibilities

Work should be carried out by suitably skilled persons with additional technical support, if necessary, under the control of the person responsible for the temporary electrical system (see Clause **4** and **6.1**).

8.3 Design assessment

The person responsible for the work should ensure the design is appropriate for the prevailing conditions on site and especially where there are additional risks not foreseen by the system designer. If necessary, they should arrange for the design of the temporary electrical system to be amended and for additional precautions to be taken.

8.4 Equipment assessment

8.4.1 General

Generally all the equipment provided for the temporary electrical system should be standard stock items of equipment or prefabricated off-site and delivered to the location with evidence of inspection and test as set out in **4.5**, **6.4** and **9.4**.

As far as is reasonably practicable, all parts of the temporary electrical system should be connected by plugs and sockets.

8.4.2 Test and identification before delivery

All equipment should be inspected and tested before delivery to site. Valid evidence of this should be provided. Any equipment lacking such evidence should be rejected, or inspected and tested with the results recorded, before use.

8.4.3 Inspection of equipment on site

Equipment delivered to site with evidence of valid formal inspection and test should be visually inspected for damage before being used in any temporary electrical system.

Any equipment constructed or repaired on site should be inspected and tested before being made available for use. Records of such work should be kept.

8.5 Live working

Work on exposed live conductors should not be undertaken unless such work can be fully justified. Where live working has been shown to be justifiable, a safe system of work for the live working should be devised and implemented.

NOTE Attention is drawn to the Electricity at Work Regulations 1989, Regulation 14 [5] for details on what work can be justified,. Guidance on the justification for live working and safe systems of work is given in HSE publications HSR25 [11] and HSG85 [12].

8.6 Connection to power supplies

8.6.1 General

Connection to supplies should be carried out according to any procedures already agreed with the owners of the supplies or laid down in the design requirements.

The means of isolation, in addition to the responsibilities for connection and disconnection, should be reconfirmed.

8.6.2 Verification of supplies

Where necessary, the owner of the electrical supply should be asked for evidence of the most recent formal inspection and test.

The characteristics of the supply, such as the number of phases, current per phase, earthing arrangements, protective devices and their ratings, polarity and earth fault loop impedance of the source should be checked against the requirements of the design and verified by test.

8.6.3 Connection using plugs and sockets

Connections made using plugs and sockets should only be made once the supply and the means of isolation have been verified.

8.6.4 Connection using single pole connectors

The connection should be made in the order: CPC, neutral, followed by the line connections. Note should be taken of the alphanumeric and colour coding as shown in **7.3.2**.

NOTE It is preferable that the person who verifies the connections is not the person who makes the connections.

The person responsible for the temporary electrical system should verify the connections of open-tails at the point of connection where these were made by local staff.

8.6.5 Connection using open-tails

Where open-tails are to be terminated, they should be provided with a correctly crimped ferrule or lug suitable for the termination.

NOTE It is preferable that the person who verifies the connections is not the person who makes the connections.

The person responsible for the temporary electrical system should verify the connections of open-tails to the source of supply where these were made by local staff.

8.6.6 Connection to supplies obtained from busbars

This is not a preferred method; however, if it is the method to be used the design requirements should be followed and close co-operation with the owner of the electrical supply should be ensured. If such a connection is used, it constitutes an extension of the installed system and should conform to BS 7671 (see also **3.33**, Note 2, and **7.3.4.4**).

8.6.7 Isolation and switching

The temporary distribution should be designed to allow simple switching and isolation of circuits for changes, addition or removal of equipment or maintenance, without disruption to other users.

8.7 Fundamental checks

8.7.1 Polarity check

All indicators showing polarity should be checked to ensure they are operating correctly.

8.7.2 Phase sequence

If motors or other phase-sequence sensitive items are used, the correct phase sequence should be established before the temporary distribution is energized.

8.7.3 Earth fault loop impedance

Critical earth fault loop impedances should be measured; the results should be recorded and compared with the limits set by the design to ensure the protective devices operate correctly in the required time.

8.7.4 RCDs

RCDs should be checked for correct mechanical operation, i.e. the test or T button should be pressed with the power on to ensure the RCD operates. Key switches and indicators related to RCD bypass should be checked for correct operation.

8.7.5 Neutral/Earth indication

Indicators intended to show correct neutral/earth connections should be checked for correct functioning before any load is connected.

8.7.6 Protective earthing and bonding arrangements

Protective earthing and bonding arrangements should be adequate to meet the design requirements and any other conditions found on site.

Supplementary equipotential bonding should be provided as necessary to maintain simultaneously accessible conductive parts at substantially the same potential to prevent danger. This should be verified as adequate according to BS 7671:2008+A1:2011, Regulation **415.2.2**.

Where simultaneously accessible exposed-conductive-parts are associated with supplies from different sources, the protective conductors should be connected to the same earthing system, which would normally be achieved by interconnection at the main earthing terminals of each source (see **7.4.3**).

For safety, the need for protective bonding should be established by a test between the extraneous-conductive-part in question and the CPC. A measurement of less than 22 kΩ requires the extraneous-conductive-part to be included within the protective bonding arrangements (see *IET Guidance Note 5* [13]). Any possible changes to site conditions during use should be taken into account (see **7.4.4**).

A resistance measurement should be made with a test instrument having a no-load voltage between 4 V and 24 V, d.c. or a.c. and a short-circuit current of not less than 200 mA. Measuring instruments and monitoring equipment should conform to the relevant parts of BS EN 61557.

*NOTE For information relating to bonding for static discharge and lightning protection, see Clause **11**.*

8.8 Protection against damage and interference

8.8.1 Cables

Cables should be run so that they do not create a hazard and are protected from all sources of damage.

If possible, cables should be routed clear of passageways, walkways, ladders, stairs, etc. They should not be passed through fire barriers without arrangements to preserve the integrity of the fire barrier. After removal of cables the fire barriers should be reinstated.

Cables laid along floors should be arranged to cause minimum obstruction and should be secured in position if disturbance is likely. Cables on the ground, which cross pedestrian and vehicle routes, should be protected from damage and ramped.

Overhead cables that cross pedestrian walkways should be at least 3.5 m above the ground. Overhead cables that cross routes over which vehicles might pass should be at least 6 m above the ground.

Special attention should be paid to safety exit routes and vehicle emergency access routes. Local or other responsible authority requirements should be met and a risk assessment made and acted upon for the arrangements made.

Electrical cables temporarily buried in the ground should have a voltage designation of not less than 450 V/750 V and the routes should be marked at suitable intervals. If necessary, cable with integral armouring should be used, or additional mechanical protection provided, to prevent damage.

Cables should not be run in a manner that allows them to overheat and should not be placed close to sources of heat. Excess cable should be laid out in a linear fashion and not left coiled while carrying current. Connectors should not be placed in gullies, gutters, drains or depressions that might fill with water.

All line, neutral and CPC single core cables for each circuit should be run together with minimum separation to facilitate identification and to minimize the effects of EMI. Care should be taken that line and neutral cables for a circuit are not separated by ferrous metal to avoid eddy current heating.

*NOTE Matters of electromagnetic disturbance or EMI in permanent installations are dealt with in BS 7671:2008+A1:2011, Chapter **44**, Section **444**.*

Plugs and sockets in areas where the public are permitted should be secured against interference or attended and supervised at all times (see **7.12**, **10.2** and **10.4**).

8.8.2 Switchgear, distribution units and other equipment

Precautions should be taken to prevent unauthorized persons interfering with any equipment. This might be achieved by placing the equipment in areas, enclosures or rooms with restricted access, by close supervision, or by de-energizing the units and/or locking them against casual access (see **7.12**, **10.2** and **10.4**).

The ISU, distribution units, switchgear, dimming, control units, lighting and audio-visual equipment should not be put in areas to which the public has access unless secured, made inaccessible, or attended and supervised to prevent interference that could result in danger.

The positioning of generators, distribution units, switchgear, dimmers, other control units, control panels, etc. should be placed so that they can be supervised and the parts of the temporary electrical system served can be monitored.

Unless the source of supply has suitable overcurrent protection the ISU should be placed as close as possible to the source and connected with cables not longer than 3 m (see **7.2.1**).

NOTE Longer cable runs from the source of supply to the first ISU may be used, provided circuit protection at the source is suitable and the cable run is protected from accidental damage and tampering.

A risk assessment of the conditions present should be made (see **6.3**).

8.9 Safe working practice

8.9.1 Identification and isolation of circuits

The electrical supply to any section of the temporary system should be securely isolated and confirmed before work is started that could involve:

a) exposing conductors, i.e. for maintenance or adjustment;

b) connection or disconnection of accessories not designed for making or breaking on load.

Re-energizing should only be authorized by the person responsible after inspection and tests have confirmed that the temporary system is safe for use.

Temporary distributions should be run so that circuits and the nearest point of isolation can be easily traced and identified. The circuits of temporary distributions should have clear identification.

All cable runs should be kept tidy, particularly in the vicinity of distribution units.

NOTE 1 This helps to prevent hazards to people of tripping or falling, prevents damage to cables and aids cable and circuit identification for fault finding, disconnection or isolation in case of emergency.

Every final circuit serving electrical equipment where people are close to or working with the equipment should have a means of isolation conveniently close to the equipment with easy access to allow isolation in case of emergency. The person operating the equipment should also know how to operate the means of isolation. A disconnector should not be relied upon for safe isolation unless locked off. The use of plug connectors for isolation should include a means to prevent unexpected reconnection.

NOTE 2 A semiconductor dimmer or similar switch device does not provide isolation. Isolation is achieved with a device that breaks all line and neutral conductors.

8.9.2 Knowledge of site emergency procedures

The person responsible for a temporary electrical system should ensure that everybody involved with work on temporary systems is aware of the emergency procedures for the event and who to contact for assistance in case of emergency.

8.9.3 Unattended system

If parts of a temporary electrical system are left unattended, those parts not required should be isolated.

Care should be taken that supplies required for ongoing work are not switched off. Supplies required for safety services should only be switched off provided safety is not compromised and those who might be affected have been informed (see **10.1**, **10.3** and **10.4**).

NOTE On some occasions, it might be necessary to leave a temporary system unattended but in an energized state.

This should only be done provided an assessment of the risks that could reasonably be expected to occur has been carried out and the risks removed or suitably guarded against (see **7.12**, **8.8**, **10.1**, **10.3** and **10.4**).

8.9.4 Access covers

Access covers and panels covering live parts should be closed and secured before an item is energized.

8.9.5 Faulty equipment

Equipment discovered to be faulty in the course of set-up or testing should be clearly labelled as such and removed from use. Faulty equipment may be repaired and re-tested at the site if means are available, otherwise the equipment should be returned to the supplier for repair, or made unusable to prevent accidental use.

8.9.6 Working, safety and emergency lighting

All parts of the site should be provided with sufficient working, safety and emergency lighting if they are to be used at night or if they do not have adequate natural light. This provision should be included in the design but additional arrangements should be made if necessary (see **7.13.2** and **10.5**).

NOTE Dependent on the nature of the event, such provisions might be legal requirements. Consultation with the event manager and the Local Authority as to their requirements might be necessary.

Reference should be made to the following as applicable:

- BS 5266-1, *Code of practice for the emergency lighting of premises*;
- BS EN 12193, *Lighting for indoor and outdoor sports events*;
- BS EN 50172, *Emergency escape lighting systems*;
- HS(G) 195, The Event Safety Guide [N2];
- PAS 51, *Guide to industry best practice for organizing outdoor events*.

8.9.7 Hand-held mains-powered equipment

Where any mains powered hand-held equipment, including musical instruments and follow spots, are in use, the equipment should be supplied either from:

a) an RCD with a rated residual operating current ($I_{\Delta n}$) not more than 30 mA and an operating time not more than 40 ms at a residual current of 5 $I_{\Delta n}$; or

b) a safety isolating transformer conforming to BS EN 61558-2-6 where the CPC of the input is not taken to the output and its secondary winding is not earthed; each piece of equipment should be connected to a separate safety isolating transformer.

8.9.8 Disabling RCDs

Where distribution units are fitted with RCD protection, any means to disable this protection should be fitted with a secure lock with a warning indicator that is under the control of the person responsible for the temporary electrical system. RCD protection should only be disabled following a risk assessment by the person responsible for that temporary system and kept under their close supervision. RCD protection should be re-enabled immediately when it becomes possible to do so (see **7.6** and **10.7**).

8.10 Communications

For co-ordinating safety procedures, areas containing distribution units, generators, dimmers, control panels and other switchgear should be provided with reliable communication links to event management and any emergency control positions.

8.11 Weather conditions on site

Equipment used in damp, excessively humid, rainy or other hostile environments should have a suitable IP rating.

Covers, tents or enclosures should be used as additional weather protection if necessary. Care should be taken to ensure that water collecting below the equipment does not cause danger (see **7.14** and **8.8.2**).

Equipment exposed to sunshine can experience a rise in temperature due to solar gain; this might cause its operating temperature to exceed its safe operating range and such equipment should be shielded from this effect.

8.12 Hazardous sites

Sites with special hazards require particular care and additional precautions should be taken. Work in such locations should only be carried out with the specific agreement and permission of the owners or occupiers [see **6.3**, e)].

Appropriate equipment might be required for swimming pools, marinas and construction sites and any additional requirements from the owners or occupiers should be complied with (see BS 7671:2008+A1:2011, Section **702**, **704** and **709**).

NOTE 1 A permit to work procedure might be required for swimming pools, marinas and construction sites.

Petroleum installations, processes producing flammable dust, mines and quarries, explosives manufacturing and similar environments require special precautions and expert advice should be obtained. Any specific requirements from the owners or occupiers of such areas should be complied with. Permit to work procedures should be established and strictly observed.

NOTE 2 The use of specific specialist equipment might be required and certain equipment might be banned. Specific permission for such work is needed.

Work on-board ships and at offshore installations should only be carried out with specific agreement from the owners or the Master of the vessel. Such work should be carried out under the direction and control of an electrically competent representative of the owners or Master.

NOTE 3 For installations on-board ships see BS 8450. For installations on pleasure craft or small vessels see BS EN 60092-507. For installations offshore see, Recommendations for the Electrical and Electronic Equipment of Mobile and Fixed Offshore Installations [14].

8.13 Medical areas or locations

Work in medical areas needs particular care and additional precautions and should only be carried out with the specific agreement of the owners or occupiers (see BS 7671:2008+A1:2011, Section **710**).

NOTE The installed electrical systems present in medical areas are intended for specific purposes.

The installed electrical systems should not be used for temporary distributions or be compromised by the introduction of supplies or earth referenced signal cables from other areas unless specific permission has been received from a person having the knowledge and authority to grant such permission (see **C.4.5**).

8.14 Agricultural areas

Work in agricultural areas especially where livestock are present might need additional precautions and should only be carried out with the specific agreement of the owners or occupiers (see BS 7671:2008+A1:2011, Section **705**).

8.15 Signs and warning notices

Safety signs should be erected as required by the design (see **7.13.3**) or wherever there could be a significant risk to health or safety (e.g. providing warnings of electrical and other hazards). The person responsible for the temporary electrical system should ensure that the correct signs are provided. Safety signs should conform to BS 5499-10.

NOTE Attention is drawn to the Health and Safety (Safety Signs and Signals) Regulations 1996 [10] for information on warning signs.

8.16 Removal of temporary electrical systems after use

The design should state how the removal of temporary electrical systems is carried out, or the person responsible should decide how this is can be safely achieved taking into account the environmental considerations, the temporary systems involved and the event requirements.

Any work required to leave the location in the condition agreed with the owners or occupiers should be carried out according to the design or as directed by the person responsible (see **6.1.2**, j), and **7.15**).

9 Inspection and testing

9.1 General

The inspection and testing should take account of the relevant parts of *IEE Code of practice for in-service, inspection and testing of electrical equipment* [N3], *IET Guidance Note 3* [N4], HSE HS(G) 107 [N5], *IET Guidance Note 8* [N6] and other applicable requirements and meet the specific design requirements and procedures prepared for the temporary electrical system (see also Annex G).

NOTE Attention is drawn to Health and Safety legislation, statutory regulations and the relevant recommendations that apply to onsite inspection and testing.

9.2 Person responsible

The onsite inspection and testing should be under the control of the person responsible for the temporary electrical system on which the work is to be carried out. They should be fully aware of their responsibility as set out in Clause **4** and Clause **6** and of the details of the design as set out in Clause **7**.

NOTE The person responsible might decide to carry out the inspection and testing themselves, or they might delegate this duty to a suitably skilled person.

The suitably skilled person(s) should understand the design and the inspection and testing regime to be carried out as well as the requirements of the event and the full extent of their responsibility.

Where possible, the inspection and testing should not be carried out by the same person who set-up the temporary system.

9.3 Records, results and certificates

9.3.1 Initial verification

Persons carrying out the inspection and testing should record the results and prepare the documentation as required. As a minimum, this should be comprised of a Completion Certificate(s) and accompanying Schedule of Test Results and where applicable a Confirmation of Electrical Completion might also be required (for details, see **G.3**).

On a system that has been split into several manageable parts or sub-systems, each person responsible for a sub-system should retain a copy of their Completion Certificate and Schedule of Test Results. Copies of the certificate(s) and results should be given to the senior person responsible for the temporary electrical system. Where appropriate, the senior person responsible should complete a Confirmation of Electrical Completion and provide a copy for the event manager (see **G.3**).

Copies of the Confirmation of Electrical Completion or the Completion Certificate as appropriate should be available to any parties that require such evidence, for example local authorities and suppliers of electricity to the temporary system and owners or occupiers of premises where the event is taking place.

9.3.2 In-service inspection and testing

Where a temporary system exists for an extended period a routine of regular inspection and testing should be implemented (see **10.2** and Annex G).

9.4 Test and identification of equipment before delivery

The equipment forming the temporary electrical system(s) should be delivered to the location with evidence that it is within a valid period having passed a formal inspection and test (see **4.5**, **6.4** and **8.4**).

The person responsible for the temporary electrical system(s) should ensure that only equipment having this evidence is used. Equipment without this evidence should either be tested before use and records of such tests kept or labelled as faulty and returned to the supplier.

9.5 Electrical systems brought by facilities providers

Facilities that include electrical systems might be introduced to site and providers of such equipment should request an electrical supply from the main temporary distribution provider or make their own arrangements with the agreement of the senior person responsible.

Those bringing facilities to site should provide a certificate for their electrical system that shows it is within a valid period having passed a formal inspection and test. The responsibility for checking that the electrical systems associated with such facilities are safe and suitable for use should be part of the original agreement between the event manager and the person accepting responsibility for the temporary electrical systems (see **4.2**, **4.3**, **6.1**, **6.4** and **7.7** to **7.11**).

9.6 Supplies to facilities providers

If electrical supplies are provided to facilities providers on site, the person responsible for the temporary electrical system should be satisfied that the equipment is safe for use before energizing. Agreement should be reached between the person responsible and the facilities providers on matters of: equipment suitability, testing of the electrical equipment, the provision of RCDs and the connection of any required protective bonding.

9.7 Visual inspection

All items should be visually inspected for damage before they are incorporated into the temporary electrical system (see **8.4.3**).

The visual inspection of the temporary electrical system should ensure it is correctly set-up according to the design, is safe and suitable for the purpose and that full account is taken of all the electrical and environmental conditions that exist or might reasonably be predicted to occur at the location. The visual inspection should include the following checks:

a) the earthing arrangements of the supplies involved are as expected and according to the design;

b) where an earth electrode(s) is required, it is correctly deployed and connected;

c) suitable means of switching and isolation are present;

d) the terminations of open-tails are correct;

e) single pole connectors are correctly connected for circuit function and fully mated;

f) protective devices are in their correct circuit positions and of the correct rating;

g) protective conductors, where required, are correctly connected;

h) all cables are correctly connected;

i) all cable runs are tidily laid and protected from damage;

j) environmental factors do not cause connectors, distribution units and other electrical equipment to become hazardous;

k) electrical equipment is positioned so that it does not create a hazard to any persons, animals or property;

l) electrical equipment is secure against tampering or unauthorized operation;

m) the temporary electrical system follows the design and requirements of the event;

n) all covers and protective barriers are correctly in place;

o) fire protection arrangements and barriers are not compromised;

p) supplies for safety services are in accordance with the design;

q) evidence is provided of formal inspection and test for all facilities brought to site that include installed electrical systems;

r) evidence is provided of formal inspection and test for all facilities providers' equipment.

Anything found faulty should be corrected and re-tested before proceeding. Faulty equipment removed should be labelled and returned to the supplier. Any significant findings during the visual inspection should be recorded and the senior person responsible for the temporary electrical system should retain a copy.

9.8 Tests

9.8.1 General

All items of equipment forming the temporary electrical system should have been inspected and tested before delivery to the location (see **4.5**, **6.4** and **8.4**) or have been formally inspected and tested before use. The testing of the system should verify that it is safe and suitable for use and that the requirements of the design are met.

NOTE 1 The procedures or order of testing might be part of the design but progress of work at the location could affect which parts of a temporary system are tested first and what tests are applied.

The person responsible for the temporary electrical system should assess the situation and operate a safe and suitable test procedure.

*NOTE 2 A temporary system might need to be re-inspected and re-tested, either as a whole or in parts (see **G.3.2**). Circumstances where this might be necessary include:*

- *after any significant alteration;*
- *after any form of accident or damage involving the temporary system;*
- *if there is any evidence of impending failure of any units within the temporary system;*
- *if the temporary system has been exposed to environmental conditions it was not designed for;*
- *if the period the temporary system remains in place exceeds the time foreseen by the design;*
- *where the design has foreseen the need for re-inspection and re-testing.*

9.8.2 Equipment tests prior to arrival on site

Prior to arrival on site the following equipment tests should have been conducted and the results recorded:

a) continuity of conductors;

b) insulation resistance;

c) polarity;

d) performance testing of RCDs;

e) functional testing of units.

9.8.3 System tests on site

After the visual inspection has been undertaken as in **9.7,** the following tests should be carried out:

a) earth electrode resistance where appropriate (see Annex C and BS 7430:1998);

b) phase sequence and polarity;

c) earth fault loop impedance;

d) prospective short circuit current;

NOTE The measurement of fault loop impedances of circuits supplied from power-processing electronic equipment might not be possible due to the designed characteristics of the equipment.

In this situation [see items c) and d)] the manufacturers should be consulted.

e) operation of the test button on RCDs;

f) voltage drop where appropriate.

The results of the tests carried out should be recorded and the person responsible should retain a copy (see **9.3**).

9.8.4 RCD setting and checking

Where adjustable RCDs are used in the temporary electrical system or at the source of supply, residual operating current and time delay should be set. Settings specified in the design should be used. If a setting of residual current is not specified, a value based on measurement or prediction should be used. If a setting of delay is not specified, a value based on assessment of the RCDs circuit position should be used to achieve discrimination.

NOTE Some measurement and re-adjustment might be needed to achieve residual current and time delay settings that are appropriate to the circuit position of the RCD.

The use of the test button on RCDs and the measurement of actual RCD performance are dealt with in Annex E; the test button should be operated every time an RCD is placed in a new circuit arrangement. If at any time the RCD fails to operate as a result of the operation of the test button, the unit should be replaced (see **7.6** and **8.9.8**).

9.9 Onsite assembly or modification

9.9.1 Units assembled on site

Units and equipment assembled on site should be fully tested before connection to any system and the results recorded (see **8.4.3**).

9.9.2 Equipment repaired or modified on site

Any equipment that is repaired or modified on site should be fully tested before connection to any system and the results recorded (see **8.4.3**).

10 Operational procedures

10.1 Competent person present

The person responsible for the temporary electrical system or a suitably competent nominated deputy should be present on site whenever any part of the system is energized.

NOTE On some occasions it might be necessary to leave a temporary system unattended but in an energized state.

This should only be done provided an assessment of the risks that could reasonably be expected to occur has been carried out and the risks removed or suitably guarded against (see **8.9.3**, **10.3** and **10.4**).

10.2 Regular inspection

The person responsible should regularly inspect the temporary electrical system to ensure its integrity is maintained. Any defects should be remedied before use of the system continues.

The person responsible should carry out or delegate any planned periodic re-testing.

10.3 Supervision of temporary systems for safety

Any part(s) of the temporary system that might require supervision at any time for safety reasons should be attended by a suitably skilled or instructed person (see also **8.9.3**, **10.1** and **10.4**).

10.4 Site security

Any part(s) of the temporary system, including all distribution units, control equipment, generator(s), cable connections or other equipment that could be subject to accidental or mischievous interference likely to cause danger, should be attended by a suitably skilled or instructed person.

*NOTE 1 Such attendance might be required at any time whether the system is energized or not (see **7.12, 8.8, 8.9.3** and **10.1**).*

NOTE 2 The instructed person might be a security guard who knows the appropriate action to be taken in the event of apparent interference.

Any part(s) of the temporary system not in use and not needing to be energized should be isolated and preferably locked against interference when not attended.

10.5 Site emergency services or procedures

Equipment or services that are identified as necessary for use during emergencies should be attended when required by site contingency plans.

Where emergency services or procedures that already exist at a site might be affected by the temporary electrical system, suitable alternative arrangements should be agreed and put into operation, (see **7.13.2** and **8.9.6**).

10.6 Non-load making and breaking connectors

Plugs, sockets and cable couplers that do not have load making and breaking capability should not be connected or disconnected while the circuit is energized.

10.7 RCD bypass

If the temporary distribution has been correctly designed to take account of residual currents that can occur or are known to be created by certain equipment, the bypassing of any RCD should not be necessary.

If the need to bypass an RCD is identified, a risk assessment should be undertaken and a safe system of work, under the control of the person responsible, should be arranged and strictly adhered to. The RCD bypass should be removed at the earliest opportunity (see **7.6** and **8.9.8**).

11 Additional considerations

11.1 Protection against lightning

NOTE This British Standard does not provide recommendations on protection against lightning strike.

If site conditions require protection against possible lightning strike (for example outdoor stages), all aspects of the sizing and setting-up of protective bonding conductors between the lightning protection system and the temporary electrical system should be the responsibility of a lightning protection designer [see BS EN 62305 (all parts)].

11.2 Discharge of static electricity

NOTE 1 Mobile and transportable units of all types, including TV and Radio technical vehicles, facilities vehicles, trailers and similar, tents and temporary structures of the type used at outdoor events are prone to static electric charge build up during use. This can be uncomfortable if discharged through a person, though usually harmless. Further information is available in BS 5958-1 and also in PD CLC/TR 50404.

Static electricity build up should be prevented by provision of appropriate discharge links, enabling discharge to Earth through a high impedance.

If equipment prone to become charged with static electricity is supplied with power from a temporary electrical system, a static discharge link should be fitted; the CPC should not be relied on for this.

If a static discharge link is provided, the person responsible for the temporary system should ensure that the link is adequate for the duty it is to perform.

NOTE 2 A significant electrostatic charge can be retained on a conductor where the resistance to Earth is in excess of 1 MΩ. Generally, resistance between metals in good or fortuitous contact rarely exceeds a few ohms.

Reports of electric shock from static prone vehicles should always be investigated in case it is a result of an electrical fault at some point in the temporary electrical system.

Annex A (normative) Construction of distribution equipment or switchgear for temporary systems

NOTE 1 This British Standard gives recommendations on the use of specially designed distribution units and switchgear classified according to conditions of use and function. Annex A lists general recommendations applicable to such equipment. Annex B outlines the functions that might be included in such equipment and Annex D, Figures D.1, D.2 and D.3, show examples of use.

NOTE 2 This British Standard only gives the basic performance recommendations for construction; more detailed specifications can be found in the relevant international and national standards for design and construction .

A.1 General

All distribution units or switchgear used for the temporary electrical distributions described in this British Standard should conform to the design, construction and safety requirements of the appropriate standard in the BS EN 61439 series. Reference should also be made to BS 4363 and BS 7375.

The conductors used in all parts of the temporary distribution including those within ISUs, CDU, FDUs and similar distribution or control units should be arranged so that the conductors forming Line, Neutral and CPC at any particular circuit position all have the same cross-sectional area.

NOTE 1 This allows standard flexible cables and connectors to be used. The various distribution units that might be designed and built for use in temporary distributions have a consistent and predictable current rating. The use of undersized or oversized conductors at any particular circuit position removes this consistency and understanding.

*NOTE 2 For surge protection devices, see BS 7671:2008+A1:2011, Chapter **53**, Section **534**.*

A.2 Construction

Distribution units or switchgear intended exclusively for indoor use should provide protection conforming to not less than IP2X in accordance with BS EN 60529:1992+A2.

Distribution units or switchgear, having supplementary protection for outdoor use, should be constructed to provide not less than IP22 in accordance with BS EN 60529:1992+A2. Where supplementary protection is not provided, construction should provide not less than IP44.

NOTE Manufacturers may design equipment for any working environment provided the limits are clearly stated.

All units should be designed for free-standing use and should be stable without requiring fixing to supporting structures. A 25° tilt test should be performed if appropriate. Carrying handles and/or lifting points should be incorporated to allow safe handling.

Units should have adequate strength and durability for the severe use that might be experienced and should be of such material which does not propagate or spread fire.

A.3 Electrical construction

Exposed conductive parts should be connected to the incoming CPC.

NOTE 1 Provision may be made for connecting additional protective bonding conductors to the CPC if site conditions require.

Input and output connections should be by approved plugs and sockets from the range listed in **7.3.4,** Table 2.

Connectors on equipment should be arranged so that cables can be connected without risk of damage caused by bending or trapping.

Each sub-circuit of a distribution should have overcurrent protection as required by BS 7671:2008+A1:2011, Chapter **43**.

Wherever three-phase and neutral overcurrent protective devices are used in distribution units, they should be four-pole devices interlocked so that all poles open together and there should be overcurrent sensing on all four conductors.

*NOTE 2 This is to take account of the probability that there is a neutral current that is greater than any phase current due to harmonics and a lack of phase balance in temporary distributions used for the activities covered in this British Standard. See also **7.3.1** and BS 7671:2008+A1:2011, Appendix 4, **5.5**.*

All wiring and components should be rated for continuous use at full load. Line, Neutral and CPCs should be of the same cross-sectional area.

Electrical design should take account of the prospective short circuit current (PSCC) of the supply in accordance with BS 7671:2008+A1:2011, Regulation **313**.

All operating controls should be marked so as to be clearly visible in poor light.

Final circuits should have RCD protection with a rated residual operating current ($I_{\Delta n}$) not exceeding 30 mA and an operating time not exceeding 40 ms at a residual current of 5 $I_{\Delta n}$.

ISUs and CDUs should have RCDs with rating and delay suitable for their intended circuit position; these might be adjustable for trip rating and delay.

A.4 Single pole connector-cable combinations

Cables carrying the csa information on their sheath should be used for single pole cable-connector combinations. If this information is not present on the cable, then the csa should be marked on the cable.

NOTE 1 A simple visual inspection of a connector-cable combination might not provide clear evidence of its current rating. It is possible to have a connector-cable combination where the cable has a lesser current capacity than that of the connector.

*NOTE 2 Within the range of KSPCs that have been generally accepted as rated at 400 A, there are versions available that are rated up to 750 A and these have a general appearance that is essentially the same as a 400 A version. The manufacturers of these KSPCs can provide terminations within their connectors for cables of a variety of current ratings. For further information, see **3.36, 3.55, 7.3.4.2, F.3.5.3** and Figure F.1.*

Annex B (informative) Distribution equipment functionality

B.1 General

This Annex describes typical features that might be encountered within distribution equipment. The functions detailed may be combined or omitted. Examples of possible use are in Annex D, Figure D.1, Figure D.2 and Figure D.3, and the related commentary.

B.2 Intake switch unit (ISU)

An ISU provides the primary connection to the source of supply and can be used as the main control for the supply to the temporary distribution. Once the primary connection to the source of supply is secured, the ISU can be safely operated or left unattended. The ISU provides a means of isolation and switching as well as overcurrent protection on the incoming circuit. Socket outlets for outgoing circuits each with a means of disconnection, overcurrent and RCD protection (see Annex E).

Where appropriate, the features of an ISU are:

a) single pole or multi-pole input connectors are provided; (see **7.3.4.1**, Table 2);

b) all single pole input connectors are properly identified by colour and alphanumeric marking. The use of keyed single pole connectors (KSPC) is preferred (see **7.3.4.1** and **7.3.4.2**);

c) an external terminal is provided to connect to a local earth electrode or protective bonding conductor when required;

d) a main disconnector is provided which breaks all poles of the supply except for the CPC;

e) the main disconnector is lockable in the “off” position and provides clear indication of its state;

f) each outgoing circuit has overcurrent and residual current protection appropriate to the circuit duty; the RCD facility might be provided by devices with adjustable trip rating and time delay;

g) outgoing circuit connections are by single or multi-pole connectors (see **7.3.4.1**, Table 2);

h) a rating plate, giving input and output capacity and other data, is permanently fixed and clearly legible;

i) a means of indication is provided to confirm correct connection of line, neutral and circuit protective conductors; this might be provided by lamps, meters, etc.; for three-phase supplies a means to show the correct phase sequence needs to be provided;

j) meters are provided to monitor the temporary system, showing rms readings of voltage and current in line and neutral conductors. Provision might also be made for the monitoring of residual current;

k) means are provided to prevent unauthorized operation;

l) a means to prevent connection or disconnection while energized is provided for connectors not designed to be connected or disconnected on load;

m) provision is made for remote emergency disconnection.

B.3 Central distribution unit (CDU)

A CDU is used to subdivide and control supplies from an ISU or other central distribution units. It is often placed at a position more convenient for system operation. As a minimum, CDUs provide a means of switching and isolation as well as overcurrent and RCD protection on the outgoing circuits (see Annex E).

Where appropriate, the features of a CDU are:

a) input connections are by single pole or multi-pole connectors (linking outputs might be provided to supply other central distribution units), (see **7.3.4.1**, Table 2);

b) all single pole input connectors are properly identified by colour and alphanumeric marking, the use of keyed single pole connectors (KSPC) is preferred (see **7.3.4.1** and **7.3.4.2**);

c) an external terminal is provided to connect to a local earth electrode or protective bonding conductor when required;

d) a main disconnector is provided, which breaks all poles of the supply except for the CPC;

e) each outgoing circuit has overcurrent and residual current protection appropriate to the circuit duty. The RCD facility might be provided by devices with adjustable trip rating and time delay;

f) indicator lights are provided to show when outgoing circuits are energized;

g) clear identification of operational controls is provided;

h) a rating plate, giving input and output capacity and other data, is permanently fixed and clearly legible;

i) a means of indication is provided to confirm correct connection of line, neutral and circuit protective conductors. This might be provided by lamps, meters, etc.;

j) meters are provided to monitor the temporary system, showing rms readings of voltage and current in line and neutral conductors. Provision might also be made for the monitoring of residual current;

k) a means to prevent unauthorized operation is provided;

l) a means to prevent connection or disconnection while energized is provided for connectors not designed to be connected or disconnected on load;

m) provision is made for remote emergency disconnection.

B.4 Cable splitter unit (CSU)

A CSU provides means to split a supply cable to two or more loads where input and all output circuits are of equal current rating.

The features of a CSU are:

a) a rating plate, giving input and output capacity and other data, is permanently fixed and clearly legibly;

b) an indicator light to show when the unit is energized is provided.

NOTE Overload protection is provided by the upstream distribution unit and a means of isolation might not be provided.

B.5 Final distribution unit (FDU)

FDUs are used for final subdivision of output circuits to individual load circuits (these might be placed to optimize cable runs or for operational convenience). As a minimum, FDUs include overcurrent and residual current protection on all outgoing circuits, the rating of the RCDs not exceeding an operating current ($I_{\Delta n}$) of 30 mA and an operating time of 40 ms at a residual current of 5 $I_{\Delta n}$ (see Annex E).

The features of FDUs are:

a) the input and output connections are by multi-pole connectors, plugs and socket outlets (see **7.3.4.1**, Table 2);

b) an external terminal is provided to connect to a local earth electrode or protective bonding conductor when required;

c) each outgoing circuit has suitable overcurrent protection;

d) indicator lights are provided to show when outgoing circuits are energized;

e) clear identification of operational controls is provided;

f) a rating plate, giving input and output capacity and other data, is permanently fixed and clearly legible;

g) a means to prevent unauthorized operation is provided;

h) a means of indication is provided to confirm correct connection of line, neutral and CPCs. This might be provided by lamps, meters, etc.;

i) a key switch might be provided to allow RCDs to be bypassed. Such a key switch needs to have an indicator to show its state. The preferred arrangement is a system where the key switch operates bypass circuitry that automatically resets to the RCD protective state when the supply is removed;

j) meters to monitor temporary system, showing rms readings of voltage, current in line and neutral and residual current;

k) a means to prevent connection or disconnection while energized is provided for connectors not designed to be connected or disconnected on load;

l) provision is made for remote emergency disconnection.

B.6 Current-using equipment

Designers and installers need to ensure that distribution equipment has appropriate overcurrent and residual current protective devices for the application. Some current-using equipment, such as motor controllers, might require specific types of protective devices. Details of the electrical characteristics need to be sought from the manufacturers.

B.7 Indicator lamps and polarity verification devices

BS EN 60073 gives details of colours for indicators. The colours to be used to indicate the circumstances applicable to equipment covered in this British Standard are as shown in Table B.1.

Table B.1 **Indicator colours**

Colour of indicator	Meaning	Use in equipment covered by BS 7909
Red	Emergency or hazardous situation	Situation requiring immediate intervention, e.g. line–CPC reversal
Yellow	Abnormal situation	Used as a warning, e.g. some circuit testers
Green	Normal or safe condition	Indication of normal conditions, e.g. correct polarity, circuit live, RCD not bypassed [A)]
Blue	Mandatory, corrective action required	Indicates mandatory action is required, e.g. RCD is bypassed [A)]
White	No specific meaning assigned	Used to indicate normal active operation of a process [B)]

[A)] Where an RCD bypass facility is provided, a blue indicator shows the RCD is bypassed. The bypassed condition is not considered a normal state requiring an action to return the RCD to the normal active condition. A green indictor can be used to show the RCD is in the normal active condition.

[B)] Historically a white indicator has been used to indicate an RCD is bypassed but this does not conform to BS EN 60073, which is the reason for the revised statement in [A)].

It is important that indicators are clearly marked to denote their function. Faults or incorrect connections are not to create erroneous or contradictory indication.

B.8 Labels

Where appropriate, a label warning of the presence of 230 V or 400 V is provided on distribution units (see **7.13.3** and **8.15**).

Where a distribution unit is 25 kg or more a label stating its weight is attached.

Annex C (normative) Earthing arrangements and temporary systems

C.1 General

The senior person responsible for any temporary electrical system should understand the implications of the different bonding and earthing arrangements and the effects they might have, as the safe and effective protective bonding and earthing of temporary systems can be complex.

The senior person responsible should ensure that all protective bonding and earthing arrangements are suitable for the planned event, however, they might delegate work to others who have the duties of a person responsible for temporary systems or parts of such systems, or to others who possess suitable competence.

C.2 Electrical environment

An electrical environment is defined in **3.18**. A clear understanding of the concept of an electrical environment is very important where temporary systems are concerned and some further information is given here.

An electrical environment is very different to what was considered to be an "equipotential zone". BS 7671 requires that within an area having a permanent installation that all exposed-conductive-parts and extraneous-conductive-parts are connected to the main earthing terminal of the installed supply.

Any installed electrical distribution and its related current using equipment has the electrical characteristics and earthing arrangements of the supply being used. The area in a building with an installed electrical system is one electrical environment because the system's characteristics are effectively constant throughout the electrical installation. A temporary system entirely within the building and supplied from the installed system involves only that one electrical environment. A generator with any temporary system it supplies that is entirely outside such a building constitutes a different electrical environment. All the electrical characteristics of the system outdoors are obviously different from those of the installed system within the building. In different electrical environments, the difference in any of the electrical characteristics and particularly the difference in potential of earth referenced conductive parts should be recognized.

Temporary systems might involve more than one supply. The distribution might enter an electrical environment where the earthing arrangements in that vicinity are not the same as those of the supply being considered. Systems supplied from different sources might be simultaneously accessible and equipment might be interconnected through earth referenced signal cables or protective conductors. In these circumstances temporary systems introduce the possibility of differing potentials to the general mass of Earth and the risk of electric shock in both normal or fault conditions; circulating currents they produce can also degrade signals. These circumstances frequently occur with temporary systems and need to be carefully considered. Annex C deals with this and Annex D shows examples of some of the situations that might arise.

Some examples of different electrical environments include the following.

a) The electrical environment within one house is different from that in a neighbouring house – the phase position, the line voltage and potential of the earth system are likely to be different. The garden outside either house is a different electrical environment. If one of the installed systems is extended into the garden, the earth potential outside is not the same as the potential of the earthing arrangement indoors, particularly if the installed system is TN-C-S in form.

b) In a block of offices the electrical environment of one floor should be considered different from that on another floor as the potential of the earthing arrangements might not be the same and different phases might also be in use. A similar situation might apply to different areas within a factory or warehouse. It is safer to consider them as different electrical environments until it has been verified that their characteristics are the same.

c) A generator supplying an OB Unit, where all equipment is outdoors, with the supply taken to earth through an earth electrode, is a different electrical environment from that within an adjacent building which has a permanently installed electrical system supplied from the DNO. All aspects of these two supplies are clearly different. If a supply from the generator or earth referenced signal cables from the OB Unit are extended into the building, careful consideration is needed to avoid the risks of possible electrical shock or degradation of signals.

C.3 Earthing arrangements

The following issues should be fully considered and taken into account.

a) The earthing arrangements of the sources of supply that are used or might be associated with any temporary system should be determined. Sources of supply might be installed systems within a building or from generators, or occasionally directly from a DNO.

NOTE 1 For further information on DNOs see ***3.15****.*

b) The earthing arrangements and supply requirements of any electrical systems that are installed in mobile or transportable units should be taken into account. In some cases, mobile or transportable units might also be the source of supply for temporary systems extending from the unit.

c) An assessment should be made as to whether or not the main earthing terminal of a generator should be connected to the general mass of Earth by using a local earth electrode or the main earthing terminal of an installed system within a building, or both.

d) An assessment should be made as to whether or not an electrical supply from an installed system within a building that is used to supply mobile or transportable units should have a connection to the general mass of Earth by means of an additional earth electrode at each mobile or transportable unit (see BS 7671:2008+A1:2011, Section **717**).

e) It should be decided if any interconnections need to be made between the CPCs of temporary distributions that are derived from various sources of supply.

Information should be available to allow decisions to be made on the earthing arrangements of temporary systems so that the design is safe and suitable and that the setting-up and operation of such systems can be carried out safely and successfully. Consideration should be given for each temporary system and this should be based upon the system's details and the practical and environmental conditions that are present.

NOTE 2 The variety of alternative situations that might be created by each temporary system(s) means that no single solution can satisfy all cases.

Information should be obtained about all electrical systems and electrical environments that are present, associated with or adjacent to a temporary system and which might become involved through earth referenced conductive parts and signal cables. The presence of system-to-system standing potentials and the performance of protective earthing during fault conditions should then be assessed. Information should include whether the supplies are arranged as

TN-S, TN-C-S, TT, or IT and whether there are overhead or buried distribution cables in the vicinity.

NOTE 3 This annex endeavours to give some information on these matters. Where practicable, cross references are given from clauses in the main text of this British Standard to specific clauses in this annex.

C.4 Installed sources of supply and earthing arrangements

C.4.1 General

In the UK, installed electrical systems can be TN-S, TN-C-S, TT or IT. Each of these earthing arrangements has a different effect on how a temporary distribution should be designed, set-up and used.

Wherever practicable, the earthing arrangements of installed systems that might be involved should be determined before design or set-up work is started. It might be difficult and time consuming to confirm the earthing arrangements of an installed system but every reasonable effort should be made to obtain this information, particularly where an installed supply is taken outside the electrical environment of its source (see **7.2.1**, **7.4.2.4**, **8.6.2** and **9.7**).

C.4.2 TN-S

C.4.2.1 TN-S and permanent systems

NOTE 1 TN-S form of distribution to general domestic and other consumers.

*TN-S was historically a common arrangement. It is now rarely, if ever, used as a new distribution to consumers. Where existing TN-S distributions have been extended or repaired, this work has typically been carried out with concentric cables using a single conductor as the PEN. Those parts of the distribution down stream of the repair or extension then have electrical characteristics that approach those of a PME distribution. Consumers in this situation might not be aware of this change (see **C.4.3**).*

NOTE 2 TN-S systems within larger commercial, industrial, public or sports premises.

Where such premises have substation(s) whose output is dedicated to those premises, then the distribution is usually TN-S.

C.4.2.2 TN-S and temporary systems

NOTE A source of supply arranged as TN-S presents the fewest difficulties when used for any temporary distribution.

In any TN-S system, the integrity of the earthing arrangement can only be established by means of a formal test and the correct presence of each conductor should be verified.

Where a generator is the source of supply, the star point or neutral of the generator should be connected to the main earthing terminal of the generator unit; this is then a TN-S system (see **C.4.2.1**). The CPC of the temporary distribution should be connected to this main earthing terminal.

C.4.3 TN-C-S

The following commentary should be taken into consideration.

*COMMENTARY ON **C.4.3***

General

Electrical supplies arranged as TN-C-S are used for the majority of new premises that are not sufficiently large to warrant the installation of a dedicated substation. Many premises have installed electrical systems that are TN-C-S in form and this number is increasing. Such installations are supplied by a DNO from a main distribution that is TN-C in form and is known as PME.

There are two specific requirements related to TN-C (PME) main distributions:

- *A TN-C arrangement is not permitted in any consumer's installation according to the ESQCR, Regulation 8 (4) [3] and the Electricity Supply Regulations (Northern Ireland) 1991 [4].*
- *A DNO is not permitted to connect a combined neutral and protective conductor (CNE or PEN) to any metalwork of a caravan or boat, according to the ESQCR, Regulation 9 (4) [3] and the Electricity Supply Regulations (Northern Ireland) 1991 [4]. The implications of this regulation appear in BS 7671:2008+A1:2011, Sections **704**, **705**, **708**, **709**, **711**, **717**, **721** and **740**, where it might have specific relevance to temporary electrical systems.*

*While some DNOs place a label adjacent to their terminations at a consumer's premises stating that the installation is supplied from a PME source, this information is frequently not present (it should be stated on Electrical Inspection Certificate and/or PIR or EICR). In addition, those electrical systems that were originally in TN-S or TT form but have been specifically converted to TN-C-S, or have gained TN-C-S characteristics due to repairs or extension of main distributions, do not normally have any indication of their re-arranged format. The information might be available from the DNO (see **3.15**, Note 2). If it is not possible to verify what the earthing arrangement of a supply is, it is safest to assume that it is of TN-C-S form.*

Where an installed electrical system in a building is derived from a PME source this introduces some particular issues that need to be taken into account in the design, setting-up and operation of temporary electrical systems. These issues are as follows.

1. Open circuit PEN (PEN failure) in the distribution provided by the DNO

The effect on a consumer depends upon where the fault occurs, the loads connected in other parts of the main distribution network and the loading within the consumer's installation. When such a fault occurs, the CPC in a consumer's premises tends to rise in voltage towards the line voltage of the installation. This rise is mitigated to some degree by any additional connections to the general mass of Earth that might exist, by design or by fortuitous contact, at the consumer's premises.

Provided the temporary system is used only within the electrical environment of the building, the risk of electric shock is reduced because of protective bonding. However, where supplies from the installed system are taken outdoors or into another electrical environment, this introduces the possibility of electric shock. This is because there is a significant voltage between the CPC of the installed supply, the general mass of Earth (if outdoors) and the extraneous- and exposed-conductive-parts of the other electrical environment. This voltage can be between 100 V and 230 V. Note that in these circumstances an RCD does not offer protection from electric shock.

PEN failures are a rare occurrence but some of these have resulted in injuries. The circumstance is generally accepted as a low risk but the possibility does exist and this risk should be taken into account. (Further information is available in IET Guidance Note 5: Protection against electric shock [13].)

A PEN failure is a loss of neutral and gives an indication of its presence as equipment does not work correctly. During a PEN failure the voltage on the neutral moves towards the voltage of the most heavily loaded phase; conversely the voltage between neutral and the least heavily loaded phase increases. This means, for example, that equipment connected to the phase carrying the greatest load suffer an under-voltage so that motors might not operate correctly, filament lighting might appear as a slowly fluctuating "brown-out" and fluorescent and discharge lighting might not strike or might extinguish, etc. Equipment connected to the phase carrying the least load suffers an over-voltage so motors might speed up, lighting might be brighter and damage to equipment is likely due to the over-voltage. During a PEN failure the phase to neutral voltage fluctuations are significantly greater than the relatively minor fluctuations that typically occur in a correctly functioning power distribution due to changes in phase balance or the switching 'off' or 'on' of loads.

If a PEN failure is present the supply should not be used. If the failure occurs during use, temporary systems using this supply should be completely disconnected at source. In these situations, particularly where single-pole connectors are used, the CPC should be disconnected.

2. Earth referenced signal cables and PME supplies

As a TN-C-S supply is derived from a PME main distribution, certain characteristics from the PME distribution appear on the CPC of the installed system. At any point in a PME main distribution the PEN conductor carries the neutral current that results from the continuously varying loads connected along the length of the PME main distribution. Therefore, at any point, the PEN conductor has a varying voltage relative to the general mass of Earth. This might vary from 0 V to 12 V typically but could reach about 20 V without there being any fault on the main distribution. Within the electrical environment of the building, this is of little or no consequence. If the supply is used outside this electrical environment, the varying voltage on the CPC can create problems of electronic hum or noise on signals, further, the possibility of a touch voltage existing should be considered.

There are many possible ways in which such problems can occur. One in particular is the use of electronic equipment within buildings powered from the installed supply but connected through an earth referenced signal cable to other electronic equipment powered from an entirely different supply with a different CPC, thereby creating circulating currents in the reference conductors related to the signals being transmitted.

Sometimes it is not realized that a TN-C-S supply is being used for a temporary system that extends outside the electrical environment of the source. In such cases, the practical problems might be more associated with the smooth operation of the equipment and event than a possible PEN failure. These situations should be taken into account; careful consideration of them might also highlight potential safety issues that could otherwise have been missed. In these circumstances the use of Class II insulated equipment can be an advantage. Similarly the transmission of signals using a method independent of earth references such as fibre optics, or radio can be considered. Signal isolating devices can be used; if so their input-to-output insulation needs to be rated to withstand the highest voltage that could occur during a PEN failure. This depends upon the characteristics of the supplies involved, and insulation rating of 1 000 V covers the worst case peak-to-peak voltage that is likely to be experienced.

3. TN-C-S as installed in domestic and smaller commercial, industrial and similar premises

Such premises are usually constructed without the use of structural steelwork or reinforced concrete and do not have an earth electrode but have a conventional TN-C-S supply relying solely on the main earthing terminal provided by the DNO for the CPC and protective bonding. There might be some additional but fortuitous connection to the general mass of Earth resulting from protective bonding but this cannot be relied upon. The problems outlined in 1. and 2. exists where a temporary distribution is taken outside the electrical environment of the installed source. Similar problems exist if extraneous-conductive-parts are introduced into the electrical environment of the building. The use of the installed supply entirely within the building does not cause the problems outlined in 1. and 2.

4. TN-C-S as installed in larger commercial, industrial, public and sports premises

Premises that are constructed using structural steelwork or reinforced concrete that is in intimate contact with the ground through foundations might have additional earthing arrangements as a result of this form of construction.

*BS 7671 requires that all extraneous-conductive-parts, such as structural steel and reinforcement rods, are connected by protective bonding conductors to the main earthing terminal of the installed system. Additional earth electrodes might be provided and connected in this manner. This needs verification before use as older buildings might not have electrical installations to BS 7671:2008+A1:2011 (see **3.33**, Note 2). This additional earthing mitigates the effects of the problems outlined in 1. and 2.*

5. TN-C-S and temporary systems extending the supply outside the electrical environment of the installed source

a) TN-C-S source as described in 3.

Where the temporary system is supplied from a source as described in 3., the problems and safety issues that might be present need to be assessed.

b) TN-C-S source as described in 4.

Where the temporary system is supplied from a source as described in 4., the assessment of the problems and safety issues might become simpler due to the additional earthing that could be present.

c) TN-C-S source supplying a mobile or transportable unit

*BS 7671:2008+A1:2011, Section **717**, requires that someone of suitable competence is present to supervise the use of the supply and that the suitability and effectiveness of the earthing arrangements have been confirmed before connection is made [see d) and **7.4.2.4**].*

d) TN-C-S source, supplementary earth electrode for the temporary system

*If practicable, where a temporary distribution supplied from a TN-C-S source is used outdoors, then the correct deployment of an additional earth electrode in the vicinity of its use is of benefit as it assists in reducing the effects of a PEN failure. The placing of an electrode or metal plate under a wheel of a vehicle on hard standing is of no significant benefit [see c) and **7.4.2.4**].*

e) TN-C-S source, used in TT form

It is permitted to make connections to the line(s) and neutral only of a TN-C-S supply and provide a specific connection to the general mass of Earth by means of a separate earth electrode. The supply can then be used in TT form to serve the temporary distribution. This arrangement may not be undertaken without the proper agreements with the owners of the source of supply and of the area where the earth electrode is deployed; BS 7340 gives guidance on such arrangements.

The use of a supply in TT form brings the need for particular design requirements. This arrangement might not be suitable for one-off, short-term use but might offer a solution where a supply is needed on a regular basis over an extended period of time. In this situation, care needs to be taken to define and agree who is responsible for the earth electrode and its effectiveness as a connection to the general mass of Earth. It is likely to be the organization owning the electrode and its earthing terminal who are responsible.

C.4.4 TT

The following commentary should be taken into consideration.

COMMENTARY ON ***C.4.4***

Sources of supply arranged in TT form are most likely to be encountered in rural areas or villages. They are often associated with main distributions that are delivered by overhead cables. The DNO provide line(s) and neutral to a premises and the owner of the premises is responsible for the earthing arrangements, often provided by their own earth electrode characterized by the black "earth pit" box. Installed systems at premises in TT form have specific design requirements as set out in the appropriate regulations of BS 7671:2008+A1:2011, although older installations might not conform to the current requirements (see ***3.33****, Note 2).*

The use of a source verified to be of TT form to supply a temporary distribution does not create any specific problems other than the possibility that the earth fault loop impedance might be variable and not particularly good. The requirements for the use of RCDs at the source and at all socket outlets are given in BS 7671.

Historically, TT installations frequently used incoming metallic water pipes as the means of earthing. With the change to plastic pipes, occupiers of premises might have been warned to have the earthing arrangements checked, though they might or might not have taken heed of this warning. For this and other reasons, many installed systems that were initially TT in form have now been converted to TN-C-S. The owners or occupiers of such premises might or might not be aware of this re-arrangement and there is not normally any relevant information attached near to the incoming supply terminals (see ***C.4.3****).*

C.4.5 IT

The following commentary should be taken into consideration.

COMMENTARY ON C.4.5

*In the UK, the IT form of distribution is generally limited to medical areas such as operating theatres, intensive care areas and similar, where the electrical safety and continuity of the supply are of high importance. Supplies for temporary distributions can not be taken from such sources unless specific permission has been sought and given by a person with the competence to understand all the implications and the authority to give the permission [****8.13*** *and* ***6.3****, j)].*

It is known that some broadcast technical vehicles are arranged in IT form and it is possible that other mobile or transportable units have installed systems of this type. In such cases, care needs to be exercised in supplying or obtaining an electrical supply from such units. In addition, the interconnection of such systems resulting from earth referenced signal cables is to be avoided.

C.5 Generators as sources of supply and earthing arrangements

C.5.1 General

NOTE Generators are often used as sources of supply for temporary systems. They typically deliver 230 V single phase or 400 V three-phase and neutral, their outputs range from about 2 kVA up to several hundred kVA, many of the larger units have the ability to be synchronized together.

This ability allows a larger single source of supply to be created or to provide seamless back-up in the event of one generator failing. The generators might be freestanding, mounted on a transportable frame, or they might be mounted on a vehicle or trailer.

Some mobile or transportable units providing technical or other facilities are equipped with onboard generators.

There are several issues related to the connection of the output from a generator to the general mass of Earth. These should be carefully considered before connection.

C.5.2 The supply from a mobile or transportable generator

Generators should have one side of the single phase supply or the star point of a three-phase supply connected to the generator chassis, generator's main earthing terminal and to the metalwork of the vehicle chassis or the frame on which the generator is mounted.

The output from the generator should include a CPC that has the same cross-sectional area as each of the line and neutral conductors. In this arrangement the generated output is in TN-S form, whether or not the main earthing terminal is connected to the general mass of Earth.

C.5.3 Generated output that is not associated with another electrical environment

NOTE 1 This situation occurs when a generator supplies a temporary system where no part of the generator, the temporary distribution or the equipment involved enters any other electrical environment or comes into contact with or within 2.5 m of conductive material that is equipotentially bonded to a different electrical system. Examples of this are where the generator and the complete temporary systems are in a field or on a parade ground.

If two or more generators serve different temporary systems all within the same electrical environment, that are related to each other by proximity, conductive materials or earth referenced signal cables, the main earthing terminals of the generators should be connected together using cables sized according to BS 7671:2008+A1:2011, Chapter **54** (see **7.4.3**).

NOTE 2 In this situation the output from the generator(s) does not need to be connected to the general mass of Earth. Connection to the general mass of Earth might be made, but it is not a requirement.

C.5.4 Generated output that is associated with or enters another electrical environment

C.5.4.1 Generator outdoors supplying equipment within a building

NOTE A typical situation is where a generator outdoors supplies equipment that is within a building having an installed electrical system. There is a possibility of there being a touch voltage hazard between equipment supplied from the generator and conductive parts bonded to the installed system. There is also the possibility of casual contact occurring between the CPC of the generated supply and conductive parts bonded to the installed system.

C.5.4.1.1 Installed system is of TN-S or TT form

The earthing arrangements of the installed system should be determined. The Electrical Installation Certificate and/or PIR or EICR for the installed system should be consulted and verified and the point of connection to an appropriate earth terminal should be visually inspected. If all is satisfactory, the generator's main earthing terminal should be connected to the selected earth terminal of the installed system.

The connection of the generator's main earthing terminal to the general mass of Earth might be made, but it is not a requirement. The person responsible should assess whether such a connection is necessary (see **C.4.2.2** and **C.4.4**).

An assessment of the resulting situation should be taken into account.

C.5.4.1.2 Installed system is or is assumed to be TN-C-S

The earthing arrangements of a building's installed system should be determined. If the installed system is confirmed as TN-C-S, or is likely to be TN-C-S, the problems outlined in **C.4.3** could be present.

The Electrical Installation Certificate and/or PIR or EICR for the installed system should be consulted and verified and the point of connection to an appropriate earth terminal should be visually inspected. If all is satisfactory the generator's main earthing terminal should be connected to the selected earth terminal of the installed system.

The main earthing terminal of the generator should be connected to the general mass of Earth where reasonably practicable, as this helps to mitigate the problems outlined in **C.4.3**. The conductor used for the interconnection between the building and the generator's earthing terminal should be sized in accordance with BS 7671:2008+A1:2011, Chapter **54**. An assessment of the potential problems that might exist should be carried out.

C.5.4.2 Generator outdoors supplying equipment outdoors that is connected through earth referenced signal cables to equipment supplied from the installed system

NOTE In this situation a generator outdoors supplies a broadcast technical vehicle, for example, which is connected through earth referenced signal cables to equipment that is within the building. This equipment might be supplied from the broadcast technical vehicle or from the installed system within the building. In either case there is a possibility of there being a touch voltage hazard between equipment supplied through the broadcast technical vehicle from the generator and the building's installed systems or conductive parts bonded to the building's system.

C.5.4.2.1 Installed system is of TN-S or TT form

The arrangement outlined in **C.5.4.1.1** should be applied.

C.5.4.2.2 Installed system is of TN-C-S or assumed to be TN-C-S in form

The arrangement outlined in **C.5.4.1.2** should be applied.

C.5.4.3 Generator outdoors supplying equipment outdoors associated with other equipment outdoors that is supplied from the installed system of an adjacent building

NOTE This could be a marquee containing electrical or electronic equipment some receiving supplies from an outdoor generator and some using supplies from an installed source in an adjacent building. In this case there is a possibility of there being a touch voltage hazard between equipment supplied from the different sources.

C.5.4.3.1 Installed system is of TN-S or TT form

The arrangement outlined in **C.5.4.1.1** should be applied.

C.5.4.3.2 Installed system is of TN-C-S or assumed to be TN-C-S in form

The arrangement outlined in **C.5.4.1.2** should be applied.

C.5.4.4 Generator acting as an alternative to, or an augmenting supply to, an installed electrical system

NOTE 1 The practice of using a generator as a switched alternative to an installation at premises, or to augment such an installation by connection in parallel requires close liaison with the owners of the installed supply.

NOTE 2 The ESQCR set the requirements for this situation, see ESQCR Part VI, Regulations 21 and 22 [3] and the Electricity Supply Regulations (Northern Ireland) 1991 [4].

Generators acting as an alternative to, or an augmenting supply to, an installed electrical system should conform to BS 7671:2008+A1:2011, Section **551**.

NOTE 3 The use of a switched alternative supply of this type is unusual and augmenting by parallel connection to such installed systems is rare in relation to temporary systems covered by this British Standard. Where such arrangements are adopted, it is important that the fault protection, overload protection and the correct earthing arrangements of the supplies are understood and followed.

The most likely arrangement to be found for switched alternative supplies in temporary systems is associated with mobile units with electrical installations. This occurs where the mobile unit has an on-board generator and the ability to switch between this and an external supply from any source. In this case the mobile unit typically receives incoming line(s) and neutral only without the protective earth. This supply is connected to a transformer that provides an electrically separated output; this output is the switched alternative to the supply from the onboard generator. The person responsible for the mobile unit controls this switching and any specific arrangements that might be needed to ensure the protective earth of the incoming supply is not used and that the earthing arrangements of the onboard installation are correctly arranged.

C.5.5 Additional information about earthing generators

The person responsible should consider the relevant supplementary information within the Health and Safety Executive Information Document, *HSE OC 482/2 Electrical safety of Independent Low Voltage a.c. Portable and Mobile Generators and Connected Systems* [N7].

C.6 Earth electrodes used in a temporary system

C.6.1 General

In those instances where it is decided that a connection to the general mass of Earth is required, then an earth electrode should be used.

NOTE It might be that this connection is required to form the principle reference to the general mass of Earth for a temporary system, or it might be that it is acting only as a supplementary connection.

In either case an assessment should be undertaken, which considers the reasonable practicability of achieving suitably low impedance to the general mass of Earth to meet the requirement, balanced by the difficulty in achieving this under the conditions that exist at the particular site.

Earth electrodes should not be driven into ground where it is possible that underground distributions for any utilities might exist, piercing of such could be catastrophic (see *HSG47 Avoiding Danger from Underground Services* [15]).

C.6.2 Effective connection to the general mass of Earth

The relevant requirements of BS 7430:1998 should be adopted.

NOTE The practice of using three copper clad steel rod electrodes each at least 1 m long driven into the earth as far as reasonably practical and spaced at about 2 m apart in an equilateral triangle or L pattern may be used. If the electrodes cannot be driven vertically they might be driven at an angle between 90° and 30° to the horizontal. A measurement of their joint impedance to earth should be made according to BS 7430:1998. Ideally a Figure of less than 200 Ω for the combined resistance to Earth of the electrodes when connected in parallel should be achieved. However the nature and dampness of the soil material at the site has a significant effect of the value of this resistance.

C.6.3 Supplementary connection to the general mass of Earth

There can be instances where, in conjunction with an adequate earthing arrangement, it might be decided to use an earth electrode as a means of making a supplementary connection to the general mass of Earth. This might be for supplementary earthing of a generator, mobile or transportable unit or other parts of a temporary system. In these cases the temporary distribution should be connected to an earth reference at the source of supply, which is often an installed system in an adjacent building (see **C.4**).

NOTE There exists a practice of using a steel rod electrode 0.6 m long, driven into the ground in the vicinity of the generator, mobile unit or a convenient point in a temporary distribution where an earth terminal is available on a distribution unit. A single electrode of this type is unlikely to be as effective as the arrangement described in ***C.6.2****.*

Annex D (informative) Possible arrangements for temporary electrical systems

D.1 Introduction

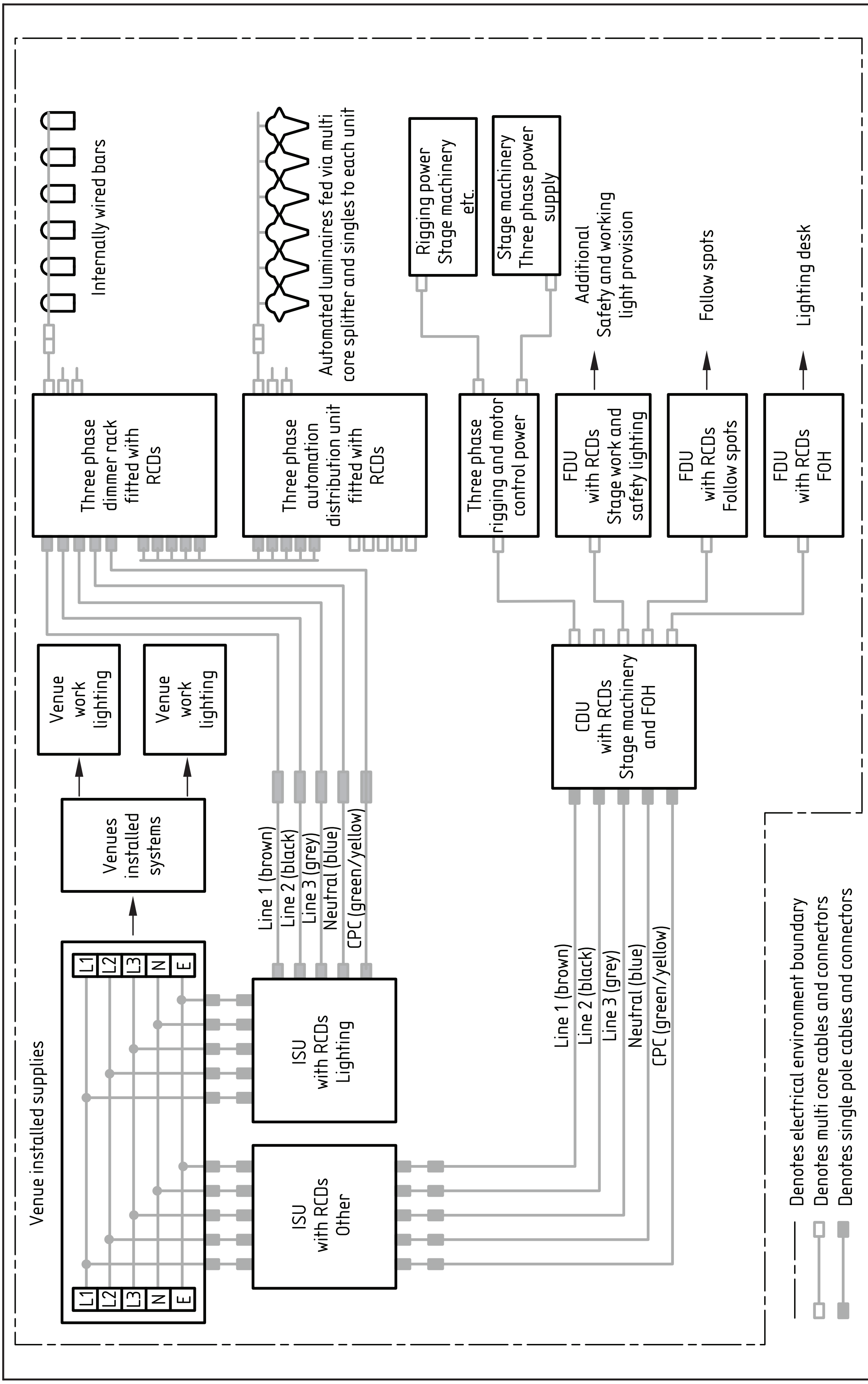
WARNING. The figures and commentary in this annex DO NOT and CANNOT cover every scenario or eventuality because it is not possible to cover all the permutations and configurations of supply, equipment and location that could occur. This annex can only illustrate how such matters can be addressed; the details of every set-up always needs to be fully assessed by the senior person responsible.

Figure D.1, Figure D.2 and Figure D.3 are examples of possible arrangements for temporary electrical systems that might serve different events. They are schematics only and are not intended to show any preferred method of creating a temporary system. The figures and commentary belong together and need to be used in conjunction with each other; they are not to be extracted and used separately. The primary purpose is to help those involved with temporary systems to consider what problems could arise and where they might exist.

Figure D.1 shows a temporary system that might be set-up for typical event, theatre or concert arrangements. It shows the temporary distribution units that could be used for such an event.

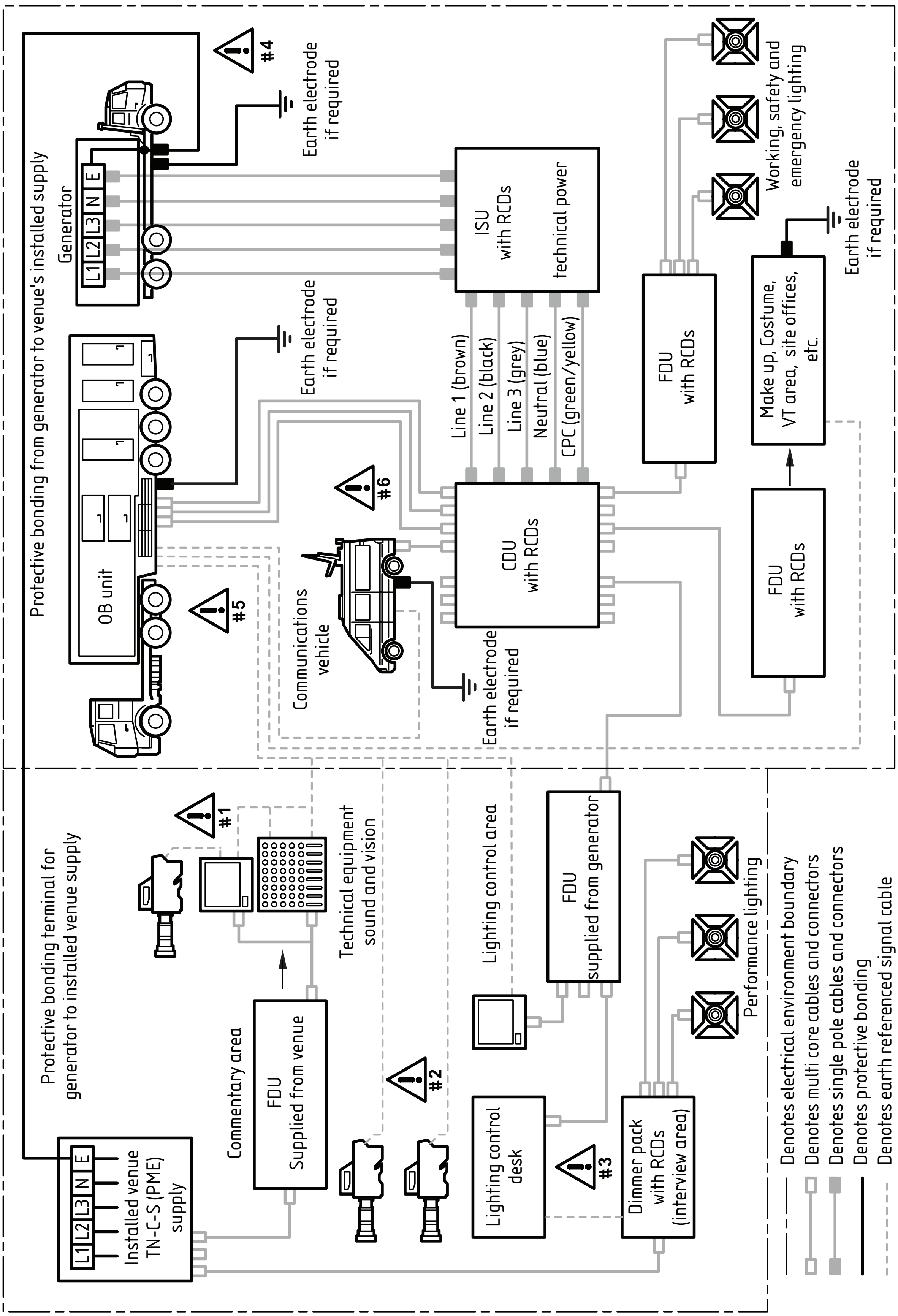
Figure D.2 and Figure D.3 show two or more electrical environments and help demonstrate some of the issues that could be encountered. Figure D.2 and Figure D.3 have numbered warning triangles added in certain places; these refer to the similarly numbered # subclauses in **D.4** and **D.5**. The triangles indicate areas where consideration needs to be given to the possibility of touch voltages being present and of circulating currents occurring in CPCs and earth referenced signal cables as a result of these. These effects and how they are dealt with need to be carefully considered for each set-up. The exact circumstances depends upon the temporary systems, the supply earthing arrangements and the equipment involved. There is no single solution that is best for all arrangements and the content of Annex C is important in this respect. Figure D.2 and Figure D.3 each show an installed system that is TN-C-S in form which is likely to create a more complex situation that needs careful consideration. Temporary systems that are, or involve, supplies that are TN-S or TT in form require similar consideration but are usually easier to deal with (see **C.4.2** and **C.4.4**). In **D.3**, **D.4** and **D.5** the commentary assumes that no faults exist; in **D.6** the situation in the presence of a fault is considered. References to possible ways of mitigating the effects of touch voltages are suggested at the end of **D.6**.

Figure D.1 **Temporary electrical system: typical event/theatre/concert arrangements**



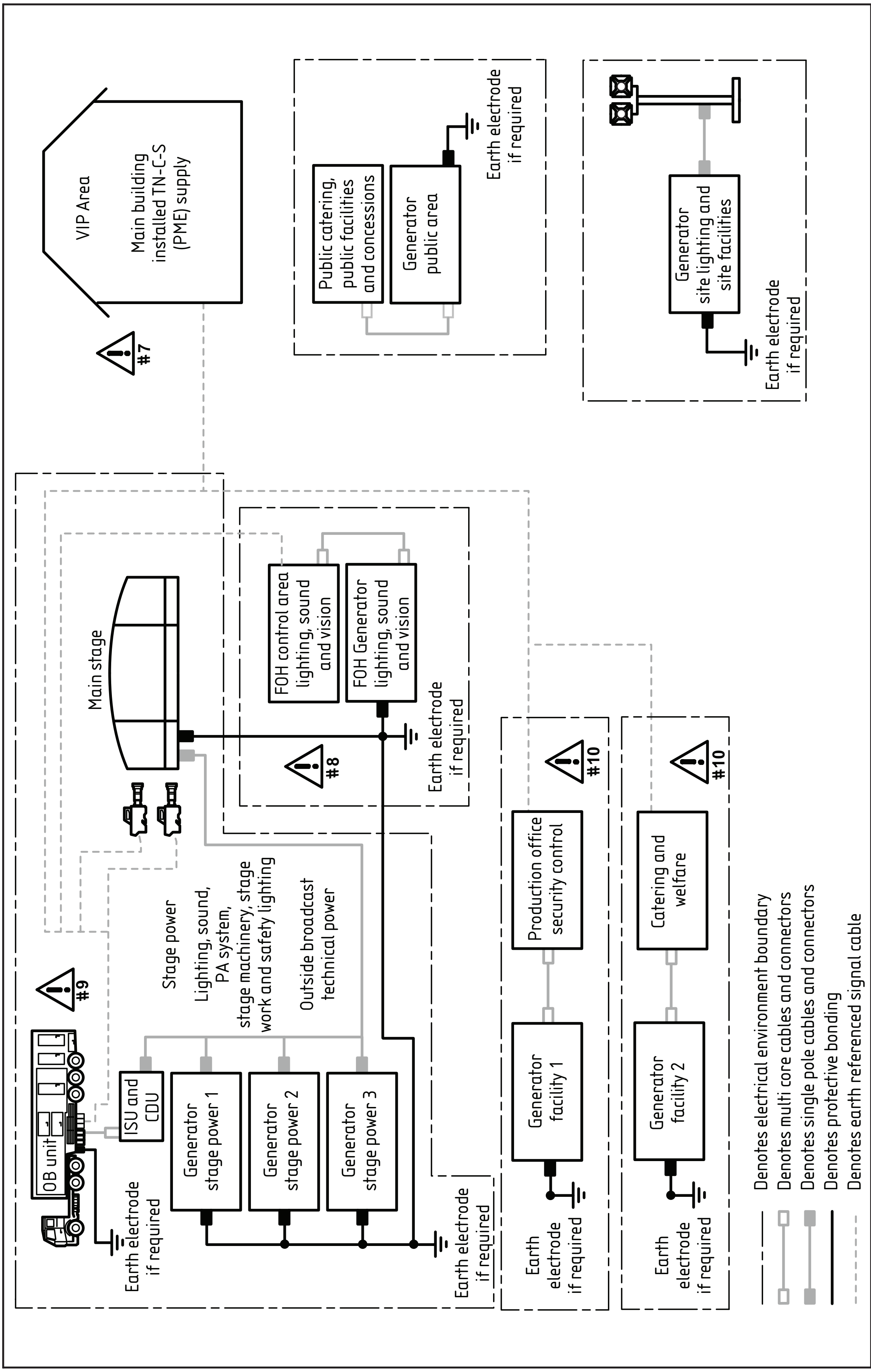
NOTE *For further details on Figure D.1 see **D.1** and **D.3**.*

Figure D.2 **Temporary electrical system: typical film/TV location**



NOTE *For more detail on the numbered warning triangles (e.g. #1) see **D.1** and **D.4**.*

Figure D.3 **Temporary electrical system: typical major event or festival**



*NOTE For more detail on the numbered warning triangles (e.g. #7) see **D.1** and **D.5**.*

D.2 Use of expressions

D.2.1 Touch voltages

In Figure D.2 and Figure D.3, the touch voltages that might exist are typically between 0 V and 12 V but could be as high as 20 V above the reference general mass of Earth without any fault being present [see **C.4.3**, commentary 2: "Earth referenced signal cables and PME supplies"]. Where such touch voltages exist, they might cause circulating current to flow in earth referenced signal cables or CPCs which in turn can degrade the signals being transmitted. Where this general situation is not present, the value of the touch voltage is stated. The presence of these conditions are indicated by the expression "touch voltage" in the following.

Where reference is made to "touch voltage" this is the potential between certain materials. The "touch voltage" might appear between:

- the exposed-conductive-parts of Class I equipment and exposed-conductive-parts or extraneous-conductive-parts of a venue's installed system; or
- any exposed-conductive-part and the general mass of Earth or extraneous-conductive-parts in contact with the general mass of Earth, this is dependent upon the exact situation being considered.

Where the "touch voltage" is indicated as being zero or very close to zero, the implication is that electrically, although not actually zero, it can be considered as zero. However, its magnitude might still be sufficient to cause circulating currents that might degrade signals being transmitted using earth referenced signal cables.

D.2.2 Earth

Note that the conductive general mass of the Earth is conventionally considered to have an electric potential at any point as zero.

D.3 Temporary electrical system, typical event, theatre or concert arrangement

Figure D.1 shows the use of a temporary system and distribution equipment for a typical event, theatre or concert arrangement. The installed system at the venue might have any of the earthing arrangements TN-S, TN-C-S or TT (see **C.4**). Provided all the equipment and temporary distribution remain within the confines of the venue building the issues as related to Figure D.2 and Figure D.3 are reduced. Although Figure D.1 shows a single electrical environment in a theatre or other venue it is possible that more than one electrical environment might exist. For instance, it is possible for the stage area and the front of house areas to be different electrical environments. Such information is needed at the design stage in order that all safety and technical requirements are fully considered.

D.4 Temporary electrical system, typical film/TV location

Figure D.2 shows the use of a temporary system and distribution equipment for a typical film/TV location. The installed system of the venue is TN-C-S in form, the generator supply is TN-S in form and is referenced to the general mass of Earth by means of an earth electrode.

There are two different electrical environments shown: one within the venue related to the installed system, the other outside the venue where the technical vehicles and other facilities are supplied from the generator. There are, however, two further electrical environments that are present but not specifically marked. These are the spaces within the OB Unit and communications vehicle.

Earth referenced signal cables are connected between the OB unit and technical equipment in the venue. Some equipment in the venue is supplied from the venue's installed system and some equipment is supplied from the generator. To minimize the "touch voltages" between CPCs of the installed system in the venue and the generated supply outside, the main earthing terminal of the venue is connected to the main earthing terminal of the generator (see **7.4.2.2**, **7.4.2.4**, **7.4.3**, **7.4.4** and **C.4.3**).

As the installed supply is TN-C-S in form, the main earthing terminal, in addition to earthing and bonding conductors and CPCs of the installed system, might easily have a "touch voltage" [see **C.4.3**, **2**)] when referenced to the general mass of Earth. Assuming that no faults are present, some typical examples of "touch voltages" and possible circulating currents in CPCs or earth referenced signal cables are outlined as follows.

NOTE Numbers #1 to #6 relate to the warning triangles shown in Figure D.2.

#1 The camera and associated technical equipment are supplied from the venue's installed system. Exposed-conductive-parts of Class I technical equipment is connected to the venue's means of earthing by CPCs.

a) With the main earthing terminal of the venue's installed supply connected to the main earthing terminal of the generator, then the "touch voltage" between the earth referenced signal cables involved and any exposed-conductive-parts or extraneous-conductive-parts within the venue is zero or very close to zero.

For the same reason there is no, or only a very small, circulating current in the earth referenced conductor of signal cables.

b) If the main earthing terminal of the venue is not connected to the main earthing terminal of the generator, a "touch voltage" might be present between the earth reference of the signal cables and the equipment when disconnected. With the signal cables connected to the equipment, a current might flow in the earth referenced conductors of the signal cables, possibly causing signal degradation.

#2 The two cameras are connected to the OB Unit through cables carrying earth referenced signals; such camera cables are complex and in addition to earth reference signals might also include a 230 V a.c. supply.

a) With the connection present between the main earthing terminals of the venue and generator the "touch voltage" between any Class I items of equipment, e.g. cameras, and exposed-conductive-parts and extraneous-conductive-parts within the venue is zero or very close to zero.

b) If the connection is not made, a "touch voltage" might be present between the cameras and conductive parts bonded to the venue's installed system.

#3 The lighting control desk and related monitor are supplied from the generator and the monitor is connected to the OB Unit through an earth referenced signal cable. The dimmers controlled by the lighting control desk are supplied from the venue's installed system.

a) With the connection present between the main earthing terminals of the venue and generator, the "touch voltage" between either the lighting desk or monitor and the dimmers (if Class I) or exposed-conductive-parts and extraneous-conductive-parts within the venue is zero or very close to zero. For the same reason there is no, or only a very small, circulating current in the earth referenced conductor of the signal cables associated with these items of equipment.

b) If the connection is not made, a "touch voltage" might be present between the lighting control desk and the dimmers (if Class I) and also conductive parts bonded to the venue's installed system.

#4 The generator and temporary distribution supplied from the generator shows that the generator might be earthed if required; in this case it has been earthed.

a) With the main earthing terminal of the venue's installed supply connected to the main earthing terminal of the generator a "touch voltage" might exist between the general mass of Earth and the generator's chassis/outgoing CPC including any earth referenced conductive parts in the outdoor electrical environment associated with the generator.

In this case it has been stated that the generator is earthed through an earth electrode; this helps reduce these "touch voltages", but it is unlikely to entirely remove them (see **C.2**, **C.3**, **C.4.1**, **C.4.3**, relevant parts of **C.5** and **C.6**).

b) If the connection is not made, it is likely that a "touch voltage" to the general mass of Earth from the generator's chassis and its outgoing CPC might still be present. This is due to the earth referenced signal cables connected between the venue's electrical environment and the OB Unit and communications vehicle, both of which are connected to the generator through the CPC.

#5 The OB Unit is supplied from the generator and is interconnected through earth referenced signal cables with equipment supplied from the venue's installation. The potential of the chassis of the OB Unit is affected by the CPC from the generator and the earth referenced signal cables from the venue. The OB Unit is also connected to the communications vehicle through earth referenced signal cables. Figure D.2 shows that this OB Unit may be earthed if required.

a) With the main earthing terminal of the venue's installed supply connected to the main earthing terminal of the generator the OB Unit's chassis is at some potential to the general mass of Earth [See #4 a)]. Therefore a "touch voltage" might be present between the OB Unit's chassis and the general mass of Earth and any earth referenced conductive parts in the outdoor electrical environment.

In this case it has been stated that the generator is earthed through an earth electrode (see #4 and its references). While it might not be necessary to connect the main earthing terminal of the OB Unit to the general mass of Earth, doing so helps reduce these "touch voltages".

Within the electrical environment inside the OB Unit "touch voltages" between earth referenced signal cables entering the OB Unit from other electrical environments and earthed exposed-conductive-parts within the vehicle is zero or very close to zero.

b) If the connection is not made, it is likely that the "touch voltage" is still present to the general mass of Earth from the Unit's chassis and its related CPC. This is due to the earth referenced signal cables from the venue's electrical environment connected to the OB Unit and then to the communications vehicle both of which are connected to the generator through the CPC.

Due to the earth referenced signal cables interconnected between equipment in the venue's electrical environment, the OB Unit and finally the communications vehicle, there might be places in the electrical environment within the vehicle that exhibit similar "touch voltages" between the signal cables and earthed exposed-conductive parts referenced to the CPC of the generator's supply. Detailed knowledge of the OB Unit's installed electrical system and signal routing is needed to assess the situation that exists.

#6 The communications vehicle is supplied from the generator and is interconnected through earth referenced signal cables with the equipment within the venue's electrical environment. In some cases this equipment is supplied from the venue's installed supply. Figure D.2 shows that the communications vehicle may be earthed if required. As shown, the communications vehicle is in a situation that is directly similar to the OB Unit in #5, to which reference ought to be made.

Communications vehicles can have some variations in their method of working. These variations change the possibility of "touch voltages" being present and their effects. The variations might be present singly or in any combination and they might include:

a) The use of the vehicle's on-board generator is likely to mean that the CPC of the circuit from the on site generator might not be connected to the communications vehicle. Detailed knowledge of the communications vehicle's installed electrical system is needed. If the CPC of the incoming supply to the vehicle is not connected to the vehicle then this removes one possible route for the introduction of "touch voltage" effects.

b) All signal transmission is achieved without using earth referenced signal cables. This removes one possible route for the introduction of "touch voltage" effects.

c) The vehicle has an external signal connection panel that is isolated from that vehicle's installed electrical system. If an earth referenced signal cable is connected to this panel there is the possibility of a "touch voltage" appearing at some place(s) within the vehicle. Detailed knowledge of the communications vehicle's installed electrical system and signal routing is needed to assess the situation that exists.

D.5 Temporary electrical system, typical major event or festival

Fig D.3 shows a temporary distribution, in simplified form (ISUs, CDUs, and FDUs are not shown), for a temporary system that might be used for a typical major event or festival. Several electrical environments are shown.

- Two are relatively simple with stand alone temporary systems (mid and lower right). These are shown as entirely separate electrical environments with their own generators. They are notionally separated by sufficient distance so that any casual interconnection or contact between exposed-conductive-parts within any other electrical environment is not possible. The generators are labelled "earth electrode if required". In this case the earth electrodes are not required, as each of the electrical environments is entirely separate (see **7.4.2.3** and **C.5.3**).
- One is a building (VIP area). It is assumed that the building (VIP area) has a correctly installed system that is TN-C-S in form.
- The FOH area has its own generator.
- The main stage and OB Unit area is one electrical environment supplied by three generators running synchronously.
- The facilities area (lower left, production offices and security control, catering and welfare) has two generators. They are shown as two electrical environments because although the generators share the same connection to the general mass of Earth, they are not synchronized and deliver supplies that are at varying voltage and frequency.

- The interiors of the OB Unit and VIP Area are each separate electrical environments but are not specifically shown.
- All the generators are labelled "earth electrode if required" (see **7.4** and **C.5**). Earth referenced signal cables are shown and are involved with most of the electrical environments.

NOTE Numbers #7 to #10 relate to the warning triangles shown in Figure D.3.

#7 Within the electrical environment of the VIP area there is sound, video and similar equipment all supplied from the installed electrical system. Signal connections are made through earth referenced signal cables connected to the OB Unit and other electrical environments outside the building. These signal cables introduce "touch voltages" and possible earth circulating currents between the signal cables and earth referenced parts within the building VIP area.

In this case, due to the physical distances involved external to the building, it is not always possible to ensure that the main earthing terminal of electrical supply within the building is connected to those of the various generators involved. In this case, the "touch voltages" therefore remain unless these signals are transmitted without relying upon earth referenced signal cables.

#8 The front of house (FOH) control area and the equipment present are supplied from a local generator that is labelled "earth electrode if required". As earth referenced signal cables connect the equipment in the FOH area with equipment in other electrical environments, the hazard is similar to that in #7. However, due to the smaller physical distance and number of signal cables involved, the preference is to connect the main earthing terminals of the associated generators with other related supplies and the stage structure. These interconnections are important (see **7.4** and **C.5**) and assist in minimizing and probably removing "touch voltages" that might be present.

At this position, the earth referenced signal cables that enter the FOH area are shown as associated with equipment within the VIP area that is supplied from a TN-C-S source. Therefore it is likely that the "touch voltages" outlined in #7 are present, however if the signals entering the building (VIP area) are not earth referenced then these "touch voltages" do not appear at the FOH area.

It is beneficial to connect the main earthing terminal of the FOH area generator to the general mass of Earth using an earth electrode.

#9 The main stage and OB Unit areas are supplied from three generators shown as synchronized together and having their main earthing terminals connected together. The generators are labelled "earth electrode if required". In the example it would be normal for these generators to be connected to the mass of Earth using earth electrodes and for them to have their main earthing terminals connected to the generator serving the FOH area in addition to protective conductors bonding the stage structure.

The generators also supply the facilities at the main stage area and the OB Unit. The OB Unit provides the technical facilities and is shown as providing earth referenced signals to various areas. The signal cables that serve the VIP area are associated with a TN-C-S system and the effect of the related earthing arrangements needs to be considered (see #7). Therefore, equipment supplied from this installed source introduces the possibility of there being a "touch voltage" to the rest of the temporary system between the protectively bonded conductive parts of the particular area and the earth referenced conductor of the signal cable. The provision of signals to the building (VIP area) using a transmission system that does not rely on earth references significantly simplifies the problems that might be experienced from "touch voltages" or the circulating currents that they might introduce.

The signal cables serving the facilities areas are entering electrical environments where the associated earthing arrangements are similar though not the same as those of the main stage and OB Unit area. Consequently the effects of "touch voltages" are less complex, but still require consideration.

The OB Unit is labelled "earth electrode if required". In this case, while not essential it could be beneficial to provide such a connection.

#10 The facilities area (lower left) is shown as two electrical environments each containing a generator serving the facilities which are production offices and security control as one unit and catering and welfare as another unit.

The generators serving the facilities area have their main earthing terminals connected together due to the close proximity of the two areas (such that casual contact or interconnection between exposed-conductive-parts of the two temporary systems could occur) and they are labelled "earth electrode if required". Here it would be beneficial for the earth electrode to be used.

The incoming signal cables are assumed to be earth referenced, therefore, if the signal cable serving the building (VIP area) in #7 is earth referenced, then there is the possibility of "touch voltages" existing between the protectively bonded conductive-parts within the facilities and the earth referenced conductor of the incoming signal cable. If the signal cables serving the building are not earth referenced, then because supplies serving the facilities area and the main stage areas and OB Unit are both referenced to the general mass of Earth through local earth electrodes, the possibility of "touch voltages" resulting from earth referenced signal cables entering the facilities units is low but not entirely removed. This is because the facilities generators and the main stage/OB Unit generators do not have their earth terminals interconnected.

D.6 Conditions with a fault present

D.3, **D.4** and **D.5** give an indication of the considerations needed regarding "touch voltages" when no faults exist. When a fault exists the implications of the touch voltages at different places are more significant.

Where permanently installed systems and temporary systems are correctly installed or set-up then the typical faults that result in an overcurrent or residual current in a circuit that is greater than the design allows for causes the appropriate circuit protective device to operate. Provided such systems are correctly designed and set-up, the touch voltages that might be present could rise to 50 V until the protective device operates.

In Figure D.2 and Figure D.3 the use of an installed system that is TN-C-S in form is shown. Though very rare it is possible for a PEN failure to occur in the TN-C-S supply involved. In this case significant risks of electric shock are created at all positions where touch voltages are indicated (see also Annex C generally and **C.4.3**, **C.5.4.1.2**, **C.5.4.3.2** and **C.6**). When a PEN failure exists, all those positions where a touch voltage of 0 V to 12 V or possibly as high as 20 V are indicated are likely to rise towards 230 V as described in **C.4.3**, **2**). These circumstances have to be understood.

The use of Class II equipment and signal transmission systems that do not rely on earth referenced signal cables all mitigate the situations indicated [see **C.4.3**, **2**)].

Annex E (informative) Residual current devices (RCDs): selection and use

E.1 What is an RCD and what does it do?

An RCD is a protective device used to automatically disconnect the electrical supply when an imbalance (the residual current) is detected between line and neutral conductors. The device normally operates when the residual current reaches a preset limit ($I_{\Delta n}$).

Residual current devices are primarily intended to give protection against the risk of dangerous (possibly lethal) electric shocks and to provide protection against fire hazards due to a persistent earth fault current, including:

a) fault protection (previously known as protection against indirect contact);

b) additional protection (previously known as supplementary protection against direct contact);

c) protection against fire.

An RCD does not provide overcurrent protection, which is usually provided by a fuse or a circuit-breaker. Combined RCDs and circuit breakers are available and are called RCBOs.

E.2 Types of RCDs

E.2.1 General

Table E.1 indicates the different types of RCDs available, a description of each device and examples of how the device is used.

Table E.1 **Types of RCDs**

	Type of RCD	Description	Usage/where used
RCCB	Residual current operated circuit-breaker without integral overcurrent protection	Device that operates when the residual current attains a given value under specific conditions	Distribution units of temporary systems Consumer units and distribution boards of installed systems
RCBO	Residual current operated circuit-breaker (RCCB) with integral overcurrent protection	Device that operates when the residual current attains a given value, and/or where an overcurrent occurs. Suitable for use by non-skilled persons	Distribution units of temporary systems Consumer units and distribution boards of installed systems. Devices are manufactured with overcurrent protection up to 125 A max.
CBR	Circuit-breaker incorporating residual current protection	Overcurrent protective device incorporating residual current protection. Devices have adjustable, residual and overcurrent protection, for use by skilled and instructed persons only	Distribution boards in larger installations, overcurrent protection typically 10 A to 6 000 A
SRCD	Socket-outlet incorporating an RCD	A socket-outlet or fused connection unit incorporating a built-in RCD	Often used to provide additional protection for the user
PRCD	Portable residual current device	A PRCD is a device that provides RCD protection for any item of equipment connected by a plug and socket. Often incorporates overcurrent protection	Plugged into an existing socket-outlet. PRCDs are not part of an installed system
SRCBO	Socket-outlet incorporating an RCBO	Socket-outlet or fused connection unit incorporating an RCBO	Often installed to provide additional protection for the user

E.2.2 RCD types AC, A, B and F

The following designations are recognized types of RCD.

a) Type AC RCDs provide residual sinusoidal a.c. current protection against a.c. earth fault currents. Type AC are suitable for many applications. Temporary systems of the type covered by this British Standard are frequently subject to a.c. with pulsing d.c. for which the Type AC RCD is unsuitable.

b) Type A RCDs provide residual current protection against a.c. earth fault currents that contain pulsating d.c. components. Type A are preferred for use with a wide range of electronic equipment used in temporary systems, supplying electronic equipment that can produce a protective conductor current with a pulsating d.c. component and harmonic currents.

c) Type B RCDs provide residual current protection against d.c. earth fault currents. They are suitable for use in the supplies for variable speed motor control where there might be a combination of residual currents containing d.c, pulsating d.c. and variable frequencies up to 1 kHz.

d) Type F RCDs provide residual current protection against pulsating d.c. currents and composite residual currents with rated frequency 50 Hz or 60 Hz intended for protection of circuits with frequency inverters supplied between phase and neutral or phase and earthed middle conductor taking into account the necessary features for these particular situations in addition to the cases covered by type A RCDs. Type F RCDs cannot be used where electronic equipment with double bridge rectifiers supplied from two phases is found or if a smooth d.c. residual current can occur.

E.2.3 Older installations with ELCBs

Historically, two basic types of earth-leakage circuit-breaker (ELCB) were available: the familiar current-operated type and the earlier voltage operated type. The voltage-operated types were unreliable and, if they are encountered, additional RCD protection needs to be used.

NOTE The voltage-operated device can be distinguished by its two separate earthing terminals – one for the connection of the earthing conductor of the installation and the other for a connection to a means of earthing. Such devices were often used on installations forming part of a TT system where the means of earthing was an earth electrode. The major drawback with the voltage-operated ELCB is that a parallel earth path can disable the device.

E.2.4 Recognized standards for RCDs

RCDs are manufactured to the current International, European and British standards and these are shown in Table E.2. An RCD found in an older installed system might not provide protection in accordance with current standards.

Table E.2 **RCD standards**

Standard	Title
BS 7071:1992	Specification for portable residual current devices
BS 7288:1990	Specification for Socket-outlets incorporating residual current devices (s.r.c.d's)
BS EN 60947-2:2006+A1	Low-voltage switchgear and controlgear – Part 2: Circuit-breakers
BS EN 61008-1:2004 [A)]	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) – Part 1: General rules
BS EN 61009-1:2004	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) – Part 1: General rules
IEC 62423:2009	Type F and Type B residual current operated circuit-breakers with and without integral overcurrent protection for household and similar uses

[A)] BS EN 61008-1 supersedes and replaces BS 4293:1983, which is withdrawn.

E.2.5 Characteristics of RCDs

RCDs are defined by three main characteristics, which are as follows.

a) The rated current carrying capacity of the device in amperes (I_n).

b) The rated residual operating current of the device in amperes ($I_{\Delta n}$).

c) Whether the device operates instantaneously or incorporates an intentional time delay to permit discrimination. Devices having a time delay are known as Selective (S) (referred to as S-type).

Devices are manufactured with different values of rated current I_n and rated residual operating current, $I_{\Delta n}$. Rated residual operating currents for devices generally fall into a range between 10 mA and 2 A. Some devices permit adjustment of the rated residual operating current. Any adjustment method or mechanism should not be accessible to ordinary, non-skilled or non-instructed persons (see BS 7671:2008+A1:2011, Regulation **531.2.10**).

It is important to note that the range of residual operating currents that causes the operation of a correctly performing RCD is 0.5 $I_{\Delta n}$ to $I_{\Delta n}$, but it is important that it does not operate at any residual current from 0 up to 0.5 $I_{\Delta n}$ (see **E.4** for performance testing and **E.3.2** to minimize the possibility of unwanted operation).

E.3 Applications

E.3.1 General

A single RCD should not be used on its own to protect an entire distribution. Section 314 of BS 7671:2008+A1:2011 warns against designing a system where a single protective device removes a supply from an entire distribution where the loss of power might create hazards. Section 314 requires that a system should be divided into subsidiary circuits each with appropriate protection, so that no hazard is created in other parts of the system as a result of a fault in a sub-circuit.

The correct device has to be selected for the particular application. Choosing the wrong device could have serious consequences and could result in electric shock or fire.

Table E.3 gives examples of particular applications of RCDs and includes references to the relevant Regulations in BS 7671:2008+A1:2011.

Table E.3 **RCD applications**

RCD, $I_{\Delta n}$	**Common applications**	**BS 7671:2008 +A1:2011**
10 mA	Where more sensitive protection is required, a 10 mA device may be used.	**415.1**
30 mA	Portable equipment has to be protected by an RCD with a rated residual operating current not exceeding 30 mA.	**411.3.3** **415.1**
	Socket-outlets used by performers, musicians and entertainers. Street market stalls are often protected by 30 mA RCDs.	**415.1**
	Final circuits of temporary distributions are protected by 30 mA RCDs.	**415.1** **711.411.3.3**
100 mA	For an installation forming part of a TT system, a 100 mA RCD could be found at the origin. A time-delayed or 100 mA S-type (or selective) device is often used to permit discrimination with a downstream device.	**314.2** **531.2.9**
	May be used in CDUs and ISUs. Often S-type 100 mA devices to achieve discrimination.	**411.3.2** **531.2.9**
300 mA	Protection against the risk of fire.	**532.1**
	May be used in CDUs and ISUs. Often S-type 300mA devices to achieve discrimination.	**411.3** **411.3.2**
	At exhibitions, shows and stands, where there is increased risk of damage to cables, distribution circuits need to be protected by an RCD with a residual operating current not exceeding 300 mA.	**711.410.3.4**
Adjustable ≤ 2 000 mA	Devices with an adjustable residual operating current or time delay are used for specific applications, such as sources of supply, ISUs and CDUs.	**531.2.10**

E.3.2 Unwanted operation

To help prevent unwanted operation of RCDs, the electrical circuits may be subdivided and protected by an RCD with a rated residual operating current four-times greater than the expected quiescent CPC current (see BS 7671:2008+A1:2011, Regulations **314.1** and **531.2.4**).

E.3.3 Discrimination

Where two or more RCDs are connected in series, discrimination needs to be provided to prevent danger (see BS 7671:2008+A1:2011, Regulation **531.2.9**). During a fault, discrimination is achieved when the upstream device nearest to the fault operates and does not affect other upstream devices.

Discrimination is achieved when S-types are used in conjunction with downstream general type RCDs. The S-type has a built in time delay and provides discrimination by simply ignoring the fault for a set period of time, allowing more sensitive downstream devices to operate and remove the fault.

For example, to provide discrimination where two RCDs are connected in series, the RCD nearest the source needs to be an S-type. RCDs incorporating time delays are not to be used for a final circuit or to provide protection for persons and livestock.

E.4 Testing

E.4.1 General

The effectiveness of the RCD has to be verified by a test simulating an appropriate fault condition and independent of any test facility, or test button, incorporated in the device (see BS 7671:2008+A1:2011, Regulation **612.10**). This performance verification is usually carried out by the equipment supplier prior to being delivered to site.

Where an RCD of 30 mA provides additional protection, the operating time may not exceed 40 ms at a residual current of 5 $I_{\Delta n}$ (see BS 7671:2008+A1:2011, Regulation **415.1.1**).

Tests are made on the load side of the RCD between the line conductor of the protected circuit and the associated CPC. Any load or appliances need to be disconnected prior to testing. RCD test instruments require a few milliamperes to operate; this is normally obtained from the line and neutral of the circuit under test. When testing a three-phase RCD protecting a three-wire circuit, the instrument's neutral is required to be connected to earth. This means that the test current is increased by the instrument supply current and causes some devices to operate during the 50% test possibly indicating an incorrect operating time. Under this circumstance it is necessary to check the operating parameters of the RCD with the manufacturer before failing the RCD.

E.4.2 Range of tests

To ensure the RCDs perform to specification, the following tests in Table E.4 are the minimum to be carried out.

Table E.4 **Test criteria**

Device	Instrument test current setting	Satisfactory result
RCD protected socket-outlets to BS 7288 and portable RCDs to BS 7071	50% of operating current 100% of operating current	Device does not operate Device operates in less than 200 ms. Where the RCD incorporates an intentional time delay it trips within a time range from 50% of the rated time delay plus 200 ms to 100% of the rated time delay plus 200 ms.
General purpose RCCBs to BS EN 61008-1 or RCBOs to BS EN 61009-1 and RCCBs and RCBOs to IEC 62423	≤50% of operating current 100% of operating current	Device does not operate Device operates in less than 300 ms unless it is of S-type, which incorporates an intentional time delay. In this case, it trips within a time range from 130 ms to 500 ms.
Additional protection $I_{\Delta n}$ ≤30 mA	Test current at 5 $I_{\Delta n}$ The maximum test time may not be longer than 40 ms, unless the protective conductor potential does not exceed 50 V. (The test instrument supplier advises on compliance.)	Device operates in less than 40 ms.

E.4.3 Test button (T button)

A test button is incorporated in each RCD. This device enables the mechanical parts of the RCD to be verified by pressing the button marked T or Test. This does not prove that the RCD is operating to specification.

E.5 Test instrument

The test instrument used to test RCDs needs to be capable of applying the full range of test current to an in-service accuracy, as given in BS EN 61557-6. This in-service reading accuracy includes the effects of voltage variations around the nominal voltage of the tester. To check RCD operation and to minimize danger during the test, the test current needs to be applied for no longer than 2 s. Instruments conforming to BS EN 61557-6 fulfil the above requirements.

E.6 Measuring earth fault loop impedance on a circuit with RCD protection

The test (measuring) current of an earth fault loop impedance test instrument might trip any RCD protecting the circuit. This prevents a measurement being taken and might result in an unwanted disconnection of supply to the circuit under test. Instrument manufacturers can supply loop test instruments that are less liable to trip RCDs. There are two common techniques as follows.

a) Limited current type

Some instruments limit the test current to below 15 mA. This means that RCDs with a rated residual operating current of 30 mA and greater do not trip.

b) d.c. biasing the RCD

Some loop testers use a d.c. biasing technique to saturate the core of the RCD prior to testing so that the test current is not detected. This technique can usually be expected to be effective for both type AC and type A RCDs.

NOTE For type AC RCDs operation is ensured for residual sinusoidal alternating currents. For type A RCDs operation is ensured for residual sinusoidal alternating currents and for pulsating direct currents.

Alternatively an RCD could be removed from the circuit for the duration of the test.

For instruments used to measure earth fault loop impedance, the requirements are given in BS EN 61557-3.

Annex F (informative) Supplies provided for temporary distributions at venues

F.1 General

This Annex outlines principles to be adopted when providing installed sources of supply that can be used by temporary electrical distributions. Following these principles can minimize the most commonly encountered problems.

F.2 Principle issues related to temporary distributions

Typically equipment used in the entertainment and related industries can introduce problems that are not found to the same degree in installed electrical systems of premises. Particular issues that need to be taken into account are as follows.

a) A supply is often provided to electrical systems in vehicles (mobile and transportable units).

b) Equipment used can cause high protective conductor currents.

c) There can be a significant quantity of triplen harmonic current created that adds in the neutral of three-phase systems.

d) Three-phase temporary distributions might have a significant lack of phase balance.

e) There can be significant inrush currents and waveform distortion caused by motors, air conditioning units, luminaires, power-processing and similar equipment supplied by the temporary distribution.

F.3 Installed source of supply for temporary distribution at venues

F.3.1 General

Venue owners need to decide what events are to be hosted so that the type and capacity of supply can be defined.

NOTE Historically, the supply provided by a venue has often been insufficient to meet all the needs of a visiting event seeking a supply for a temporary system.

A venue owner might decide to offer two or more sources of supply for temporary distributions that are installed at physically separate places at the venue. Ideally, each source of supply needs to have been derived from the same primary source within the venue's permanent distribution and have directly comparable electrical characteristics. Due consideration of this would be helpful as it might affect the temporary distributions set-up by an event if supplies are taken from each source. It might be that the supplies available at each place do not have the same electrical characteristics. Information about such circumstances needs to be available (see **F.4**).

F.3.2 Venue representative

It is important that a person is appointed to represent the venue and that they are competent to work with visiting organizations on all electrical matters and has a good working understanding of this British Standard.

F.3.3 Earthing arrangement

The source of supply for a temporary distribution can be TN-S, TT or TN-C-S. The preferred form is TN-S. If a supply is TN-C-S, it is important that underground structural metalwork embedded in foundations is connected to the main earthing terminal of the venue's installed system. It is also important that any other additional earth electrodes, such as mats, rods or similar, are connected to the main earthing terminal to minimize the possible effects of a PEN failure. For TN-S or TT systems, such additional measures would also be beneficial.

F.3.4 Conductors supplying an installed source for temporary distributions

The neutral conductor of the installed distribution to the source of supply for a temporary distribution needs to be at least of the same cross-sectional area as each of the line conductor(s). Consideration needs to be given to the potential lack of balance in three-phase supplies and the additive effect of triplen harmonic currents in the neutral conductor.

The CPC needs to be at least of the same cross-sectional area as each of the line conductor(s) so that the possibility of high protective conductor currents can be catered for most effectively and to provide as low a value of earth fault loop impedance as reasonably practicable.

F.3.5 Method of connection to a venue's installed source

F.3.5.1 General

Connection of a temporary distribution to a venue's installed supply might be to a switched fuse or to connectors (see **7.3.4.1**, Table 2). The use of connectors is preferred; connection of a temporary distribution to busbars is not preferred.

The venue owner might wish to retain control over the switching and connection of temporary distributions whether by switched fuse or connectors. This decision might affect the detail design of the source of supply and/or its enclosure.

F.3.5.2 Switched fuse as the means of connection

A switched fuse where the fuse rating can be selected to suit the temporary distribution is acceptable; in this case, the temporary distribution is connected to the terminals of a switched fuse by using open-tails.

F.3.5.3 Connectors as the means of connection

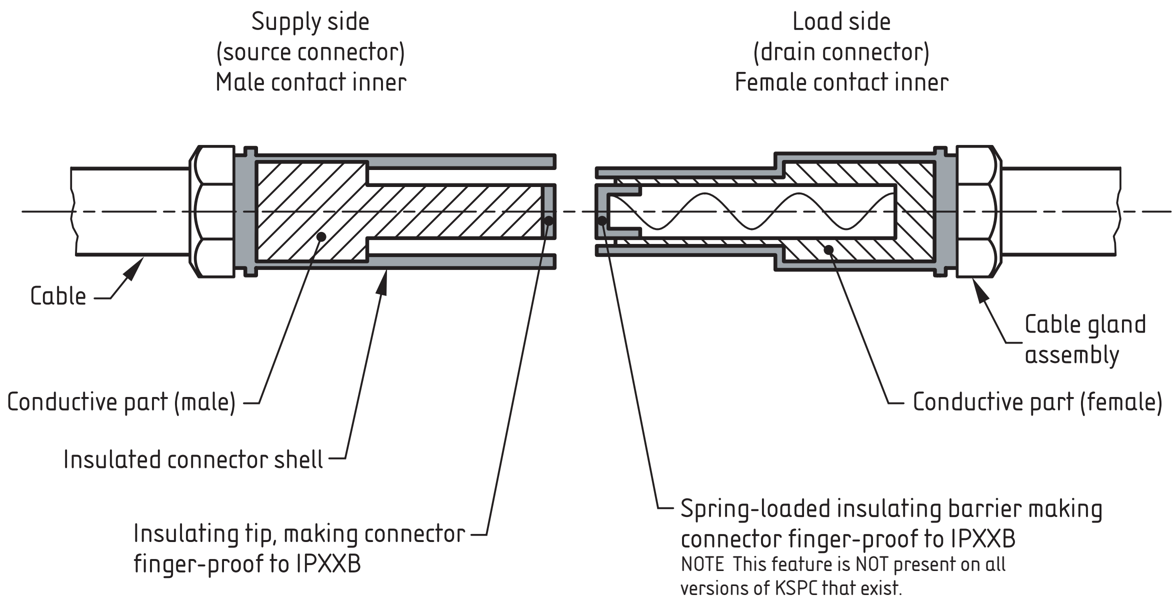
Where installed connectors are offered as the means of connection it is preferable that these are to **7.3.4.1**, Table 2.

Where a supply of 16 A to 125 A is required, the socket outlets have the appropriate rating: see BS EN 60309-2 (referred to as Ceeform in this annex).

Where a supply of over 125 A is required, it is to be provided by keyed single pole connectors (KSPC), having keyed mating arrangements that are compatible for their circuit position. These are to be coloured and carry alphanumeric markings according to BS 7671:2008+A1:2011, Table 51 (a.c. circuits). Where these types of single pole connectors are used at the source of supply, the source connectors are to be of the panel mounted shuttered type that only permit connection in the order Protective Conductor, Neutral, Line 1, Line 2 and Line 3, and disconnection in the reverse order.

*NOTE KSPCs are unusual as the contact part of the supply-side connector has a "male" appearance and the contact part of the load-side has a socket or "female" appearance. All supply-side (male contact) KSPC connectors need to pass an IPXXB finger test (see BS EN 60529). The load-side (socket/female contact) KSPC connectors exist in two versions, one version satisfies IPXXB and the other does not (see Figure F.1). Several different manufacturers make these connectors and they are available in panel mounting and cable coupling forms. The terms "male" and "female" relate to the electrical contact sense and not to the shape of the insulating shells. KSPCs are also mentioned in **3.36**, **3.55**, **7.3.4** and **A.4**.*

Figure F.1 **Typical section of a keyed single pole connector (KSPC)**



NOTE Connectors are also available in panel mount form.

The venue owners or occupiers might choose to have a selection of connectors at different ratings each with its own appropriate circuit protective devices. This depends on how the venue owners choose to operate and the nature of the events that might be hosted.

F.3.5.4 Circuit protective devices

Overcurrent protection needs to be suitable for the rating of the connector and cable provided. Single-phase supplies fitted with circuit-breakers would normally be double-pole devices unless another means of isolation is provided. Three-phase supplies would normally be four pole devices with overcurrent sensing on all poles (see Table F.1).

*NOTE 1 In a temporary distribution connected to a venue's supply, the first distribution unit is an intake switch unit (ISU) as detailed in **B.2**.*

Any RCD provided at the source of supply for a temporary distribution needs to take into account the variable nature of the loads that might be connected, as high protective conductor currents might be present; an ill chosen RCD might render the circuit unusable. Any RCD installed needs to be able to operate correctly on a.c. waveforms that contain harmonics and d.c. components. The ratings and time delay of RCDs need to be selected with care; it might be beneficial to consider using RCDs with adjustable residual operating current rating and time delay. Where RCDs are provided, they need to break line(s) and neutral (see Table F.1).

NOTE 2 The temporary distributions that are to be supplied from such positions contain RCDs of suitable rating for their duty and circuit positions.

F.3.5.5 Additional earth terminal for temporary distributions

An additional earth terminal is needed at each position where a source of supply is offered. This is to enable the connection of protective conductors and for connection to the main earthing terminal of any generator(s) that might be associated with the event. The terminal and associated protective conductor needs to be sized to match the maximum current capacity of the source of supply at that position (see **F.3.4**).

F.4 Information and labelling of sources of supply

Persons responsible for temporary electrical distributions that might take a supply from a venue's installed source are likely to request evidence that such a source of supply is in good order. They might also ask for details of the supply's electrical characteristics and wish to see the Electrical Installation Certificate, PIR or EICR.

If there are two or more physically separate places where temporary distributions might be connected to a source of supply, then this information needs to be made available (see **F.3**).

A label needs to be provided adjacent to the source of supply for temporary distributions stating the characteristics of the supply. See Figure F.2 for an example of the label and the details required. Where there are two or more sources of supply in physically separate places the labels on each need to indicate the presence of the others and how the related electrical information might be obtained.

Figure F.2 **Example of label for sources of supply**

Location or reference of this supply:	
Location of supply distribution board/circuit number:	
Voltage (U_0):	V
Number and type of line conductors:	1 phase 2 wire ☐ 3 phase 4 wire ☐ Other ☐ (state)
Supply earthing arrangement:	TN-S ☐ TN-C-S ☐ TT ☐
Prospective short circuit current:	kA
Earth fault loop impedance (Z_e):	Ω
Overcurrent device at origin of this supply:	Type: Rating:
Max. current available (per line):	A
RCD:	Type: Rating: Delay:
Title and contact details for person responsible for the venue's electrical matters:	

F.5 Power rating versus circuit breaker and RCD rating

Table F.1 shows RCD ratings for appropriate discrimination in conjunction with circuit breakers within the temporary distribution.

The RCD rated residual operating current needs to be at least four times greater than the expected quiescent CPC current.

Table F.1 **Connectors, circuit breaker and RCD ratings at the venue**

Socket outlet size and type	Circuit breaker rating	RCD sensitivity $I_{\Delta n}$
400 A Single Pole types (three-phase, neutral and CPC)	400 A four pole	3 A (S-type) [A)]
125 A red Ceeform (three-phase, neutral and CPC)	125 A four pole	1 A (S-type) [A)]
63 A red Ceeform (three-phase, neutral and CPC)	63 A four pole	300 mA (S-type) [A)]
32 A red Ceeform (three-phase, neutral and CPC)	32 A four pole	30 mA [A)]
16 A red Ceeform (three-phase, neutral and CPC)	16 A four pole	30 mA [A)]
400 A Single Pole types (one-phase, neutral and CPC)	400 A double pole	3 A (S-type) [A)]
125 A blue Ceeform (one-phase, neutral and CPC)	125 A double pole	1 A (S-type) [A)]
63 A blue Ceeform (one-phase, neutral and CPC)	63 A double pole	300 mA (S-type) [A)]
32 A blue Ceeform (one-phase, neutral and CPC)	32 A double pole	30 mA
16 A blue Ceeform (one-phase, neutral and CPC)	16 A double pole	30 mA

[A)] This may be replaced by an RCD with appropriate adjustable residual operating current and time delay to meet the range of possible settings that might be needed.

Annex G (normative) Inspection, testing and certification

G.1 General

*NOTE This annex gives the recommendations for inspection and testing. For small/simple systems, these are covered in **5.5** to **5.7** and are summarized in **G.2**; for large/complex systems these are covered in Clause **9** and are summarized in **G.3**. The Annex also provides samples of Completion Certificates, Schedule of Test Results and Confirmation of Electrical Completion.*

Each time any temporary electrical system is set-up for an event, it is classed as a new system and should be verified accordingly.

As a minimum the simplified inspection and testing routines in this British Standard should only be carried out where the following applies:

a) all the equipment has been designed and constructed for the purpose, is in unit form and has been connected together to form the temporary system required (see **4.5**);

b) equipment suppliers have ensured the equipment is safe for use, which is normally done by carrying out a formal inspection and test of all electrical equipment prior to delivery to site (see **4.5**);

c) the responsible person on site has ensured equipment selected for use is visually checked for damage, is suitable for the intended purpose and is within a valid period having passed a formal inspection and test, prior to connection into the system;

d) the nature of the supply has been verified as being suitable for the event;

e) the calibration of any test equipment used should be regularly verified so that it is known to be operating to its specification.

Where any part of a temporary system is fabricated on site or items a) to e) are not met, such parts should be tested in accordance with BS 7671 or *IEE Code of Practice for in-service inspection and testing of electrical equipment* [N3] as appropriate.

G.2 Small/simple temporary electrical systems

G.2.1 General

NOTE Small/simple temporary electrical systems are set out in ***4.3****, Note 1, and Clause* ***5****.*

Reference should be made to **4.5** and the inspection and testing should follow the procedures in **5.5** to **5.7** supported by the information in **G.2** where appropriate.

G.2.2 Inspecting and testing of the source of supply

The socket-outlet to be used should be inspected. It should be in good condition and not cracked, damaged, loose or damp, or show signs of overheating. Provided it is in good condition, it should be tested to check for correct polarity and earth fault loop impedance. The socket outlet may be used provided it is in good order, correct polarity indication is shown and the earth fault loop impedance is of a value that ensures overcurrent and residual current devices operate correctly.

NOTE There are plug-in devices commercially available that check polarity and earth fault loop impedance [see ***5.3****, c)].*

G.2.3 Inspection of equipment forming the temporary electrical system

As equipment is selected for use, it should be visually checked for damage and the evidence of valid formal inspection and test should be checked. Damaged equipment or that lacking such evidence should not be used.

G.2.4 Inspection of a completed temporary electrical system

Once a temporary system is set-up, it should be checked to ensure that connections are correct, cables are routed safely and correctly, equipment is safely positioned and that nothing is likely to cause damage, or be damaged.

G.2.5 Testing the temporary electrical system and RCDs

After connection to the supply, several representative tests should be made at final circuit socket-outlets to ensure that polarity is correct and earth fault loop impedance is still satisfactory.

The test or “T” button on the RCD(s) should be operated in order to prove disconnection.

G.2.6 Documentation

NOTE Formal documentation of the inspections and tests in ***G.2.2, G.2.3, G.2.4*** *and* ***G.2.5*** *is not required.*

All the equipment involved with the temporary system(s) should have evidence that they have passed a valid formal inspection and test and this evidence should be made available to any authority requiring confirmation that the system is in good order.

G.3 Large/complex temporary electrical systems

G.3.1 General

*NOTE Large/complex temporary electrical systems are set out in **4.3**, Note 2, and covered by Clauses **6** to **10**.*

Reference should be made to **4.5**. The inspection and testing should take account of **6.1.3**, **6.2**, **6.4**, **7** and **8.4** to **8.8** and follow the procedures in Clause **9** supported by the information in **G.3** below, where appropriate.

G.3.2 Duration of the temporary electrical system

G.3.2.1 General

The design should have taken into account the planned duration of the temporary system, the location and the type of use it receives. Based on this, either the designer should recommend, or the person responsible should decide, the period between the inspection and test at initial set-up and any re-inspection and retest that might be required (see **7.1**, **9.2**, **9.3**, **9.7** and **9.8**).

G.3.2.2 Short duration temporary systems

The planned period of existence of a temporary system might be sufficiently short that the assessment of its design, duration, environment and use indicate that the inspection and test at initial set-up together with the regular inspections indicated in **10.2** should be acceptable without further periodic re-inspections and retests.

NOTE An example of a short duration would be a touring show spending a few days in the same venue or an outside broadcast covering a specific event such as a football match.

G.3.2.3 Long duration temporary systems

Where the period of existence of a temporary system is planned to be long (see Note) then as a result of the assessment of the design, expected duration, environment and use, an appropriate interval should be set for future re-inspections and retests. The person responsible should always re-assess the need for re-inspections and retests and the intervals between them. These future re-inspections and retests should be done in addition to the regular inspections indicated in **10.2** [see Commentary to Figure G.1, k)].

NOTE An example of a long duration event might be an outdoor, public, seasonal event (e.g. a temporary ice-rink operating through winter) or a long running TV drama or theatre show. In favourable conditions, a long duration might be greater than three months and in severe conditions, might only be a few days.

G.3.2.4 Existence of temporary systems extended for longer than planned.

NOTE 1 The period of existence of a temporary system might be extended beyond the original planned period.

Where this occurs, the person responsible should re-assess the suitability of the design, its potential extended existence, the environment and its use or change of use. The designer should be consulted where practicable.

If any changes to the temporary system or to the inspection and testing routine are necessary as a result of the assessment, these changes should be implemented [see Commentary to Figure G.1, l)].

NOTE 2 An example of an extended duration event might be a theatre show in the same venue that has had a run extended owing to its success. The period before retest might be set by a third party (e.g. the venue or local authority).

G.3.2.5 Temporary systems associated with touring events

Each time a temporary system is set-up at any location it should be treated as a new system and inspected and tested accordingly. Each location brings changes in use, environment and electrical supplies and a re-assessment of these circumstances should be conducted and any changes needed should be implemented. A new Completion Certificate(s) should be completed for each location.

G.3.3 Details of the source of supply

Electrical characteristics of the supply and associated protective devices should be confirmed and the design checked to ensure it is suitable for the supply. Characteristics that should be confirmed include:

a) the type of supply and its earthing arrangements;

b) type and rating of overcurrent protective devices;

c) type and rating (or settings if adjustable) of an RCD at the source.

G.3.4 Inspection and testing of the source of supply

The supply should be inspected and the Electrical Installation Certificate or most recent PIR or EICR for the supply should be requested from the owners of the supply. The following tests should be carried out or the values obtained from the PIR or EICR:

a) polarity;

b) phase sequence;

c) functional switching/isolation test;

d) prospective short circuit current;

e) earth fault loop impedance;

f) operation of any RCD.

G.3.5 Inspection of equipment forming the temporary electrical system

As equipment is selected for use in a temporary system, it should be visually checked for damage. The evidence of valid formal inspection and test should be checked. Damaged equipment or that lacking evidence of valid formal inspection and test should not be used (see **8.4.2** and **8.4.3**).

G.3.6 Inspection of a temporary electrical distribution

NOTE The sequence of work at an event might require parts of a temporary distribution to be set-up and made operational before the whole temporary distribution is complete.

Before being connected to a supply, the inspection of any temporary distribution, complete or in part, should ensure that:

a) all equipment is in good condition;

b) the temporary distribution meets the design requirements;

c) the connections are correct, particularly where single pole connections are made;

d) cables are routed safely and correctly;

e) the presence and connection of all protective conductors, including supplementary bonding conductors, is correct;

f) the type and rating of circuit protective devices is correct;

g) equipment is safely positioned;

h) all environmental conditions are properly taken into account;

i) no part of the temporary system is likely to cause damage or be damaged;

j) any temporary distribution or part of a distribution that is about to be connected to a supply should have a means of isolation that is under the control of the person responsible so that the distribution can be isolated as required;

k) appropriate warning notices and labels are present.

G.3.7 Testing the temporary electrical distribution

The design should specify the circuits that should be tested or the person responsible should specify these circuits based on the design and circumstances at the event and the environmental conditions present (see **9.8, G.3.1** and **G.3.2**). These tests should include the output of the first ISU and as a minimum a selection of final circuits. The results should be recorded on the Completion Certificate and the Schedule of Test Results (see **G.3.9.1**, Figure G.1 and Figure G.2).

NOTE The circuits and extent of testing to be carried out depends upon the extent of the whole or the part of the temporary distribution being considered and is decided by the person responsible or as required by the design.

As a minimum polarity and earth fault loop impedance tests should be conducted. If appropriate, phase rotation, volt drop and prospective short circuit current tests should also be conducted.

The use of any circuit with an earth fault loop impedance greater than the expected design value should be assessed by the person responsible.

Where any part of a temporary system is fabricated on site such parts should be tested in accordance with BS 7671 or *IEE Code of Practice for in-service inspection and testing of electrical equipment* [N3] as appropriate.

G.3.8 Testing RCDs and setting adjustable RCDs

The test or "T" button on the RCD(s) should be operated in order to prove disconnection.

Any adjustable RCDs at the source of supply or within the temporary distribution should be checked for correct setting of the rated operating current and time delay (see BS 7671:2008+A1:2011, Regulation **531.2.10**).

G.3.9 Documentation

G.3.9.1 General

NOTE 1 The owners or occupiers of venues or locations where temporary systems are used or who provide supplies for temporary systems have a right to request evidence that the temporary system(s) is safely set-up for use. The usual means of providing this evidence is by Completion Certificate or Confirmation of Electrical Completion as appropriate.

A Completion Certificate, supported by a Schedule of Test Results, should be produced for each new temporary system set-up, or when the system is altered significantly (see **G.3.7**).

As a minimum there should be a Completion Certificate for temporary systems connected to each separate source of supply.

Where an event is extensive or complex enough to require more than one Completion Certificate, a Confirmation of Electrical Completion should be provided by the senior person responsible to indicate that the temporary electrical system has been set-up, inspected, tested and is safe and suitable for use at the event: an example of such a document is shown in Figure G.3.

NOTE 2 It is possible that a single source of supply might have several temporary distributions connected to it, for instance a source might be connected to an ISU that in turn supplies three entirely different temporary distributions each of significant complexity. In this case the design might require, or the person responsible might decide, that each distribution from the ISU warrants a separate Completion Certificate, with a further Completion Certificate that deals with the part of the temporary distribution from the source to the ISU (see Commentary on Figure G.1).

NOTE 3 The detail entered on a Completion Certificate depends upon the period that the temporary system remains in existence. The Completion Certificate shown in this Annex can be used for temporary systems having a short or long term existence (see Commentary on Figure G.1).

NOTE 4 Examples of a Completion Certificate (Figure G.1), a Schedule of Test Results (Figure G.2) and Confirmation of Electrical Completion (Figure G.3) are shown. Guidance on filling in these documents is provided after each figure.

NOTE 5 Records of Completion Certificates, Schedules of Test Results and Confirmation of Eletrical Completion can be produced as paper or electronic documents.

Figure G.1 **Completion certificate**

COMPLETION CERTIFICATE

(For use with BS 7909, Code of practice for temporary electrical systems for entertainment and related purposes)

This Certificate, showing the results of inspections and tests carried out on the temporary distribution described, should be handed to the event manager. A copy should be available for the owner of the electrical supply which feeds the temporary system. One certificate should be prepared for each electrically separate temporary distribution.

This document is not valid without a completed Schedule of Test Results

	Ref. No.:
Part 1: Description of the activity being covered and supply characteristics	
1. Event:	2. Location or venue:
3. Does this certificate cover a subsection of a larger system? Y/N If yes, give details:	4. Supply: Single phase ☐ Three-phase ☐ Max demand: ________ A or kVA (delete as appropriate)
5. Date of inspection and test:	Distribution schematic attached? Y/N

Part 2: System details of supply used (One certificate for a system fed from each separate supply)		
6. Source of supply used	Generator at:	Installed supply at:
7. Supply earthing arrangements	TN-S ☐ TT ☐ TN-C-S ☐ IT (see BS 7909:2011, **C.4.5**) ☐	
8. Protective devices at source of supply	CB/RCBO/fuse rating: ___________ A Type:	RCD/RCBO $I_{\Delta n}$:___________ mA Time delay setting:___________ ms
9. Additional earthing arrangements	Are earth electrodes deployed? Y/N	Give details:
10. Interconnection of earthing systems	Have deliberate connections between the temporary distribution and any other system been made? Y/N	Give details:
11. Protective devices in the ISU if present	CB/RCBO/fuse rating: ___________ A Type: ______________________	RCD/RCBO $I_{\Delta n}$: ___________ mA Time delay setting: ___________ ms
12. Final circuits details and tests should be shown on a Schedule of Test Results, where appropriate.		
13. Specify any deviations from BS 7909 or the design, or other significant information:		

Part 3: Essential inspection and tests

14. Visual inspection satisfactory ☐	15. Polarity throughout satisfactory ☐
16. Earth fault loop Z throughout satisfactory ☐	17. RCD 'T' buttons satisfactory ☐
18. Evidence of formal inspection and test provided and satisfactory for electrical equipment ☐	
19. Earth loop impedance of the supply, measured at the source of supply or ISU if present: __ Ω	
20. Planned duration of this system:	21. Date to re-inspect & re-test this system:

Part 4: Declaration

I certify that the temporary electrical distribution system described above has been set-up in accordance with the recommendations of BS 7909:2011 and inspection and testing has been completed. To the best of my knowledge and belief, the system is safe and suitable for the intended purpose.

Name:	Responsibility on event:
For and on behalf of:	
Signature:	Date:

COMMENTARY ON Figure G.1

Guidance on filling in a Completion Certificate

Dependent upon the size and complexity of the temporary electrical system, a Senior Person Responsible might decide to split the responsibilities for the temporary system into sections. A Completion Certificate is needed for each separate supply that is used. Where a single source is split to supply different sections, such as, lighting, sound, a mobile unit, an interview area or a catering facility, for example, the Senior Person Responsible might decide that a Completion Certificate with its supporting Schedule of Test Results is to be provided by the Person Responsible for each of these sections .

a) *Part 1: Enter details as required.*

b) *Part 2 (6 and 7): In 6 enter the supply details as requested. In 7 enter the earthing arrangements of the supply as confirmed in* ***G.3.3****.*

c) *Part 2 (8): Where the Completion Certificate deals with the temporary distribution supplied from one source, enter the details of the overcurrent protection at the source (as* ***G.3.3****). Enter the details of the RCD at the source (as* ***G.3.3*** *and/or* ***G.3.8****). Where the Completion Certificate deals with only a section of the temporary distribution supplied from one source, the details of overcurrent and RCD protection are those for the device(s) protecting the supply to this particular section of the temporary distribution. In this case, the supply might be protected by devices in an ISU or CDU.*

d) *Part 2 (9): Enter information about any additional earth electrodes that might have been deployed, such as at a generator, or a mobile or transportable unit, etc. Enter details such as where the electrode is deployed, connected and its impedance to the general mass of Earth.*

e) *Part 2 (10): Enter details of any deliberate connections of the CPC to the CPCs of other electrical systems indicating which other electrical systems have been interconnected. For more information, see Annex C and Annex D.*

f) *Part 2 (11): Enter details of overcurrent protection at the ISU (as* ***G.3.7****). Enter details of the RCDs at the ISU (as* ***G.3.7*** *and/or* ***G.3.8****). The ISU in whatever form is typically the first point of control of a supply to a temporary distribution that is definitely under the control of the person responsible. In this case where the Completion Certificate deals with a section of the temporary distribution supplied from one source, the details of overcurrent and RCD protection are those for protective device(s) in an ISU or CDU [see item c)].*

g) *Part 2 (12): This requires that the test details of the final circuits tested have been entered on the Schedule of Test Results applicable to this temporary distribution or section of the temporary distribution. The applicable Schedule of Test Results should be included with the Completion Certificate.*

h) *Part 2 (13): Enter information about any deviations from the requirements of BS 7909 or from the design. Other comments might be appropriate, such as why this temporary distribution is particularly suitable for its purpose, a particular reason for this temporary distribution, or if the temporary distribution is removed before a certain date.*

i) *Part 3:(14 to 18): Tick boxes to confirm all relevant tests have been carried out and, the results are acceptable and have been entered on the applicable Schedule of Test Results.*

j) *Part 3: (19) The earth fault loop impedance is the value measured at the source of supply, i.e., ISU, CDU or distribution unit, this effectively being the control position for the temporary distribution or section being considered (see* ***G.3.7****).*

k) *Part 3: (20 and 21): Enter the planned duration that this temporary electrical system is due to exist (see* ***G.3.2****). If the temporary electrical system is planned to exist for a long period and has an intended date for periodic re-inspection and retest, this date should be entered at 21. (See* ***G.3.2.3****.)*

l) Part 3: (20 and 21): Where the planned duration of any temporary electrical system is extended beyond that initially intended, a date for a periodic re-inspection and retest should be set and entered at 21 (See ***G.3.2*** *and* ***G.3.2.4****). A planned routine for periodic re-inspection and retest for the future should be set and recorded.*

m) Where the event requires the issue of more than one Completion Certificate, a Confirmation of Electrical Completion should be provided; see Figure G 3.

Figure G.2 **Schedule of Test Results**

This schedule has to be accompanied by a valid Completion Certificate.											
SCHEDULE OF TEST RESULTS		Completion Certificate ref: _______						Page _____ of _____			Date: __________
Schedule of circuits tested		Protective devices				Conducted tests					Comments
		Fuse or CB	RCD details								
1	2	3	4	5	6	7	8	9	10	11	12
Circuit details	Final circuit	Type and rating	Fixed/Adjustable	Delay	Rating $I_{\Delta n}$	RCD test (measured or T button)	Polarity	Phase sequence	Z_s	PSCC	
	✓	A	F/A	ms	mA	M/T	✓	✓	Ω	kA	
Instruments used											
Earth fault loop impedance				Prospective short-circuit current (PSCC)					RCD test		

COMMENTARY ON Figure G.2

Guidance on filling in a Schedule of Test Results

a) Circuit details: enter the description of the circuit (column 1) as noted on the circuit diagram or schematic of the design and tick the box (column 2) if it is a final circuit.

b) Protective devices: enter the details for the protective devices at the source of the circuit.

For fuses/circuit breakers, state what type and current rating (column 3). If the device is a fuse, enter the type under comments (column 12).

For RCDs, state whether the device is fixed or adjustable by entering F or A in column 4. In the columns for delay (column 5) and trip current (column 6), either:

- *enter the values that have been set (for adjustable type) or enter only the $I_{\triangle n}$ value for a fixed rated device. Check the operation using the T button and enter "T" into column 7;*

OR:

- *measure the operating time and operating current and enter these values in columns 5 and 6. In this instance enter "M" into column 7.*

c) Polarity: tick the box once polarity has been verified (column 8).

d) Phase sequence: indicate the result of phase sequence (rotation) test, where required (column 9).

e) Enter the measured values of earth fault loop impedance and prospective short-circuit current (PSCC) (columns 10 and 11).

f) Comments (column 12): give additional information, such as, details of circuits vulnerable to testing, environmental hazards or other observations on the operation of the system. Any deviations should be detailed along with the risk management strategy. Also include details of circuits that might need re-checking or managing for any other reason.

Figure G.3 **Confirmation of Electrical Completion**

NOTE For use where the event requires more than one Completion Certificate

Confirmation of Electrical Completion

(For use with BS 7909:2011, Code of practice for temporary electrical systems for entertainment and related purposes)

This document confirms that the temporary electrical system and its sub-systems associated with the event detailed below have been set-up, inspected and tested appropriately to ensure that they are safe and suitable for use.

Part 1: Details of event

1. Event:

2. Location or venue:

3. Planned period of existence of the event:

Start date: ____________ Removal date: ____________

4. Number of Certificates attached: _____

Part 2: Schedule of sections

Sub-system	Person Responsible	Organization	Certificate reference

Part 3: Confirmation

As the Senior Person Responsible, I confirm that the temporary electrical systems, as outlined in the schedule above, are safe and suitable for the purposes required by this event.

Signed:

For and on behalf of:

Name print:

Date:

Distribution:

SPR to retain a copy.

Copy to be provided to Event Manager for retention.

Other:

COMMENTARY ON Figure G.3

Guidance on filling in a Confirmation of Electrical Completion

a) Part 1 (1 to 4): Enter as required.

b) Part 2: This allows a row for each section of a temporary system or sub-system, Under column "sub-system", enter the name of the section. Enter the name of the Person Responsible in the next column, and where appropriate enter the organization assembling this section. Provided this sub-system is safe and suitable, enter the Completion Certificate reference number in the final column.

c) Part 2: More lines can be added to Part 2 as required.

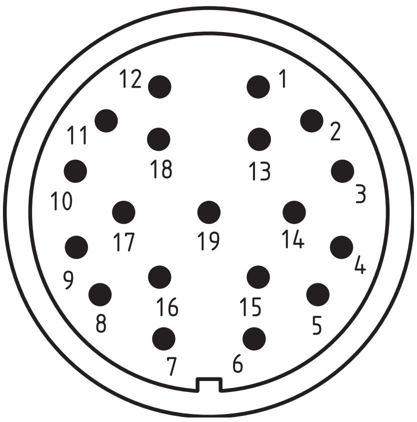
d) Part 3: This is where the safety and suitability of the temporary electrical system is formally confirmed. The Senior Person Responsible signs the confirmation and ensures that the appropriate distribution of documents is carried out.

Annex H (informative) Multi-pin connectors used for lighting applications

H.1 19 pin circular connector

This connector can be used in various configurations dependent on the source and use of shown is for 6 lighting circuits and is historically the standard arrangement for lighting applications in the UK. It is known that different pin-outs exist for other lighting applications and also for some sound applications.

Figure H.1 **Standard connections for a 19-pin connector used for lighting applications**



Pin number	Use	Circuit number
1	Line	1
2	Neutral	1
3	Line	2
4	Neutral	2
5	Line	3
6	Neutral	3
7	Line	4
8	Neutral	4
9	Line	5
10	Neutral	5
11	Line	6
12	Neutral	6
13	CPC	1
14	CPC	2
15	CPC	3
16	CPC	4
17	CPC	5
18	CPC	6
19	CPC	A)

A) Pin 19 is sometimes used for bonding extraneous metalwork.

A variety of different connector styles are used for multicore lighting circuits, and most are of a metal construction although not all have the facility to connect the exposed metal parts of the shell to a CPC. As it is foreseeable that a live conductor could become detached and touch the shell, some form of additional protection is required.

Either of the following can be used:

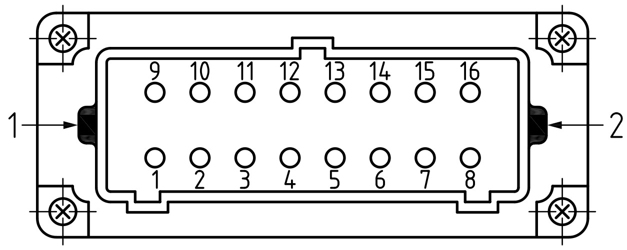
- permanent durable rubber type sleeving is used to over-sleeve each conductor connection and a protective insulating boot is placed over all the conductors housed within the metal shell in such a fashion that failure of a wire or connection cannot result in the shell becoming live; or
- the shell is connected to a CPC.

H.2 16 pin rectangular connector

This connector is used in the UK and Europe and in general it can be used in various configurations dependent on the source and use of the load it is supplying. Care is needed to ensure that the connectors at the source of supply and the load input are wired in the same configuration. The cables used to connect the source to the load need to have correct pin-to-pin direct connections. If these conditions are not met, there is a risk that an incorrect connection of line, neutral and/or CPC is made, creating a danger of electric shock.

The 16 pin connector is to be used for 6 lighting circuits with the source and load connectors wired according to the pin-out shown in Figure H.2.

Figure H.2 –Standard connections for a 16-pin connector used for lighting applications



Key
1 Shell 1
2 Shell 2

Pin number	Use	Circuit number
1	Line	1
2	Line	2
3	Line	3
4	Line	4
5	Line	5
6	Line	6
7		A)
8		A)
9	Neutral	1
10	Neutral	2
11	Neutral	3
12	Neutral	4
13	Neutral	5
14	Neutral	6
15		A)
16		A)
Shell 1	CPC	Parallel CPC for all circuits A)
Shell 2	CPC	

A) There are 2 connections used for a CPC, referred to here as shell 1 and shell 2. Some configurations also connect pins 7, 8, 15 and 16 in parallel with shell 1 and shell 2 for CPC use.

NOTE 1 This connector is used in the UK and Europe. In the UK the typical pin-out is that shown in Figure H.2. This connector is detailed in DIN 15765, where the pin-out recommended is compatible with that shown in Figure H.2.

NOTE 2 As other configurations of this connector exist in the UK, and particularly in Europe, it is essential that the pin-out of the source and load connectors are verified before a distribution is connected and energized. If this is not carried out, there is the risk of the miss connection of line, neutral and/or CPC that can lead to the danger of electric shock and damage to the connectors.

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 546, *Specification – Two pole and earthing-pin plugs, socket-outlets and socket-outlet adaptors*

BS 1363 (all parts), *13 A plugs, socket-outlets, adaptors and connection units*

BS 4293, *Specification for residual current-operated circuit-breakers* [4)]

BS 5550-7.5.4, *Cinematography – Production and presentation – Film and television location lighting – Specification for single pole high current plugs and socket connectors* [5)]

BS 5958-1, *Code of practice for control of undesirable static electricity – Part 1:General considerations*

BS 7071:1992, *Specification for portable residual current devices*

BS 7288:1990, *Specification for socket outlets incorporating residual current devices (s.r.c.d's)*

BS 8450, *Code of practice for installation of electrical and electronic equipment in ships*

BS EN 60073, *Basic and safety principles for man-machine interface, marking and identification – Coding principles for indication devices and actuators*

BS EN 60092-507 (IEC 60092-507), *Electrical installations in ships – Part 507: Pleasure craft*

BS EN 60309-1 (IEC 60309-1), *Plugs, socket-outlets and couplers for industrial purposes – Part 1: General requirements*

BS EN 60309-2 (IEC 60309-2), *Plugs, socket-outlets and couplers for industrial purposes – Part 2: Dimensional interchangeability requirements for pin and contact-tube accessories*

BS EN 60320-1:2001+A1:2007, *Appliance couplers for household and similar general purposes – Part 1: General requirements*

BS EN 60947-2:2006+A1:2009, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*

BS EN 61008-1, *Specification for residual current operated circuit-breakers without integral overcurrent protection for households and similar use (RCCBs) – Part 1: General rules*

BS EN 61009-1, *Specification for residual current operated circuit breakers with integral overcurrent protection for household and similar uses (RCBOs) – Part 1: General rules*

BS EN 61140 (IEC 61140), *Protection against electric shock – Common aspects for installation and equipment*

BS EN 61557-3, *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 3: Loop impedance*

4) BS 4293 has been withdrawn and superseded by BS EN 61008-1 as well as BS EN 61008-2 and BS IEC 1008-2-2.

5) BS 5550-7.5.4 is current but obsolescent, meaning that this is no longer being maintained by the committee.

BS EN 61557-6, *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 6: Effectiveness of residual current devices (RCD) in TT, TN and IT systems*

BS EN 62305 (all parts), *Protection against lightning*

IEC 62423:2009, *Type F and Type B residual current operated circuit-breakers with and without integral overcurrent protection for household and similar uses*

PD CLC/TR 50404, *Electrostatics – Code of practice for the avoidance of hazards due to static electricity*

DIN 15765, *Entertainment technology – Multi-core cable systems for mobile productions and entertainment technology*

Other publications

[1] ASSOCIATION OF EVENT VENUES. *Association of Event Venues & Event Supplier & Services Association Rules and Regulations for Electrical Stand Installations 2009*. www.aeoforums.org.uk/files/electrical_regulations_2009.pdf

[2] ASSOCIATION OF BRITISH THEATRE TECHNICIANS. Technical Standards for Places of Entertainment. http://www.abtt.org.uk/publications/books/technical-standards-for-places-of-entertainment-2009. 2009

[3] GREAT BRITAIN. The Electricity Safety, Quality and Continuity Regulations 2002(b) (ESQCR), as amended. London: HMSO.

[4] GREAT BRITAIN. Electricity Supply Regulations (Northern Ireland) 1991, as amended. London: HMSO.

[5] GREAT BRITAIN. The Electricity at Work Regulations 1989. London: HMSO.

[6] IET, *Guidance Note 7: Special Locations*. IET Publications [6)].

[7] GREAT BRITAIN. Management of Health and Safety at Work Regulations 1999. London: HMSO.

[8] GREAT BRITAIN. Provision and Use of Work Equipment Regulations 1998. London: HMSO.

[9] GREAT BRITAIN. The Supply of Machinery (Safety) Regulations 2008. London: HMSO.

[10] GREAT BRITAIN. The Health and Safety (Safety Signs and Signals) Regulations 1996. London: HMSO.

[11] HEALTH AND SAFETY EXECUTIVE. *Memorandum of guidance on the Electricity at Work Regulations 1989*. (HSR25) HSE Books, 2007.

[12] HEALTH AND SAFETY EXECUTIVE. *Electricity at work – Safe working practices* (HSG85). HSE Books, 2003.

[13] IET, *Guidance Note 5: Protection against electric shock*. IET Publications [6)].

[14] IEE, *Recommendations for the electrical and electronic equipment of mobile and fixed off shore installations.* IET Publications [6)], 1992.

[15] HEALTH AND SAFETY EXECUTIVE. *Avoiding Danger from Underground Services* (HSG47). HSE Books, 2000.

6) This was originally published by the IEE but is now published and available from the IET: www.theiet.org.

Further reading

BS 7540 (all parts), *Electric cables – Guide to use for cables with a rated voltage not exceeding 450/750 V*

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 60898-1, *Electrical accessories – Circuit breakers for overcurrent protection for household and similar installations – Part 1: Circuit-breakers for a.c. operation*

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