A guide for the connection of a low voltage installation to The Guernsey Electricity Network

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Definitions

GEL Guernsey Electricity Limited.

Base station A location containing equipment for the functioning of a mobile phone network.

Cabin A multi-functional temporary building constructed generally from timber and wallboard or GRP, which may be secured on-site for long-term use or be transported for temporary use.

Certified meter
A meter that is of an approved pattern and certified by Guernsey Electricity Limited.

CNE Combined neutral and earth.

Consumer User of the electrical installation downstream from the GEL meter.

Contractor A person electrically competent in designing and/or installing electrical installations.

Cut-out Item of electrical equipment for terminating the GEL supply cable and housing the GEL protective device.

GRP Glass Reinforced Plastic.

Low voltage (a.c.)
Exceeding 50 V but not exceeding 1000 V between conductors, or 600 V between conductors and Earth.

Mast A free standing structure to which items, such as antennae are secured at height so they can transmit and receive signals.

Mess room A room or building providing meals and recreational facilities for workers.

PEN conductor A conductor that combines both neutral and protective functions and associated with PME.

PME Protective Multiple Earthing is the most common form of system within the GEL network, and uses a single conductor for both neutral and earth functions (see TN-C-S).

SNE Separate neutral and earth.

Stand A stall or booth for selling or exhibiting goods.

Street furniture Items of street furniture include street lighting columns, bus shelters, telephone kiosks, advertising panels, road signs, parking ticket machines and electric vehicle charging points (this list is not exhaustive).

Temporary building
A building that is transported from one location to another and typically used for a period of time related to a particular event.

TN-C-S (Terre Neutral Combined Separated)
A system having a single conductor for both neutral and earth functions in the GEL network, and separate conductors for neutral and earth functions in the consumers' installation.

TN-S (Terre Neutral Separated)
A system having separate conductors for neutral and earth functions in the GEL network and the consumers' installation.

TT (Terre Terre)
A system having the GEL network connected to Earth at the transformer and the consumers' installation connected to Earth independent of the GEL network.

Traditional construction
Buildings having external walls of bricks, blocks and natural materials, such as granite.

Wallboard A board used to construct walls (or ceilings) and manufactured from gypsum in sheets, typically 2.4 m x 1.2 m.

Introduction

The intention of this guide is to provide information on the common types of low voltage (a.c.) electrical systems available from Guernsey Electricity Limited (GEL). Including the range of operational parameters within the network, such as:

- Earthing arrangement
- Prospective short-circuit current
- Earth fault loop impedance
- Voltage and current

The information provided is primarily for use by persons involved in designing and/or installing electrical installations (referred to as contractors). Such persons may require particular information, when planning for new electrical installations, or when planning additions or alterations to existing installations.

Where information of the type of supply and parameters in a particular location on Guernsey is required please contact GEL.

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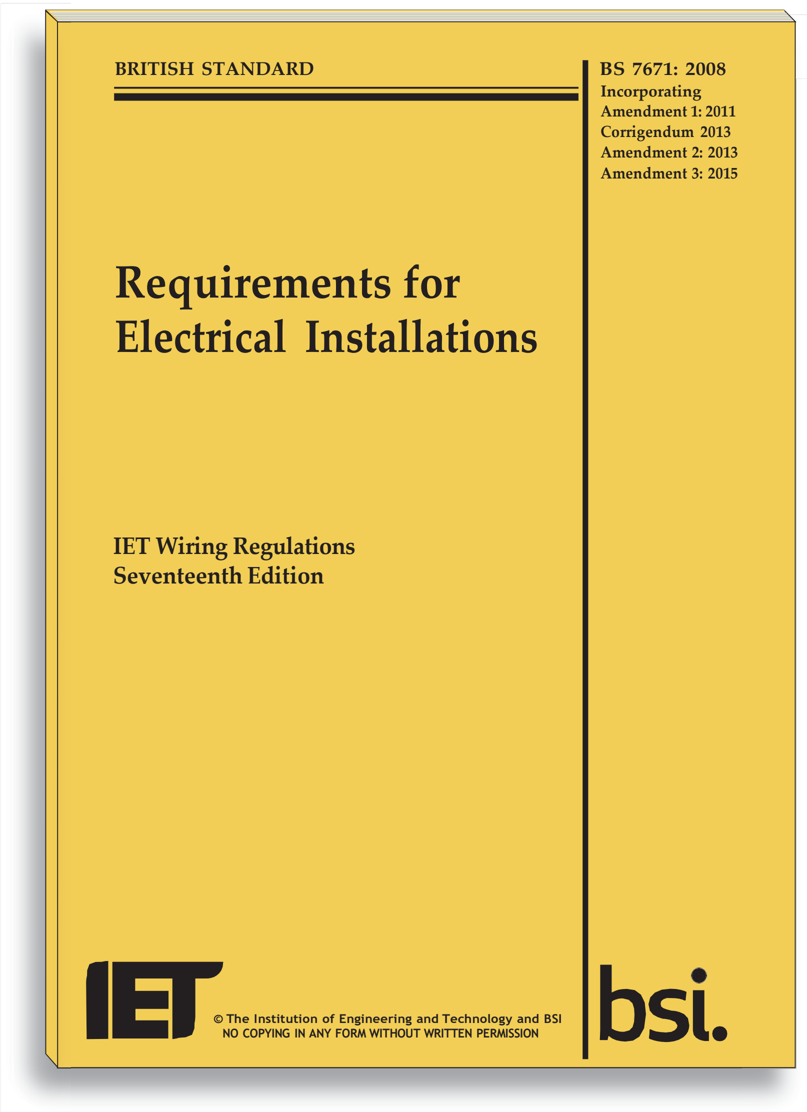
Scope

The information provided in this guide only applies to new and existing electrical systems supplied at low voltage (a.c.) by GEL. An overview of the GEL low voltage (a.c.) network and the requirements to be met for electrical installations to be connected to the network will be discussed. Including how the GEL earthing terminal may, or may not, be used.

To aid contractors designing and/or carrying out electrical installation works this guide also reflects some of the applicable requirements of *BS 7671*[1] (*Requirements for Electrical Installations*), and other relevant British and Harmonised Standards and Codes of Practice that may need to be met, in order for an installation to be connected to the GEL network.



The Requirements for Electrical Installations - *BS 7671: 2008*, as amended

[1]For a consumers installation to be connected to a GEL supply the relevant safety regulations of *BS 7671* applicable to that particular installation must be met, unless these regulations are supplemented by other legislation and/or standards.

1 Types of system

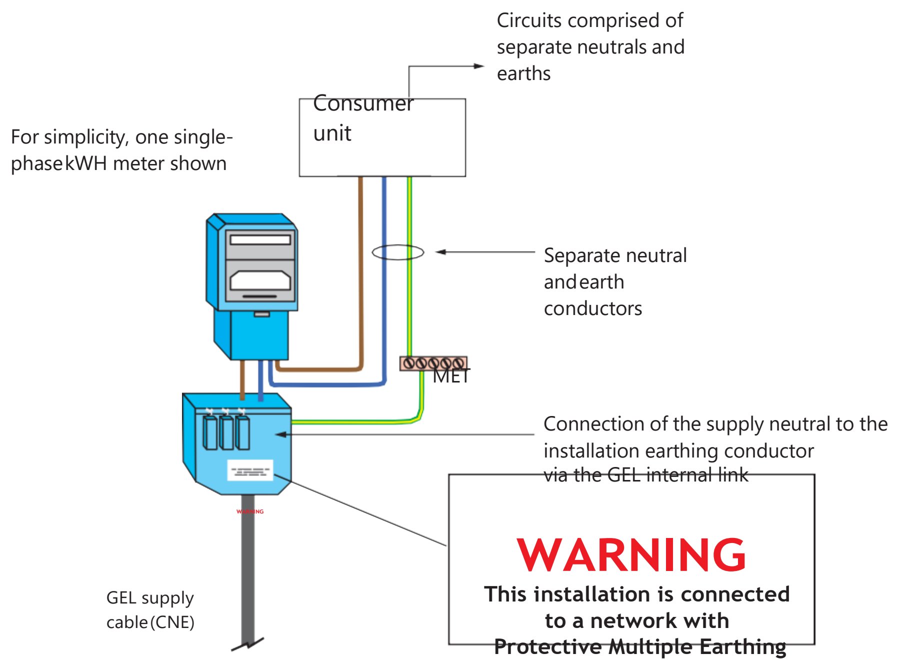
Whilst there are many existing single-phase supplies connected to the GEL network, where a new supply is required to a consumer's property, a three-phase (400 V) supply will be provided. The current rating of this three-phase GEL supply will be based on the current demand of the consumer's installation, up to a maximum cut-out rating of 600 A per phase. If the demand exceeds 600 A three-phase, an additional GEL supply may be provided.

For new supplies, a Protective Multiple Earthing (PME) system will be provided, unless it is inappropriate for reasons of safety (refer to Section 10). The particular PME supply connection will be one of the following types:

- Type A, denotes a PME supply connection, having a low impedance earth fault path (refer to Section 2), and
- Type B, is used to denote a PME supply connection where GEL cannot guarantee a low impedance earth fault return path for the PME supply.

Where GEL allows a Type B connection, appropriately rated RCDs must be provided in the consumer's installation to ensure circuit disconnection is achieved, in accordance with *BS 7671*, under earth fault conditions. Refer to Section 4 'TT systems'.

PME systems generally use CNE (Combined Neutral Earth) cables having insulated line conductors and one conductor that combines both neutral and earth functions. The supply neutral conductor, often referred to as a PEN (combined protective and neutral) or CNE (combined neutral and earth) conductor, is terminated at the GEL's switchgear (cut-out) where connection of the earthing conductor to the supply neutral is achieved by means of an internal link provided by the GEL. The use of a combined conductor applies only to the supply and not to the consumer's installation, so separate neutral and earth conductors must be used within the consumer's installation, as shown in Fig 1.1.



Three-phase PME supply

Fig 1.1 Illustration of a GEL three-phase (PME) supply cut-out

Another type of system within the GEL network is TN-S. This system uses cables having insulated line conductors and two separate conductors to provide neutral and earth functions. Typically the neutral conductor is an insulated core incorporated within the cable and the earth conductor is the outer metallic sheath. GEL is currently in the process of converting existing TN-S systems to TN-C-S, so over time existing TN-S systems will be phased out.

In locations where the GEL earth is unavailable a TT system should be used. For a TT system the consumer[2] must provide the means of earthing for their installation by installing independent earth electrodes.

Regardless of the type of system GEL supplies to consumers' premises it is the responsibility of the consumer[3] to ensure their electrical installation meets all relevant requirements of *BS 7671* and other British and Harmonised Standards that are applicable, before connection to a GEL supply is given.

The GEL supply cable of any system will be terminated into a cut-out from which insulated and sheathed cables (known as 'meter tails') will supply a certified meter to record the quantity of electricity used by the consumer (see Fig 1.2). Depending on the paticular tariff, single or 3 phase meters may be installed.

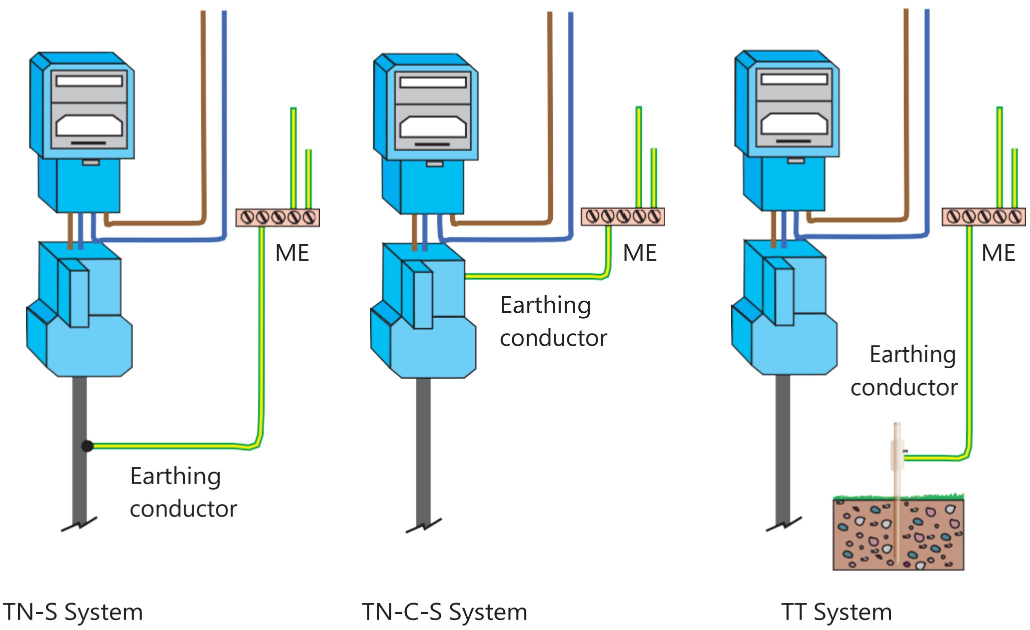


Fig 1.2 Example of GEL supply terminations for three types of system
(for clarity, only one single-phase meter is shown)

[2] Installation of earth electrodes is normally confirmed by an electrical contractor, unless the consumer is the contractor.

[3] Although it is the responsibility of the consumer to ensure their electrical installation meets all relevant requirements,confirmation is normally provided by an electrical contractor carrying out inspection, testing and notifying the consumer of compliance, unless the consumer is the contractor.

The position of this termination will generally be inside the consumer's premises, unless in the particular circumstances it is more reasonable to place it outside those premises. In the latter circumstances a suitable enclosure is required.

To provide easy access at all times to the GEL switchgear and meter the preferred mounting height of a service position is 1.2 m (for example, where the service position is under a staircase). This preferred height is increased to 1.5 m where the service position is within a garage or other location that places the GEL switchgear at risk.

It should be noted that should a consumer refuse or fail to take the supply through the meter GEL have provided, GEL have powers to discontinue the supply (Subparagraph 5 from Schedule 3 of The Electricity (Guernsey) Law, 2001 refers).

2 PME systems

GEL provides a Protective Multiple Earthing (PME) system. In this system, the neutral conductor is connected to earth at or near the supply transformer, at one or more points within the system and at or near each final termination point, as shown in Fig 2.1.

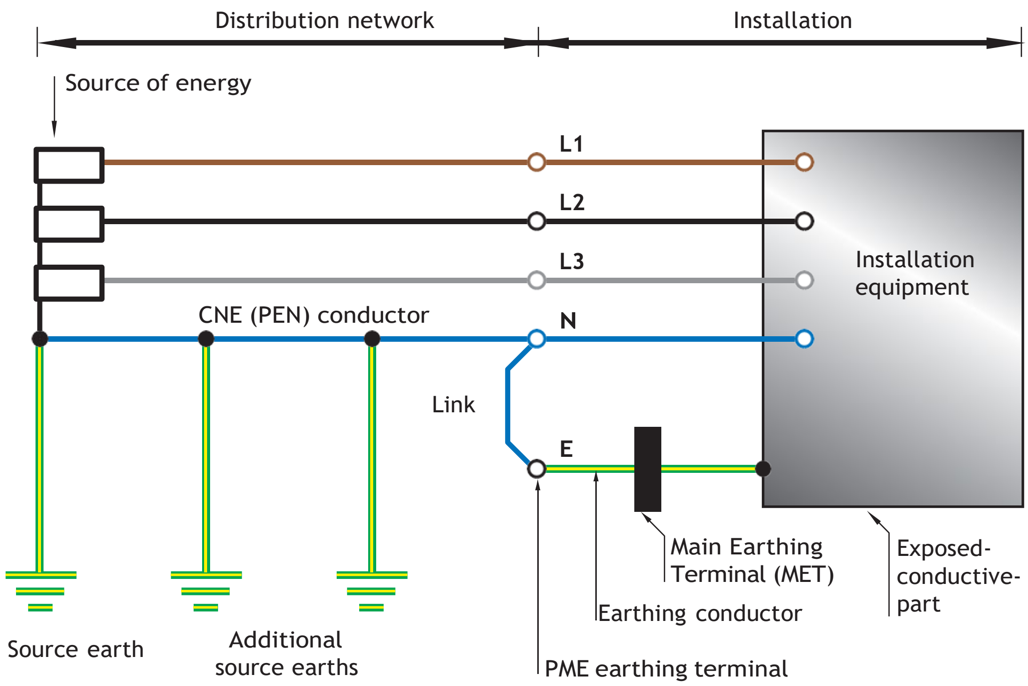


Fig 2.1 Example of the PME system

The combined conductor provides two functions; it carries unbalanced load currents and provides an earth fault return path. The return path must have a low impedance so that fault current will, ensure rapid disconnection of supply. However, low impedance typically means high fault current within the GEL networks, resulting in the need for protective devices within the GEL cut-out to have a high prospective fault current rating, for example, 16 kA.

Using a combined conductor presents two distinct disadvantages to PME systems, as follows:

1. Under normal conditions, a small voltage difference may exist between the PME earthing terminal at the origin of an installation and ‘true’ Earth potential, depending on the distribution network configuration and loading. This small voltage above Earth potential could, under certain conditions (such as reduced body resistance due to the presence of water), create the possibility of ‘perceived shock’ for a person simultaneously in contact with an exposed-conductive-part or an extraneous-conductive-part and ‘Earth potential’.

2. An open-circuit in the PEN conductor within the network can cause the combined neutral/earth terminal at the cut-out in consumers’ premises to rise above earth potential, due to carrying load currents from installations downstream from the open-circuit. Consequently, the protective conductors connected at that terminal are also likely to rise in potential; meaning any metallic parts, such as gas pipework connected in the consumers’ installation is also likely to rise above earth potential, creating a risk of electric shock to any person in simultaneous contact with such parts and the general mass of Earth.

To minimise the effects of load currents from an open-circuit to consumers' metalwork, the main protective bonding conductors of PME systems normally have a larger cross-sectional area than bonding conductors used in TN-S or TT systems (see Section 5). The earthing conductor in PME systems may also be required to have a larger cross-sectional area.

An example of a three-phase CNE cable having solid aluminium insulated line conductors and a copper combined neutral/earth conductor (PEN) formed from uninsulated stranded conductors, is shown in Fig 2.2.

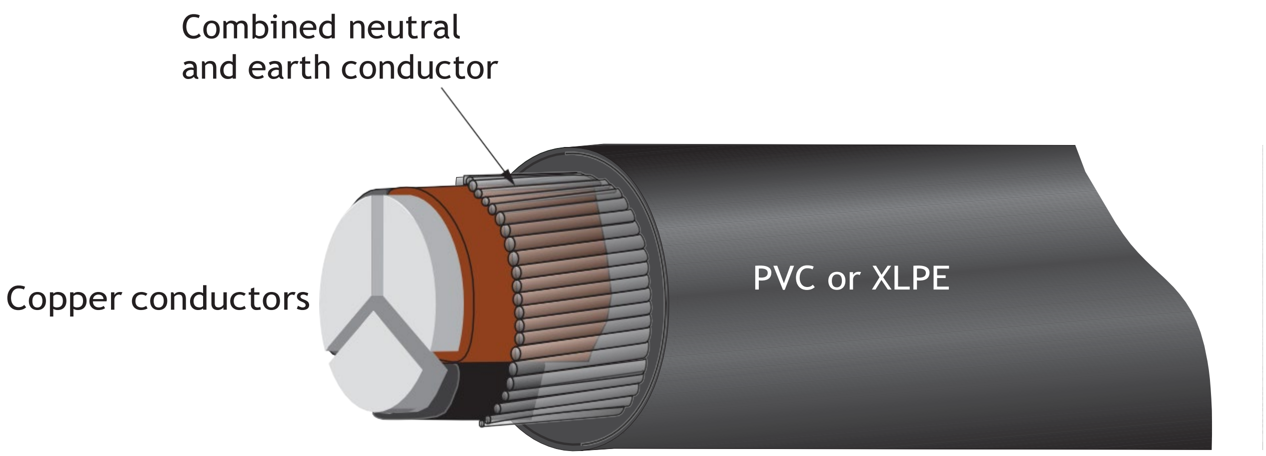


Fig 2.2 A three-phase CNE cable

3 TN-S systems

Some parts of the GEL network are formed of a TN-S system (see Fig 3.1), due to the historic nature of electrical systems having paper insulated lead (or armoured) sheath cables. Consequently, some consumers will have a TN-S supply, whereby the metallic sheath of the cable serves as the protective conductor and normally provides part of the earth fault impedance path for their installation.

However, it should not be assumed that where a metallic sheath cable exists in consumers' premises that the system is indeed TN-S. Some existing cables have been incorporated into the PME network and some do not provide a secure and reliable earth fault impedance path, due to the metallic sheath having a high value (Ω) of impedance.

Earth connections to lead sheath cables are typically made by clamps or soldering. Earth connections to armoured cables are typically made by clamps and/or glands.

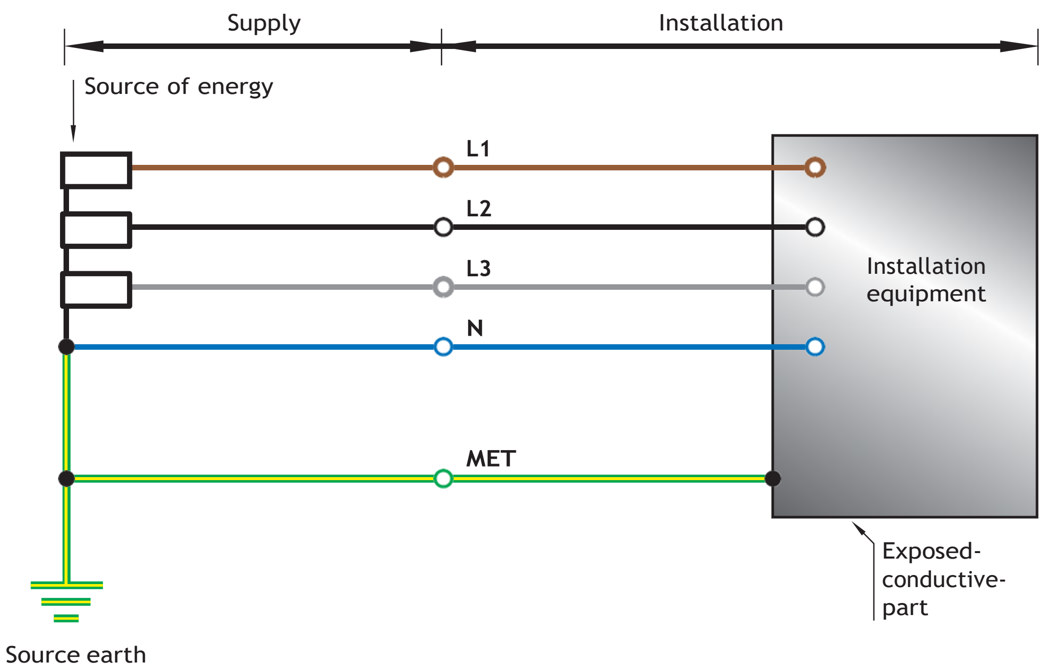


Fig 3.1 Example of the TN-S system

4 TT systems

The TT system is generally supplied where parts of the GEL network is unable to secure a reliable value (Ω) of earth fault impedance path; meaning GEL is unable to provide an earth terminal. For a TT system the consumer[4] provides independent electrode(s) buried in the ground. A TT system is illustrated in Fig 4.1.

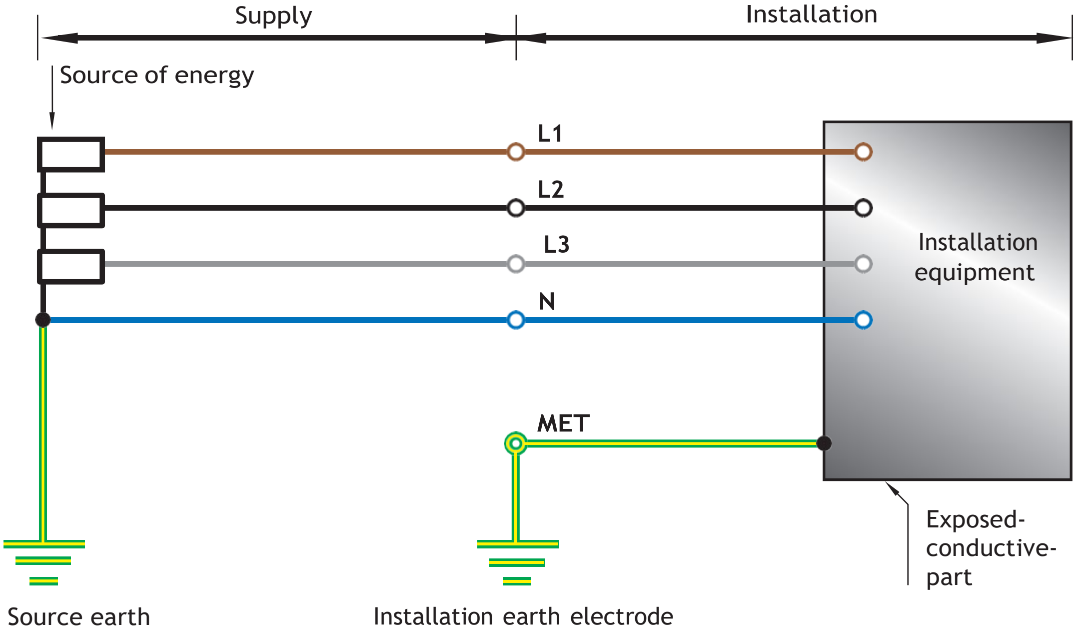


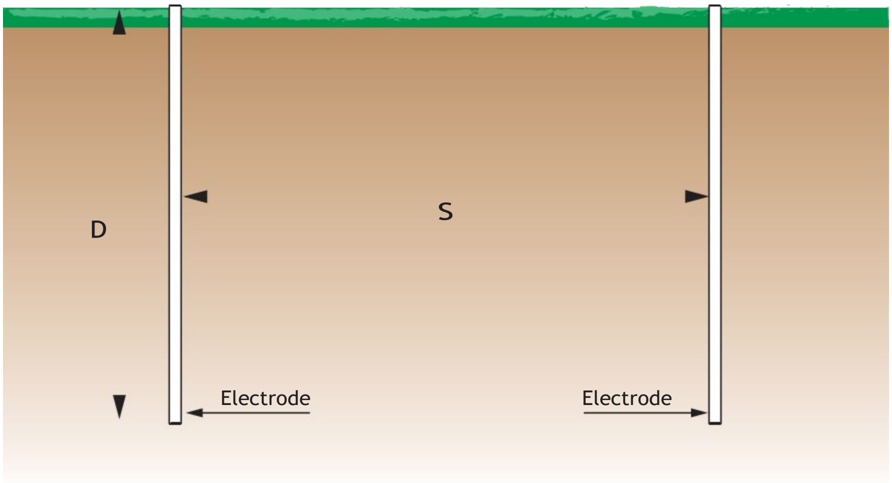
Fig 4.1 Example of the TT system

Earthing the consumers' installation by independent earth electrodes generally results in a high value (Ω) earth fault return path. Consequently, Residual Current Devices (RCDs), in addition to overcurrent protective devices, are normally needed to provide electric shock protection (Chapter 41 (*Protection against electric shock*) of *BS 7671* refers).

Where more than one earth electrode is used, an appropriate separation distance should be provided between the electrodes. For example, where the depth (D) of the earth electrode shown in Fig 4.2 is 2 m the separation distance (S) should not be less than 2 m.

The permitted types of earth electrode are listed in Regulation 542.2.3 of *BS 7671*, and guidance on the installation of different types of earth electrodes is contained in *BS 7430: 2011 Code of practice for protective earthing of electrical installations.* A typical domestic earth electrode installation is shown in Fig 4.3.

[4] Installation of earth electrodes is normally carried out by an electrical contractor, unless the consumer is the contractor.



It is often assumed that rods or pipes are outside each other's resistance areas if the separation distance (S) is not less than the driven depth (D). Little is to be gained by a separation beyond twice the driven depth.

Fig 4.2 Separation distance of earth electrodes

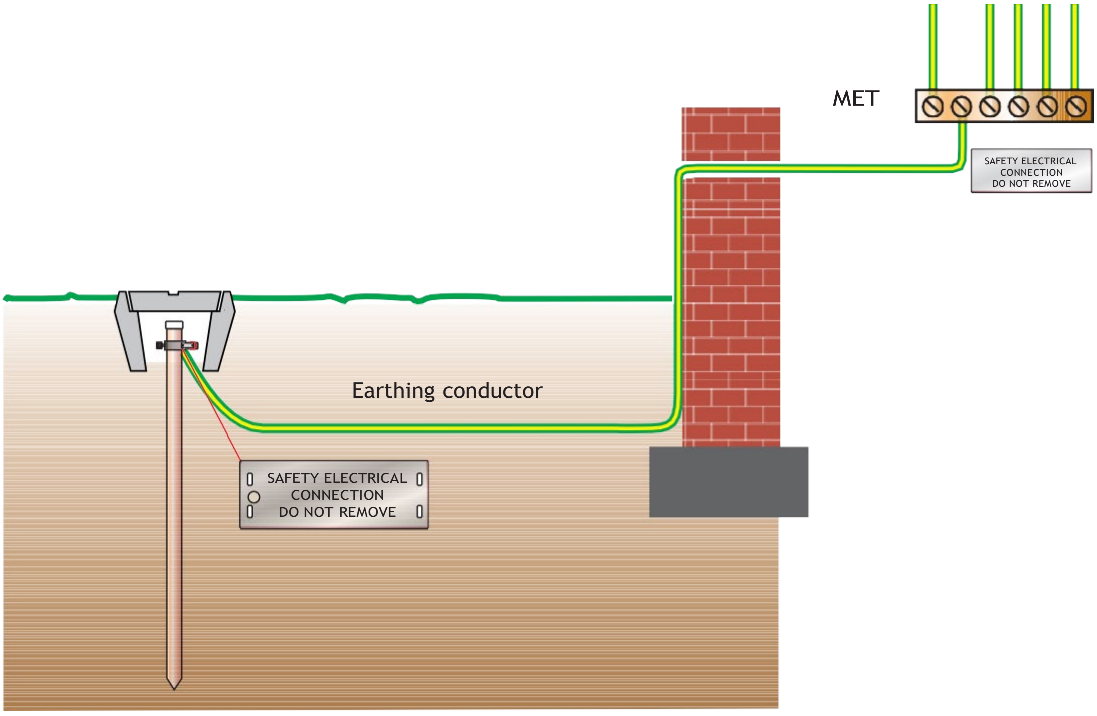


Fig 4.3 Example of an earth electrode installation

Table 41.5 of *BS 7671* gives a range of maximum earth fault impedance values for TT systems protected by non-delayed RCDs, and although, for example, an RCD rated at 30 mA may have a maximum earth fault loop impedance of 1667 Ω, Note 2 of that table recognises that an earth electrode resistance exceeding 200 Ω may not be stable. Therefore, GEL requires that for a TT system the measured earth electrode resistance should not exceed 200 Ω.

5 Earthing provisions and consumers' earthing and bonding

Regardless of the arrangement (TN-C-S, TN-S and TT) at the GEL supply position in the consumer's installation, it is the responsibility of the consumer[5] to ensure their installation has a secure connection to the means of earthing that provides a reliable and low earth fault impedance path, and that adequate equipotential bonding is installed.

GEL recognises the difficulties for consumers to provide a secure and reliable earthing system for their installation and will, where practicable, provide an earth terminal. The GEL earth terminal provides a link between the consumer's earthing system and the neutral star point of the distribution transformer.

Earthing

Connections to the GEL supply for earthing the consumers' installation are only applicable to TN-C-S and TN-S systems. Where the system is TN-C-S (PME) an earth terminal for customer use will be provided, unless the type of premises and/or installation places an increased risk on the use of the PME earthing terminal. Section 10 (*Locations having specific risk*) discusses the use of the PME earthing terminal where risks are increased.

For TN-S systems the provision of an earth terminal will depend upon the reliability of the supply cable metallic sheath. There are parts of the GEL network that cannot provide a secure and reliable value (Ω) of earth fault impedance path, and where this is the case GEL is unable to provide an earth terminal.

Where an earth terminal is provided by GEL, the consumer is not permitted to make a connection to that terminal; the connection must be made by an inspector appointed by GEL. Alternatively, the consumer may choose to form a TT installation from buried earth electrodes.

[5] Although it is the consumers' responsibility for secure earthing, this is normally confirmed by an electrical contractor carrying out inspection and testing and notifying the consumer, unless the consumer is a contractor.

Where doubt exists regarding the type of supply system, it is important to contact GEL to verify the type of system before commencing any electrical installation work. Where an earthing connection is to be made to GEL switchgear the minimum size of cross-sectional area for the earthing conductor is 16 mm².

For a TT installation the earthing conductor must comply with Section 543 (*Protective conductors*) of *BS 7671*. Additionally, and as is often the case for a TT installation, where the earthing conductor is buried in the ground the minimum cross-sectional area given in Table 54.1 of *BS 7671* must be met.

Protective equipotential bonding

Protective equipotential bonding (main and supplementary) is the installation of protective conductors to extraneous-conductive-parts and, where applicable, exposed-conductive-parts, so that in the event of a fault all metalwork within the installation will have a similar rise in earth potential. Fig 5.1 illustrates the application of the requirements of Regulation 411.3.1.2 for a single installation connected to a PME supply.

An example of the application of the requirements of Regulation 411.3.1.2 to a single installation

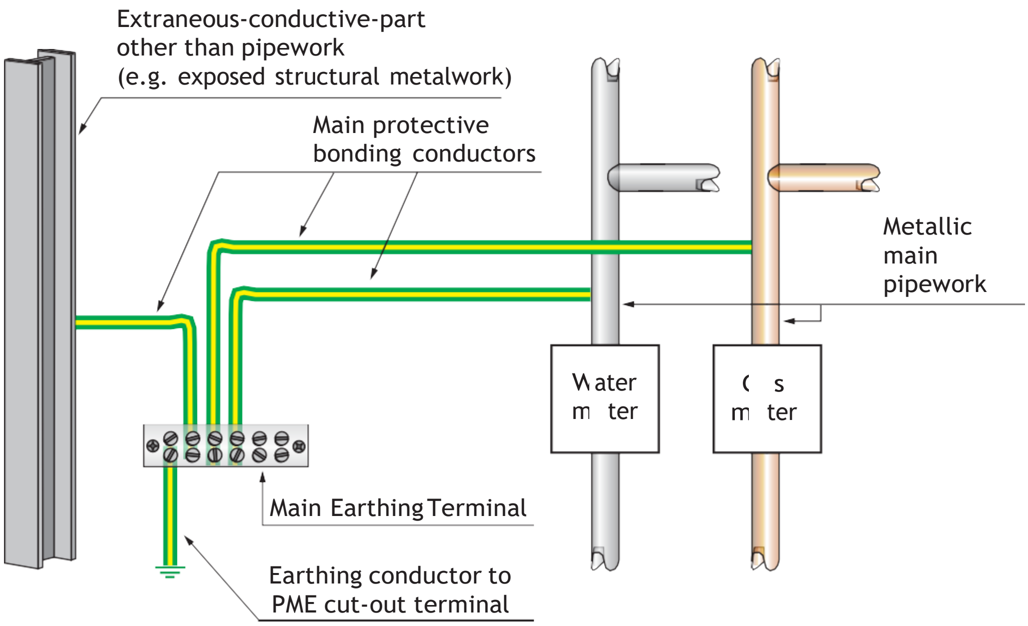


Fig 5.1 Example of the application of protective equipotential bonding

The requirements of Regulation 411.3.1.2, for extraneous-conductive-parts to be connected to the Main Earthing Terminal (MET) by main protective bonding conductors complying with Chapter 54 of *BS 7671*, should be applied in each installation and, where an installation serves more than one building, in each building containing extraneous-conductive-parts.

The size of main protective bonding conductors required in consumers' installations is related to the type of electrical system. For TN-S and TT systems, bonding conductors should have a cross-sectional area not less than half the cross-sectional area of the size required for the earthing conductor and a minimum 6 mm² (Regulation 544.1.1 of *BS 7671* refers).

For TN-C-S (PME) systems, main protective bonding conductors must be sized in accordance with the neutral conductor of the GEL supply and Table 54.8 of *BS 7671*. However, in some circumstances GEL may require a larger protective bonding conductor.

Table 5.1 Reproduction of Table 54.8 from *BS 7671*; minimum cross-sectional area of the main protective bonding conductor in relation to the neutral of the supply

Copper equivalent cross-sectional area of the supply neutral conductor (mm^2)	Minimum copper equivalent cross-sectional area of the main protective bonding conductor (mm^2)
35 or less	10
over 35 up to 50	16
over 50 up to 95	25
over 95 up to 150	35
over 150	50

The minimum copper equivalent cross-sectional area is given by a copper bonding conductor of the tabulated cross-sectional area or a bonding conductor of another metal affording equivalent conductance.

To aid the contractor, Figs 5.2 and 5.3 each show examples of installations (with different earthing arrangements) that are distributed throughout a complex of buildings.

At each of the Buildings A, B and C in Figs 5.2 and 5.3, the only extraneous-conductive-parts are incoming metallic service pipes. However, other extraneous-conductive-parts may be present in a building served by an installation, for example, steel beams forming exposed structural parts of the building, which must also be main bonded. Both installations have a TN system (TN-S in Fig 5.2 and TN-C-S in Fig 5.3) serving Buildings A and B and a TT system serving Building C only.

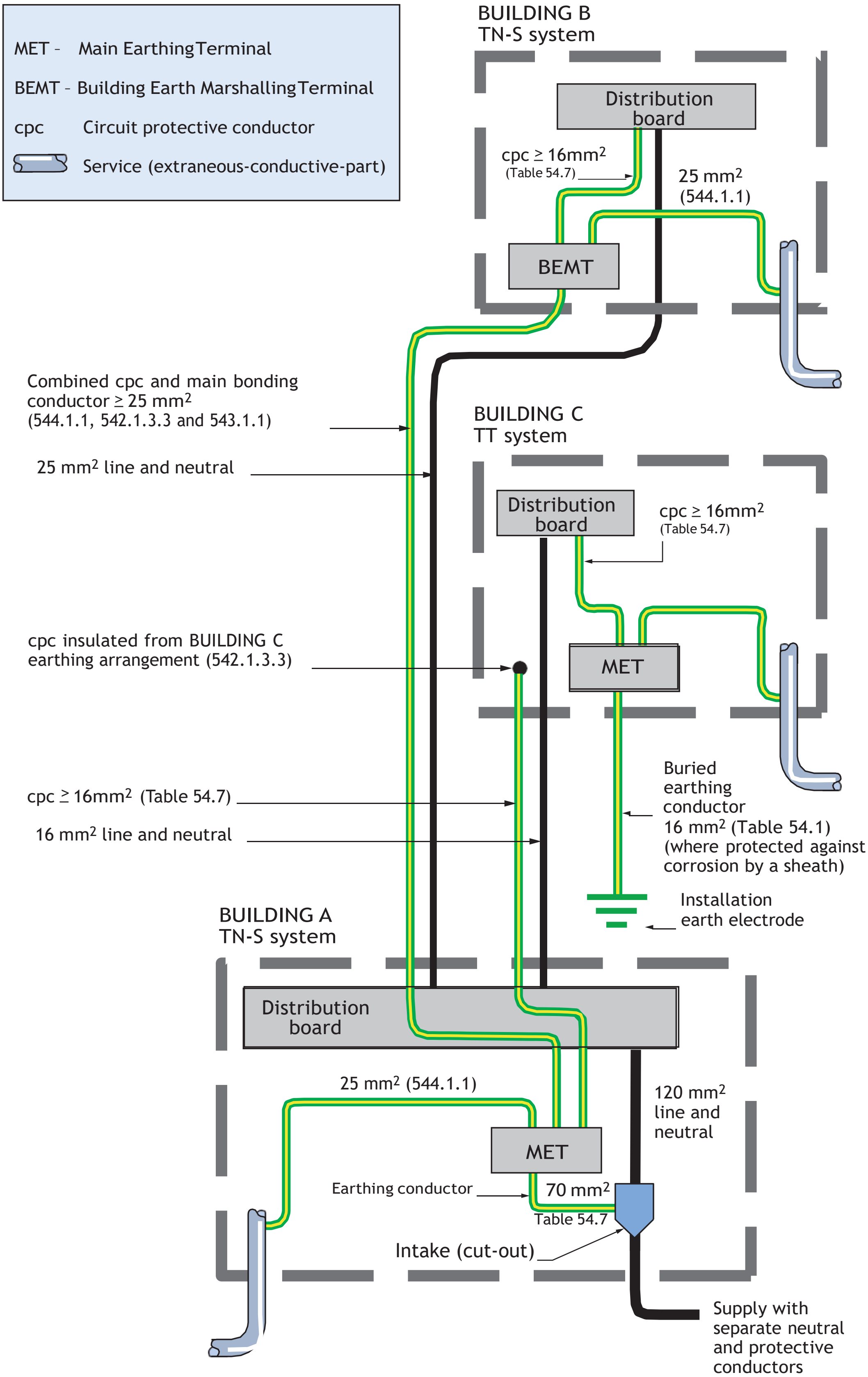


Fig 5.2 An example of the application of Regulation 411.3.1.2 where an installation forming part of a TN-S system serves more than one building

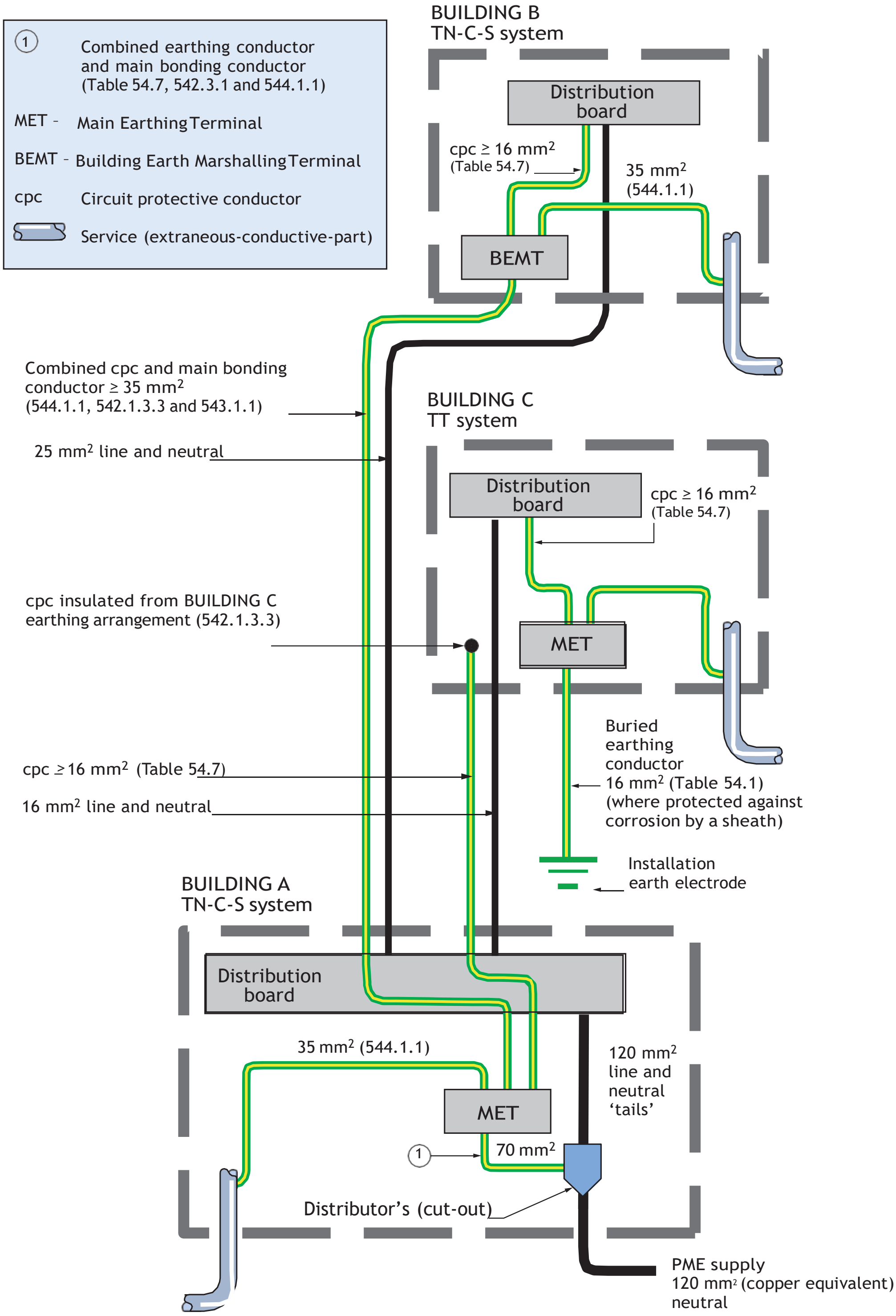


Fig 5.3 An example of the application of Regulation 411.3.1.2 where an installation forming part of a TN-C-S system serves more than one building

Two points to note are that the Building Earth Marshalling Terminal (BEMT) in Building B is connected to the MET in Building A by a main bonding conductor (formed by the cpc of the distribution circuit), and that the installation at Building C has its own MET.

In these illustrations all the numbers and tables given in brackets are references to *BS 7671,* and the term BEMT is used to describe the terminal serving as the earthing terminal in Building B. This term is not the only term used for such a situation in the electrical industry, the term Earth Marshalling Terminal (EMT) is also used.

It should be noted that Figs 5.2 and 5.3 are merely examples of earthing and bonding for a complex of buildings; they do not represent any particular situation. In practice a range of situations may arise.

6 Voltage, current and frequency

Low voltage supplies within the GEL network operate at 230 V[6] single-phase and 400 V three-phase. High voltage supplies may also be offered at 11 kV and 33 kV; however, HV supplies are outside the scope of this guide.

The amount of current that can be delivered by GEL is limited by the supply capacity of the network. The maximum current rating of the GEL cut-out for a three phase installation is 600 A per phase. Early contact with GEL is required where any additional loads or service alterations are necessary. It is essential this is carried out prior to the commencement of any works. The frequency will be 50 Hertz in all cases.

7 Prospective short-circuit current

It should be acknowledged that for any network (or circuit) of conductors the maximum value of prospective short-circuit current (PSCC) will occur at the start of the network, and the minimum value of PSCC will occur at the end, due to factors such as type and length of distribution cable, the cross-sectional area of the conductors and the supply transformer. Fig 7.1 provides an example.

The PSCC value within the GEL network is not constant, so it is impractical for this guide to provide exact values of PSCC for specific locations within the GEL network. Therefore, to select a protective device that is capable of breaking any short-circuit current that may occur within the installation the following maximum values should be assumed at the point of connection of a service to the GEL network:

- Single-phase 230 V connection to a low voltage distribution main - 16 kA
- Three-phase 400 V connection to a low voltage distribution main - 18 kA
- Three-phase 400 V connection to the busbars within a substation - 25 kA

[6] These values of voltage given in this section are not constant. Consequently, a tolerance value of +10 % or – 6 %should be allowed.

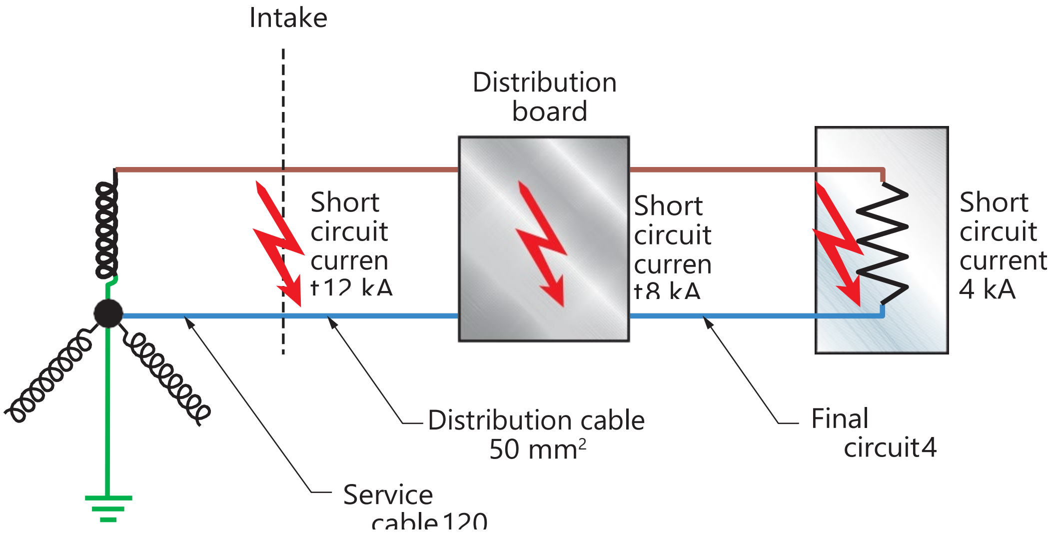


Fig 7.1 Example of reducing PSCC within a network of conductors

These maximum declared values of PSCC will reduce with every metre of cable from the point of connection to the GEL network. Tables 7.1, 7.2 and 7.3 are based on these maximum values and they provide examples of the expected PSCC at the GEL switchgear in consumers' premises for a range of services using CNE cable.

Although designing to a PSCC maximum value (given in this section) generally results in a designed PSCC value in excess of the actual PSCC value when the supply is connected; such a method provides future proofing. For example, with a growing GEL network and upgrading of old distribution equipment, a location currently having a PSCC value below the maximum value is likely to have an increased value.

Table 7.1 PSCC values for a typical 100 A single-phase service connection

Type of conductor	Length of service (m)	Expected PSCC (kA)
16 mm² Cu or 25 mm² Al	10	7.8
	15	6.0
	20	4.9
25 mm² Cu or 35 mm² Al	10	9.3
	15	7.4
	20	6.2

Cu - Copper
Al - Aluminium

Table 7.2 Expected PSCC for three-phase 400 V aluminium service (or its copper equivalent) connected to a load distribution main

Size of conductor (mm²)	Length of service (m)	Expected PSCC (kA)
35	10	12.2
35	20	8.8
95	10	15.3
95	20	13.0
185	10	16.2
185	20	14.7

Table 7.3 Expected PSCC for three- hase 400 V aluminium service (or its copper equivalent) connected to the busbars v thin a substation

Size of conductor (mm²)	Length of service (m)	Expected PSCC (kA)
95	10	21.0
95	20	17.5
185	10	22.4
185	20	20.0
300	10	22.8
300	20	21.0

8 External earth fault loop impedance values (Z_e)

It should be acknowledged that for any network (or circuit) of conductors the maximum value of earth fault loop impedance will typically occur at the end of the network, and the minimum value of earth fault loop impedance will typically occur at the start, due to factors such as type and length of distribution cable, the cross-sectional area of the conductors and the supply transformer. An example of increasing values of earth fault loop impedance within an installation is shown in Fig 8.1.

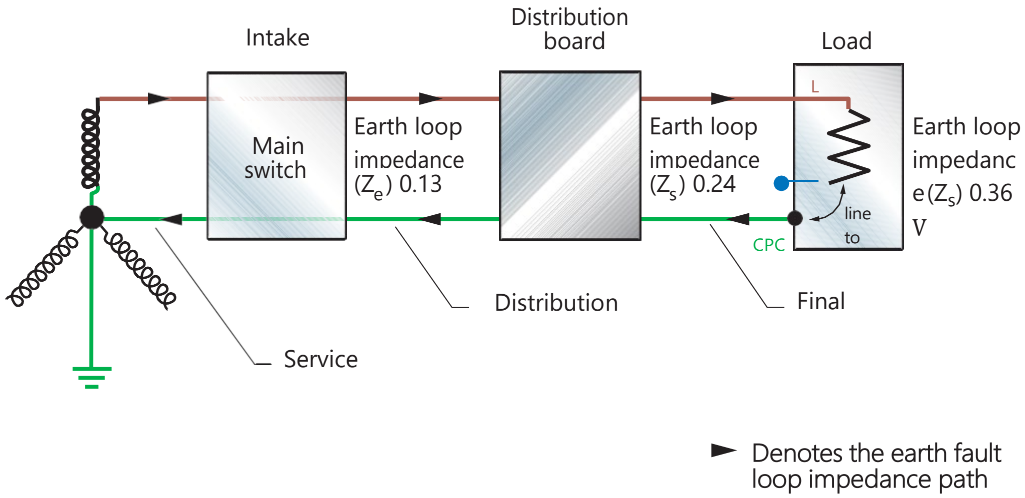


Fig 8.1 Example of increasing values of earth fault loop impedance within an installation

The value of external earth fault loop impedance (Z_e) within the GEL network is not constant, and so it is impractical for this guide to provide values of Z_e for any specific location within the GEL network. However, to provide contractors with an expected Z_e at the GEL switchgear in consumers' premises, the following maximum values are unlikely to be exceeded.

Table 8.1 Maximum values of Z_e at the GEL switchgear in consumers' premises

Earthing provision	Type of system	Z_e Value (Ω)
PME earthing terminal provided	TN-C-S	0.35
Cable sheath earthing terminal provided	TN-S	0.8
No earthing terminal provided	TT	21

Note: The declared value of 21 Ω for a TT system relates to the GEL source earthing electrode, and does not include the impedance of the consumer's earth electrode(s)

Due to distribution maintenance or modifications (and at times of fault) GEL cannot guarantee Z_e values throughout the life of an installation connected to the GEL network. Consequently, GEL will not accept responsibility for any change in Z_e values. For these reasons, it is essential that consumers' have their installations inspected and tested periodically.

9 GEL protective devices

To provide electrical protection for GEL equipment on consumers' premises, GEL will provide a fuse(s) at their switchgear position. The fuse will have a short-circuit rating suitable for the prospective short-circuit current at that point of the network and capable of carrying the expected maximum current for the installation.

For new supplies up to and including 100 A, GEL will provide cartridge fuse links to *BS 1361* Type II in their cut-out. In existing supplies up to and including 100 A, a range of fuse ratings and fuse links may be found (see Fig 9.1).

In older style cut-outs (metal) the fuse holder may contain either a cartridge fuse or fuse wire. Where an existing supply requires a fuse link replacement, GEL cannot guarantee that a fuse link having the same rating and/or type is fitted.

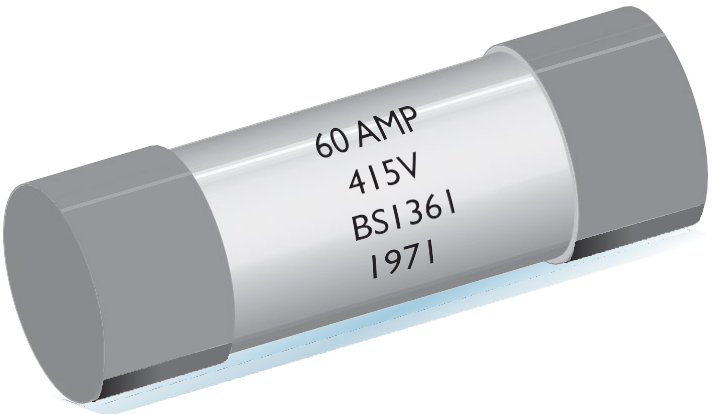


Fig 9.1 Example of a cartridge fuse to *BS 1361*

Note: Consumers are not permitted to access any of the GEL equipment including cut-outs.

10 Locations having specific risk

For new supplies the system provided by GEL will be Protective Multiple Earthing (PME) (Section 2 refers). However, as described in Section 2, PME systems have two distinct disadvantages.

1. Under normal conditions, a small voltage difference may exist between the PME earthing terminal at the origin of an installation and 'true' Earth potential, depending on the distribution network configuration and loading.
2. An open-circuit in the PEN conductor within the network can cause the GEL combined neutral/earth terminal at the cut-out in consumers' premises to rise above earth potential, due to carrying load currents from installations downstream from the open-circuit. As shown in Fig 10.1, this can create a shock risk.

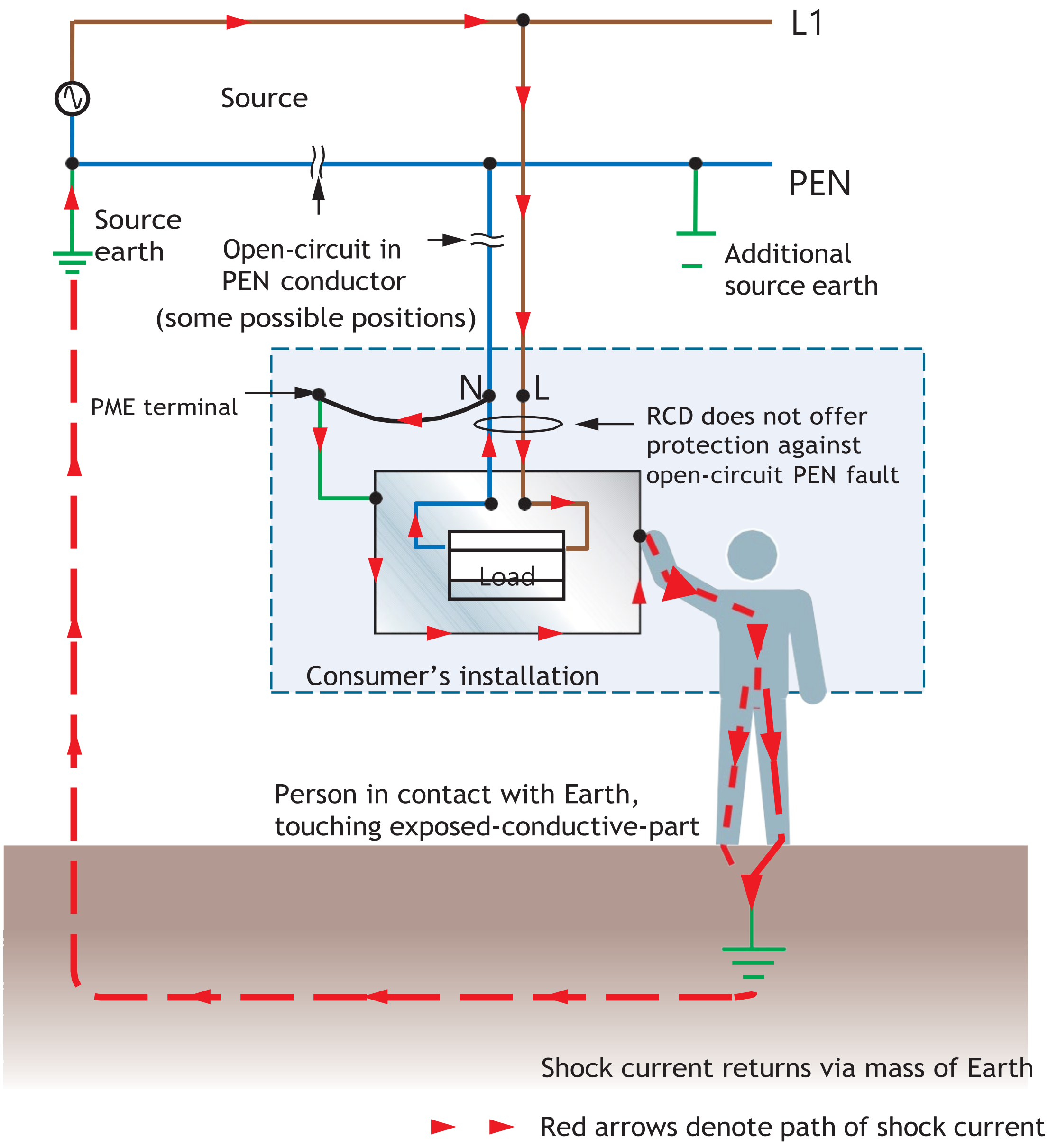


Fig 10.1 Open-circuit in PEN conductor

This section describes a number of situations where the PME system is supplied and where the use of the PME earthing terminal is either prohibited or restricted to where specified conditions are met.

It should be remembered that for an installation to be connected to a GEL supply, it is the responsibility of the consumer to ensure their installation uses an appropriate earthing arrangement for the particular location, and that their installation complies with the requirements of *BS 7671* and other applicable British and Harmonised Standards.

This section is divided into two sub-sections to provide clarity between those installations that apply to 'fixed locations' and those installations that apply to 'mobile locations'.

The following fixed locations are included:

The following mobile locations are included:

10.1 Agricultural and horticultural premises

The use of the PME earthing terminal within an agricultural or horticultural location is dependent upon how the particular location or parts of the location is used.

For example, where the location is a building having traditional construction and used for residential purposes the PME earthing terminal may be used, whereas for a building intended for livestock purposes it is advisable not to use the PME earthing terminal, especially where extraneous-conductive-parts, such as feeding troughs are present.

Livestock can be quite sensitive to voltage differences that may occur between the supply (PME earth) and extraneous-conductive-parts ('true Earth') within the installation.

The risk to livestock from voltage difference is recognised in Section 705 (*Agricultural and horticultural premises*) of *BS 7671,* and addressed by Regulation 705.415.2.1. Locations intended for livestock must have additional protection by supplementary bonding to connect all exposed-conductive-parts and extraneous-conductive-parts that can be touched by livestock.

Furthermore, a note to that regulation points out that the use of a PME earth facility is not recommended for locations intended for livestock, such as, for example, a milking parlour, unless the floor incorporates a metal grid.

Where a building having extraneous metalwork is intended for livestock the preferred method is to form a TT system having a separate connection to Earth and appropriately rated RCD(s) protection.

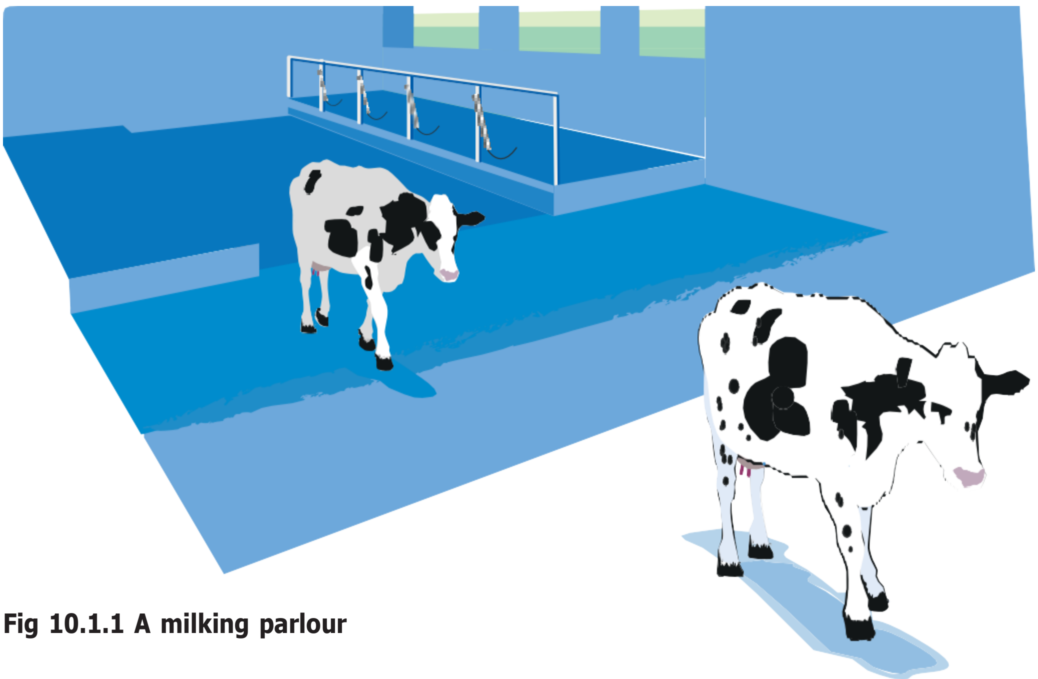


Fig 10.1.1 A milking parlour

10.2 Buildings having metal-frame and metal-clad construction

For buildings having a metal-frame and metal-cladding, as illustrated in Fig 10.2.1, the use of the PME earthing terminal should be considered by the contractor on a building-by-building basis. Deciding to use the PME earthing terminal will depend upon on whether, or not, the metal-frame and metal-clad exterior are extraneous-conductive-parts and, if so, the reliability of their continuity. Unless it is established that all accessible extraneous-conductive-parts will be connected to the main earthing terminal, use of the PME earth terminal is prohibited.

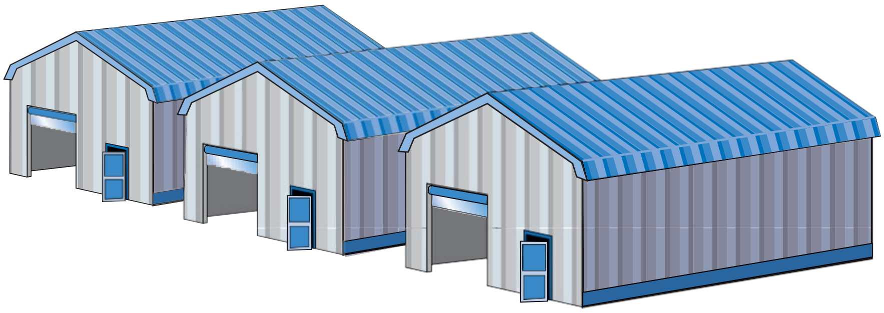


Fig 10.2.1 Buildings having a metal-frame and metal-cladding

Alternatively, a TT system having a separate connection to Earth and appropriately rated RCD(s) should be used. Where a TT system is used, fitting installation earth electrodes may not be required. For example, as illustrated in Fig 10.2.2, the structural engineer may permit the earthing conductor to be secured to a steel stanchion, enabling the metal-frame of the building to serve as the earth electrode, as permitted by Regulation 542.2.3 of *BS 7671*.

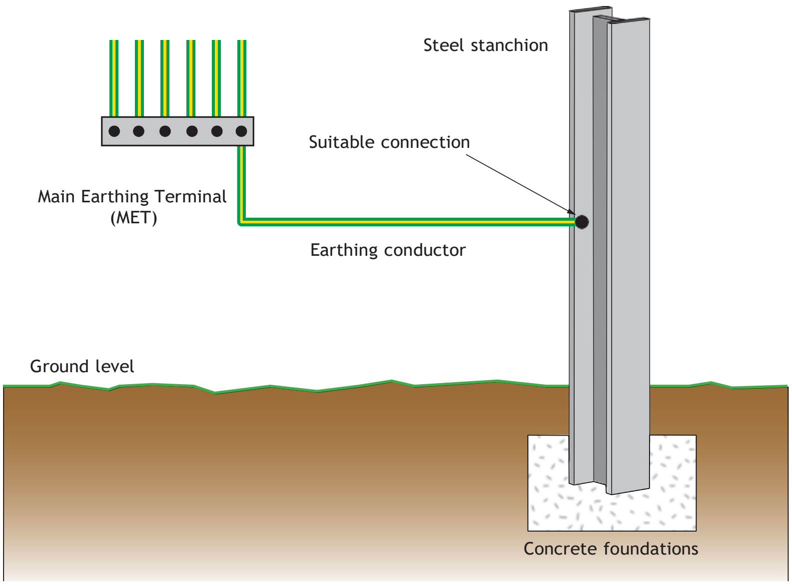


Fig 10.2.2 Example of structural steel serving as earth electrode

10.3 Caravan sites, camping sites and similar locations

Due to the potential risks explained in Section 2, the use of the PME earthing terminal is restricted to the permanent buildings (having traditional construction[7]) of caravan sites and similar locations, such as open-air sites used for music festivals.

The PME earthing terminal is prohibited for connection to locations having metal-framed construction including caravans, trailer tents and similar structures.

For locations where PME is prohibited, a TT system, as shown in Fig 10.3.1, having a separate connection to Earth and appropriately rated RCD(s) protection is preferred. Where electrical installations are required in caravan sites, camping sites and similar locations the requirements given in Section 708 (*Electrical installations in caravan/camping parks and similar locations*) of *BS 7671* should be met, to receive a GEL supply.

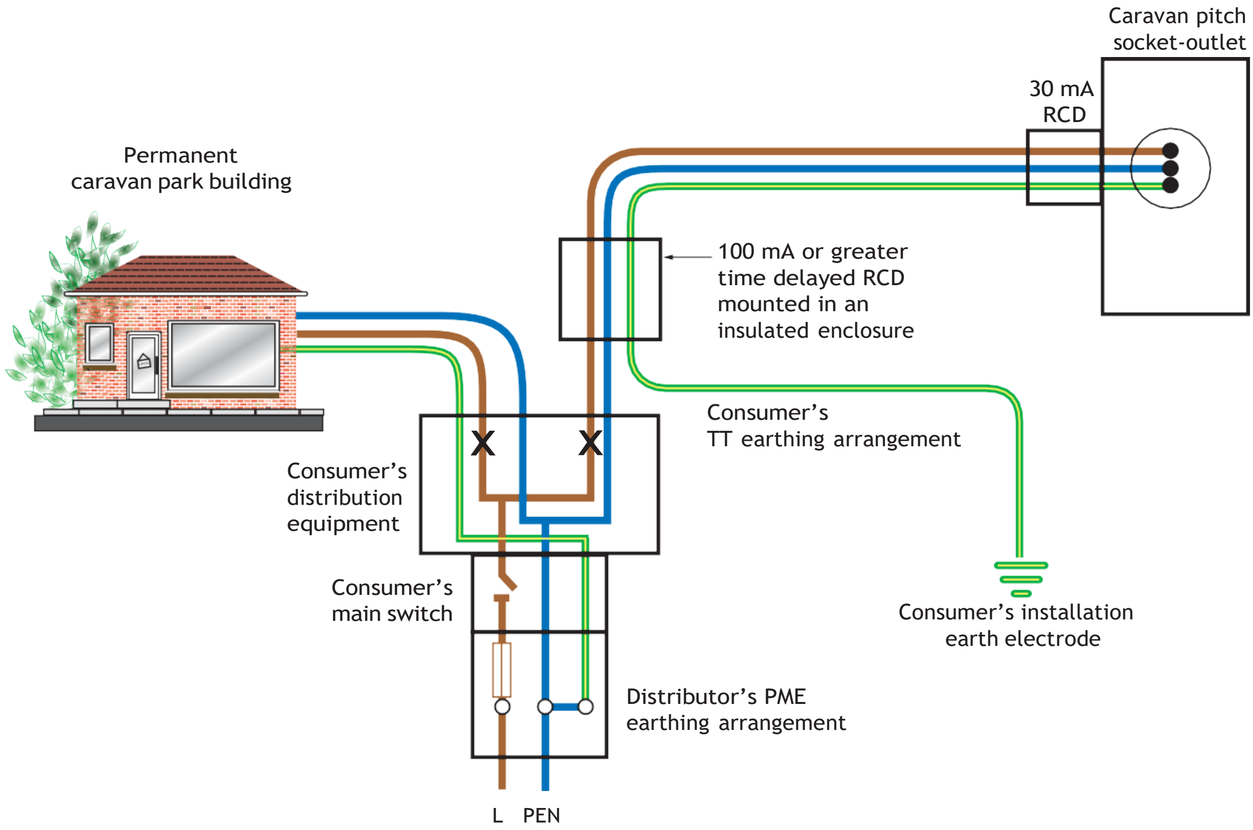


Fig 10.3.1 A typical caravan site installation (for clarity, only one phase of the distributor's supply is shown)

[7] Where a location has the area to accommodate one-off events, such as a caravan show; meaning temporary buildingsmay be used, consideration should be given to Section 10.9 (Locations used for exhibitions and shows) and Section
10.15 (Supplies to temporary buildings).

10.4 Construction and demolition sites

Where PME is provided for the temporary supply to construction and demolition sites[8] the earthing terminal should not be used for the installation within the site, due to the risk of a potential (voltage) difference occurring between the supply and extraneous-conductive-parts within the installation, such as scaffolding and cranes.

Fig 10.4.1 Construction and demolition sites

BS 7671 also recognises the risks of using a PME earthing facility for temporary installations within construction and demolition sites and although PME is not precluded, PME may only be used where it is assured that all extraneous-conductive-parts are reliably connected to the main earthing terminal (Regulation 704.411.3.1 refers).

The preferred option for construction and demolition sites is a TT system having a separate connection to Earth and appropriately rated RCD(s) protection. The TT system should be formed on the consumers' side immediately after the GEL metering equipment. Information on TT systems is given in Section 4.

The consumers' installation must comply with the applicable parts of Section 704 (*Construction and demolition site installations*) of *BS 7671.* Typically the person(s) responsible for site safety must ensure the requirements of *BS 7671* are met, and that when in service the installation is maintained in a safe condition throughout the period of construction or demolition work.

Further guidance regarding electrical safety for construction and demolition sites on the Island of Guernsey can be found in *The Organisation & Management of Health & Safety in Construction*. This approved Code of Practice can be downloaded from the Health and Safety section at: www.gov.gg

[8] A construction site or a demolition site is taken to mean the area of the site where practical work is carried out. Buildings within the site, for example, cabins used for offices are not included and may therefore use a PME earthingterminal (where required).

10.5 Fuel filling stations

The use of the PME earthing terminal within a fuel filling station is dependent upon how the particular location or parts of the location is used. The PME earthing terminal must not be used within the forecourt area, a TT system being preferred. However, where the location is a permanent building of traditional construction, such as the forecourt shop, the PME earthing terminal may be used providing all the applicable requirements of *BS 7671* are met.

The forecourt areas of fuel filling stations, as shown in Fig 10.5.1, are classed as explosive atmospheres; meaning the requirements of *BS 7671* require supplementing by the requirements or recommendations of other British or Harmonised Standards (Regulation 110.1.3 of *BS 7671* refers). One such standard; *BS EN 60079-14* (*Explosive atmospheres - Part 14: Electrical Installations design, selection and erection*) gives the specific requirements for the design, selection, erection and initial inspection for electrical installations in, or associated with, explosive atmospheres.

BS EN 60079-14 reflects general guidance for high risks areas, such as the forecourts of petrol stations; clause 6.3.3 (TT type of system earthing) requires a TT system to have separate Earth and appropriately rated RCD(s) protection.

Fig 10.5.1 A garage forecourt

Fig 10.5.2 shows, by example, one reason why PME must not be used in the forecourt area: the potential of diverted neutral currents flowing to Earth via underground tanks and pipework means there is a possibility of sparking at joints and connections in pipes.

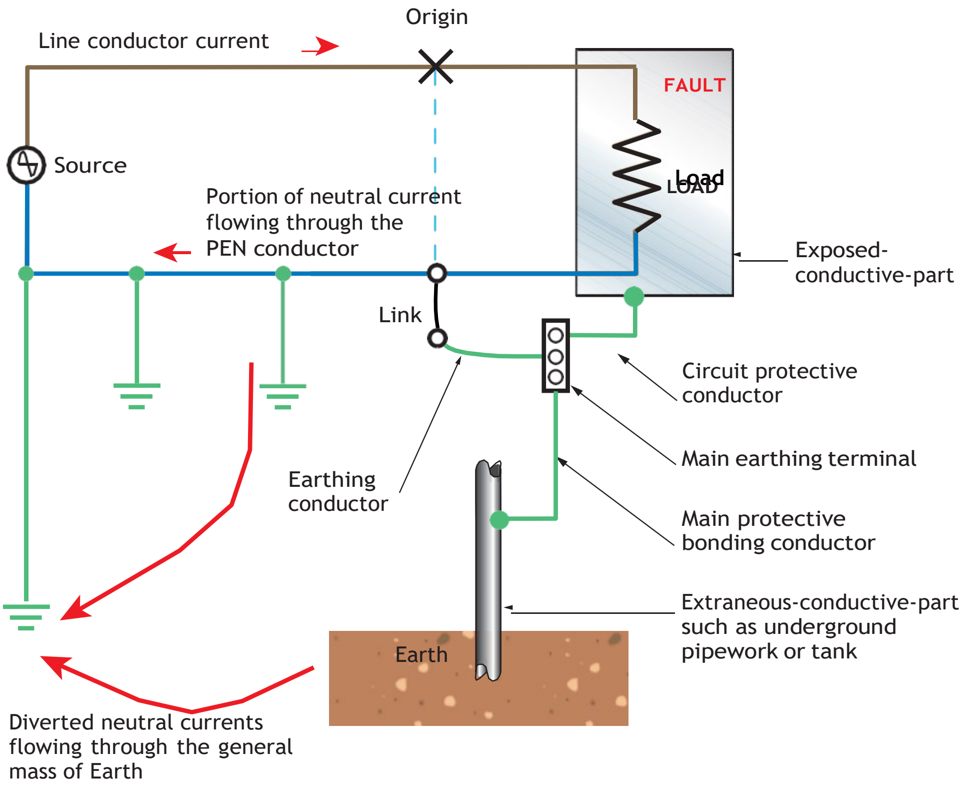


Fig 10.5.2 Example of diverted neutral current flowing to Earth in a PME system

Further information regarding the safety of electrical installations in fuel filling stations can be found in 'The Blue Book' published by APEA (Association for Petroleum and Explosives Administration) a UK based organisation.

10.6 Locations having a swimming pool

A location having a swimming pool poses an increased risk of electric shock to users. This shock risk associated with swimming pools and their surrounding '*zones*'[9] is a consequence of a reduced body resistance and good contact with Earth arising from wet partially clothed bodies.

Provided the requirements (especially the bonding) given in Section 702 (*Swimming pools and other basins*) of *BS 7671* are met; the PME earthing terminal may be used within the location. However, a TT system having a separate connection to Earth and appropriately rated RCD(s) is preferred.

[9] Zones are explained in Section 702 of *BS 7671*.

10.7 Locations having phone masts or radio masts

The use of the PME earthing terminal within locations having a phone mast or a radio mast is restricted, due to, for example, the difficulties in bonding all accessible extraneous-conductive-parts of the location.

Depending on the network functions, a location having a mast may be termed a ‘Base station’, if it contains the transmitters, receivers and other associated equipment required to make the mobile phone network function.

Where the building containing the transmitters, receivers and other equipment is of traditional construction, or a cabin, the PME earthing terminal may be used provided all accessible extraneous-conductive-parts are securely bonded in accordance with *BS 7671*.

For locations having a phone or radio mast, other than the aforementioned types of building, a TT system having a separate connection to Earth and appropriately rated RCD(s) is preferred.

Fig 10.7.1 provides an example of a mast and a cabin constructed of GRP within an enclosure formed by metallic fencing.

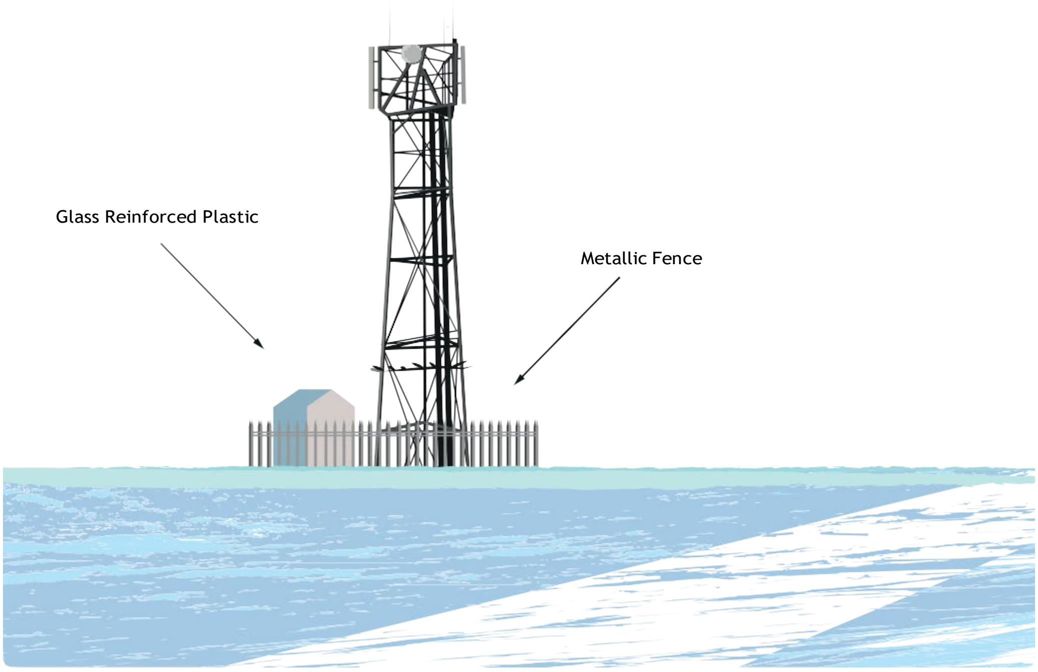


Fig 10.7.1 Example of a mast and a cabin constructed of GRP within an enclosure formed by metallic fencing

According to the Channel Islands Competition and Regulatory Authorities (CICRA) there are over 70 masts on Guernsey.

10.8 Locations having street furniture

Street furniture may be supplied with PME from either a feeder pillar or directly from the GEL distribution main CNE cable.

Locations having more than one item of street furniture may have either individual PME connections or looped PME connections, and regardless of the type of PME connection the earthing and bonding conductor of an item of street furniture is required to be a minimum copper equivalent cross-sectional area of 6 mm².

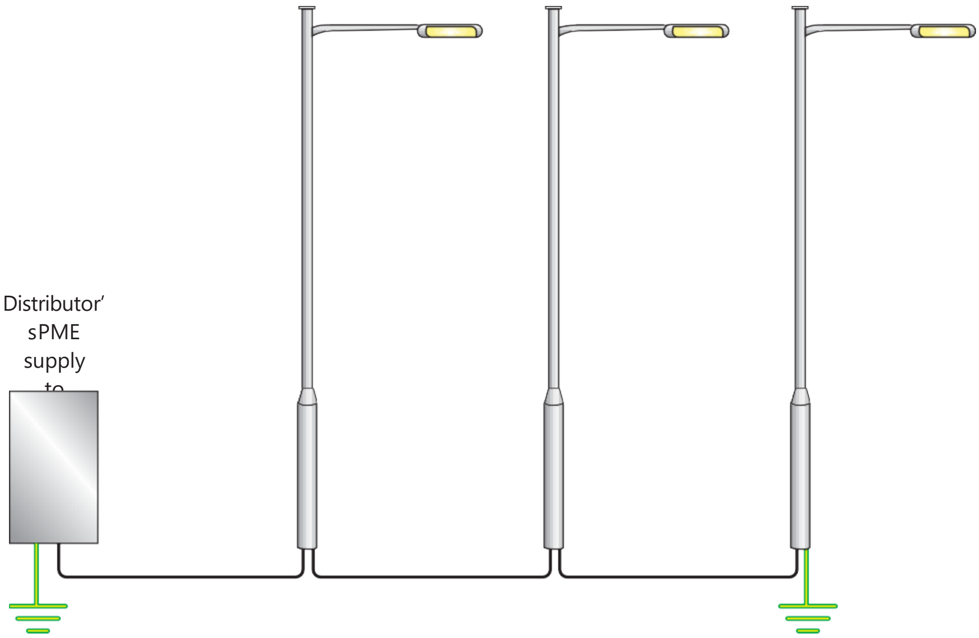


Fig 10.8.1 Circuit supplying street lamps, using cables with separate line, neutral and protective conductor

It should be noted that where GEL provides a PME supply for street furniture and the consumer wants to extend that supply to downstream items of street furniture, it is prohibited for the consumers’ installation to continue the PME supply using CNE cables. The PME supply must be segregated, for example, at a feeder pillar (see Fig 10.8.1), and SNE cables, such as armoured cables as illustrated in Fig 10.8.2, used for downstream supplies.

Where street furniture, excluding an electric vehicle charging point, is to be connected to a GEL supply the requirements given in Section 714 (*Outdoor lighting installations*) of *BS 7671* must be met.

Electric vehicle charging points are an item of street furniture that requires additional consideration. Consequently, information is given in Section 10.13.

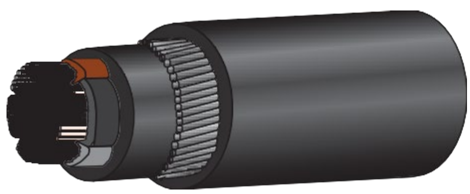


Fig 10.8.2 Example of a four core armoured cable

10.9 Locations used for exhibitions and shows

The use of the PME earthing terminal within a location used for exhibitions and shows is either restricted or prohibited, due to the temporary installations used for exhibitions and shows, and the potential for metal-framed stands.

Where a permanent building is used for exhibitions and shows the PME earthing terminal should be restricted to the fixed installation within that building, unless adequate supervision of the installation and reliable earthing is ensured within the location staging the exhibition or show.

Where an exhibition or show is staged at open-air venues and it is known that metal-framed stands having electrical installations will be used, use of the PME earthing terminal is prohibited. For locations where PME is prohibited, a TT system having a separate connection to Earth and appropriately rated RCD(s) is preferred.

For connection to a GEL supply, installations must meet the requirements given in Section 711 (*Exhibitions, shows and stands*) of *BS 7671*.

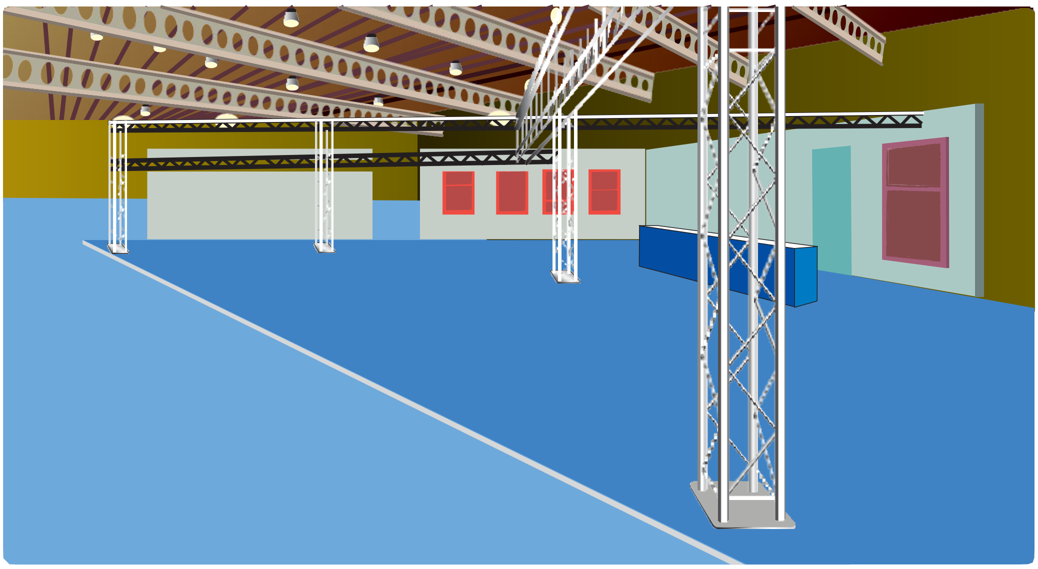


Fig 10.9.1 A metal-framed exhibition stand

10.10 Locations used for mines and quarries

The use of the PME earthing terminal within a location used for mines and quarries is dependent upon how the particular location or parts of the location is used. For example, the PME earthing terminal may be used for a permanent building, such as a cabin used as a mess room for site workers.

For locations of mines and quarries (other than permanent buildings) a TT system having a separate connection to Earth and appropriately rated RCD(s) is preferred. Alternatively, if the site has a secondary substation that is solely for the electrical installation of that particular site, a TN-S system formed from the transformer neutral may be used.

Mines and quarries are locations having specific risks, including the potential for an explosive atmosphere. Consequently, *BS 7671* does not provide specific requirements for installations in mines and quarries; meaning, the requirements of *BS 7671* require supplementing by the requirements or recommendations of other British or Harmonised Standards (Regulation 110.1.3 of *BS 7671* refers).

One such standard; *BS 6907-2: 1988* (*Electrical installations for open-cast mines and quarries. General recommendations for protection against direct contact and electric shock*) gives the specific requirements for the types of suitable systems to include TN-S, TT and IT (clause 6 (Power systems) refers).

Furthermore, information on how to provide electrical safety in mines and quarries is available free of charge from the Health and Safety Executive (HSE) for Great Britain. Two separate guidance documents titled; *Electrical safety in mines* and *Electrical safety in quarries* can be downloaded from the HSE website at: www.hse.gov.uk

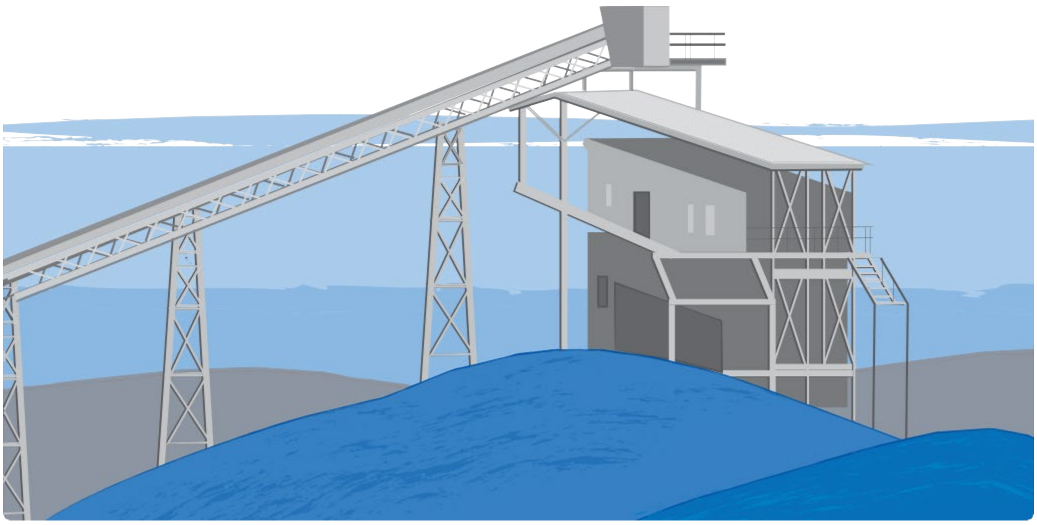


Fig 10.10.1 A quarry

10.11 Marinas and similar locations

The use of the PME earthing terminal within a marina and similar location is restricted to permanent buildings (having traditional construction) that are used for low risk activities, such as the shops and offices of the marina complex. This is because of the potential risks associated with PME systems under either normal conditions or open-circuit of the PEN conductor, and users being in contact with 'true Earth' (see Section 2).

Therefore, using the PME earthing terminal to connect locations within the marina having metal-framed construction is prohibited, including boats, other floating vessels and similar structures. For locations where use of the PME earthing terminal is prohibited, TT systems having a separate connection to Earth and appropriately rated RCD(s) are preferred.

For a safe environment within a marina and similar location the requirements given in Section 709 (*Marinas and similar locations*) of *BS 7671* must be met, for the installation to be connected to a GEL supply.

Fig 10.11.1, provides an example to highlight some of those requirements given in Section 709 for a marina having a floating pontoon. Note the use of an earth electrode to form a TT system for the shore and pontoon distribution cabinets.

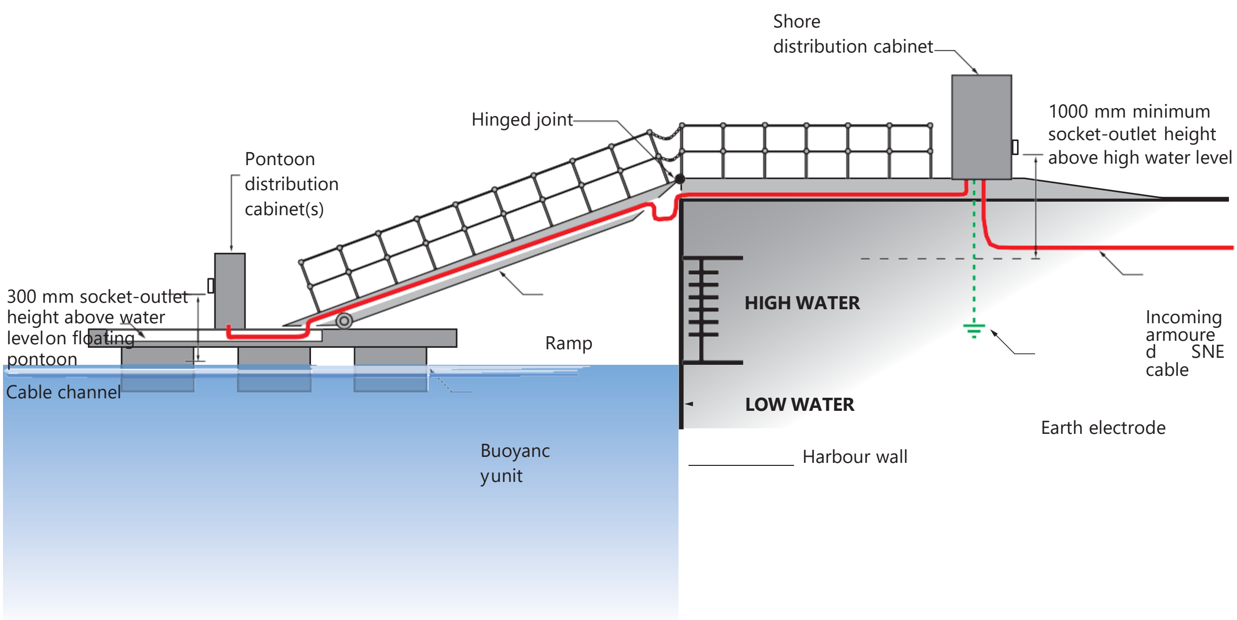


Fig 10.11.1 Example of a pontoon and the application of Section 709 of *BS 7671*

10.12 Oil refineries and distribution depots

Although a connection to the GEL Protective Multiple Earthing (PME) network may be provided for the supply to oil refineries and oil distribution depots; use of the PME earthing terminal is prohibited.

Oil refineries and oil distribution depots should use a TT system having a separate connection to Earth and appropriately rated RCD(s). Alternatively, if the site has a secondary substation that is solely for the electrical installation of that particular site, a TN-S system formed from the transformer neutral may be used.

Oil refineries and oil distribution depots (similar to the forecourts of fuel filling stations) are classified as explosive atmospheres; meaning, the requirements of *BS 7671* need to be supplemented by the requirements or recommendations of other British or Harmonised Standards (Regulation 110.1.3 of *BS 7671* refers).

The guidance regarding *BS EN 60079-14* given in Section 10.5 should be followed.

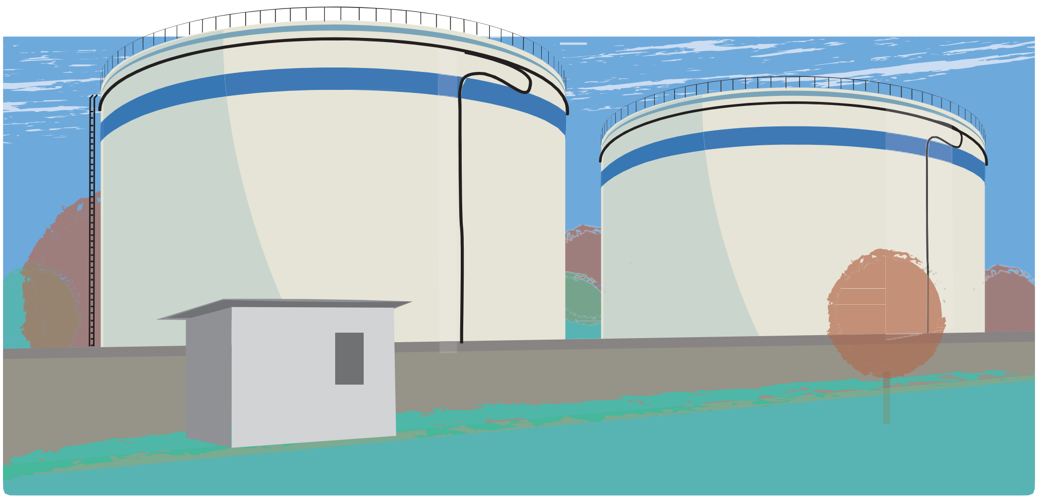


Fig 10.12.1 An oil distribution depot

10.13 Vehicle charging points

Vehicle charging points (VCPs) may be items of street furniture, for example, where they are installed adjacent marked bays in locations used for public vehicle parking. VCPs may also be installed in private locations, examples are, adjacent marked bays in areas used for workplace vehicle parking and within the outdoor area of domestic premises.

Regardless of a VCPs location for connection to the GEL supply the requirements given in Section 722 (*Electric vehicle charging installations*) of *BS 7671* must be met.

Where VCPs are to be installed the type of earthing system at the particular location must be taken into account. For example, where VCPs and associated circuit(s) are arranged to be within the equipotential zone of a PME earthing system, connection to the PME earthing terminal is permitted.

Where such an arrangement cannot be achieved the PME earthing terminal should not be used for VCPs. A TT earthing system, as shown in Fig 10.13.1, should be used.

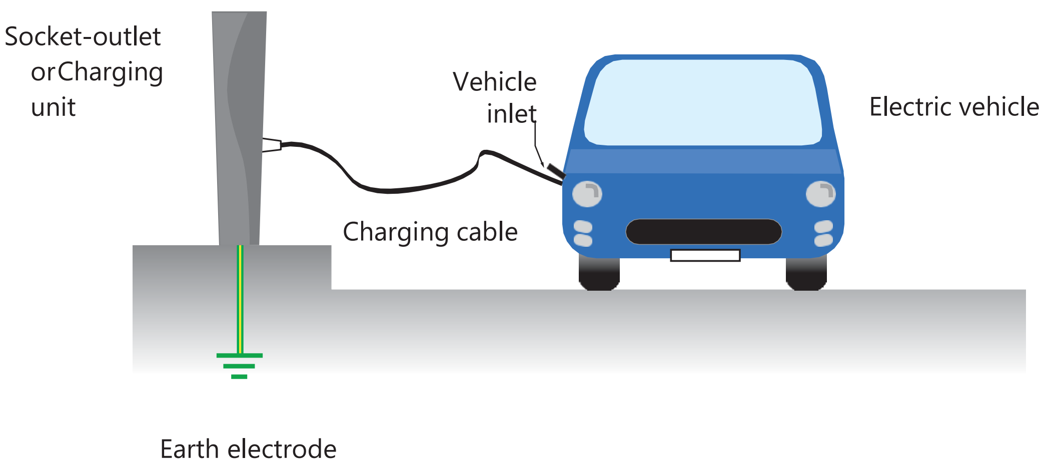


Fig 10.13.1 A vehicle charging point

10.14 Caravans and motor caravans

The use of the PME earthing terminal for connections to caravans and motor caravans is prohibited, due to the risks associated with persons simultaneously in contact with an exposed-conductive-part or an extraneous-conductive-part and 'true Earth' under either normal conditions or open-circuit conditions, as discussed in Section 2.

The PME earthing terminal may be used in buildings within a location having the facilities to accommodate caravans and motor caravans, provided those buildings have traditional construction and are used for low risk activities, such as administration purposes.

Under both normal and open-circuit conditions the GEL combined neutral/earth terminal at the cut-out can rise above earth potential. Consequently, conductors connected at that terminal are also likely to rise in potential; meaning any metalwork, such as the chassis or metal structure of a caravan or motor caravan connected to the electrical installation, is also likely to rise above earth potential and in doing so, create an electric shock risk.

A TT system having a separate connection to Earth and appropriately rated RCD(s) protection should be used for connections to caravans and motor caravans, to eliminate those risks associated with PME.

Caravan or motor caravans generally incorporate an 'inlet socket' to form the link between the electrical installation and the low voltage supply (see Fig 10.14.1).

The requirements of Section 721 (*Electrical installations in caravans and motor caravans*) of *BS 7671* must be met for electrical installations in caravans and motor caravans, to be connected to a GEL supply.

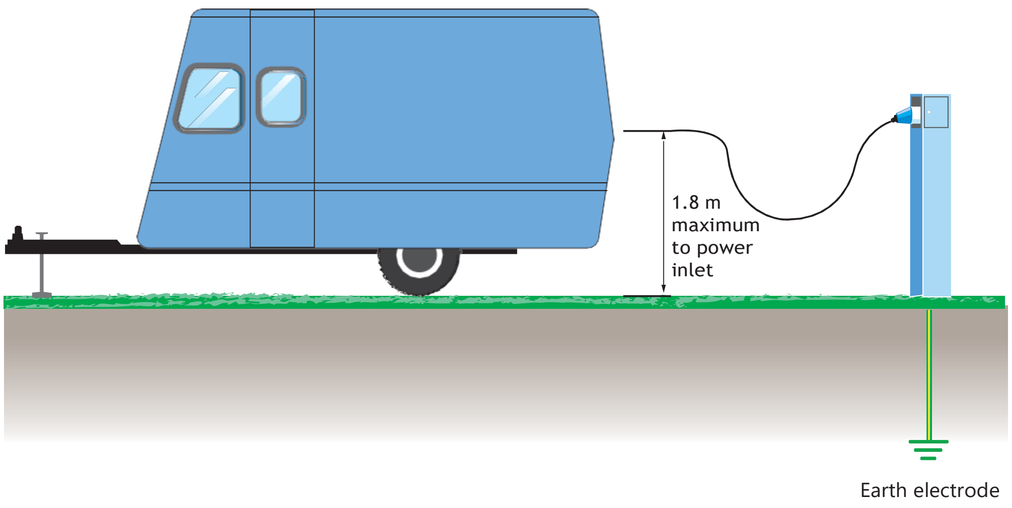


Fig 10.14.1 Supplies to caravans and motorhomes

10.15 Supplies to temporary buildings

A connection to the GEL Protective Multiple Earthing (PME) network will generally be given for the supply to locations accommodating a temporary building. However, the use of the PME earthing terminal within a temporary building will depend on its construction and how the building is used.

For example, where a temporary building is a cabin and used for a site office during demolition of a building, the electric shock risk is low; meaning the PME earthing terminal may be used for the building, whereas for a building having metallic framework and used at an open-air show to provide washing facilities, the risk is increased and it is advisable not to use the PME earthing terminal. In all cases, the contractor should carry out an assessment of the characteristics of the particular situation to decide on whether, or not, to use the PME earthing terminal.

Where the contractor having considered the particular conditions decides the PME earthing terminal is not suitable, a TT system having a separate connection to Earth and appropriately rated RCD(s) is preferred.

Fig 10.15.1 A temporary building

10.16 Travelling fairgrounds and circuses

The use of the PME earthing terminal for supplies to locations accommodating travelling fairgrounds and circuses is restricted to permanent buildings of traditional construction that have a low risk use, for example, a building used for administration purposes or food purchase/consumption purposes.

The PME earthing terminal must not be used for temporary supplies to amusement rides, amusement arcades, stands and tents. A TT system having a separate connection to Earth and appropriately rated RCD(s) should be used.

For an electrical installation to meet the risks associated with travelling fairgrounds and circuses the requirements given in Section 740 (*Temporary electrical installations for structures, amusement devices and booths at fairgrounds, amusement parks and circuses*) of *BS 7671* must be met, to connect the installation to a GEL supply.

Fig 10.16.1 Fairground installations

10.17 Vehicles having a low voltage electrical installation

The use of the PME earthing terminal for connections to vehicles having a low voltage electrical installation is prohibited, due to the risks associated with PME in either normal conditions or open-circuit of the PEN conductor, as explained in Section 2.

Vehicles having low voltage electrical installations are typically of metallic construction; meaning they present the same risks as caravans and motor caravans. Subsequently, for the reasons explained in Section 10.14, a TT system should be used for connections to vehicles having a low voltage electrical installation.

The PME earthing terminal may however be used within buildings of a location having the facilities to connect vehicles having a low voltage electrical installation, provided those buildings are permanent and of traditional construction and used for low risk activities, such as administration purposes.

For connection to a GEL supply electrical installations in vehicles must meet the requirements of Section 717 (*Mobile or transportable units*) of *BS 7671*.

Fig 10.17.1 A mobile unit

11 Application process for a supply from GEL

Where a new electrical supply, additional load and/or alterations to an existing supply is required, a formal application must be made to GEL, using the application form entitled; *Application for New Supply, additional Load and/or Alterations to Supply*, which can be downloaded from the GEL website: www.electricity.gg/my-account/new-supply.

This application form, which is shown in the Appendix, must be completed fully in accordance with the explanatory notes provided on the GEL website. The printed application form should be signed and posted to:

Guernsey Electricity FREEPOST GU355, GY1 5SS

An overview of the GEL application procedure for a new electrical supply, additional load and/or alterations to an existing supply is shown in Fig 11.1.

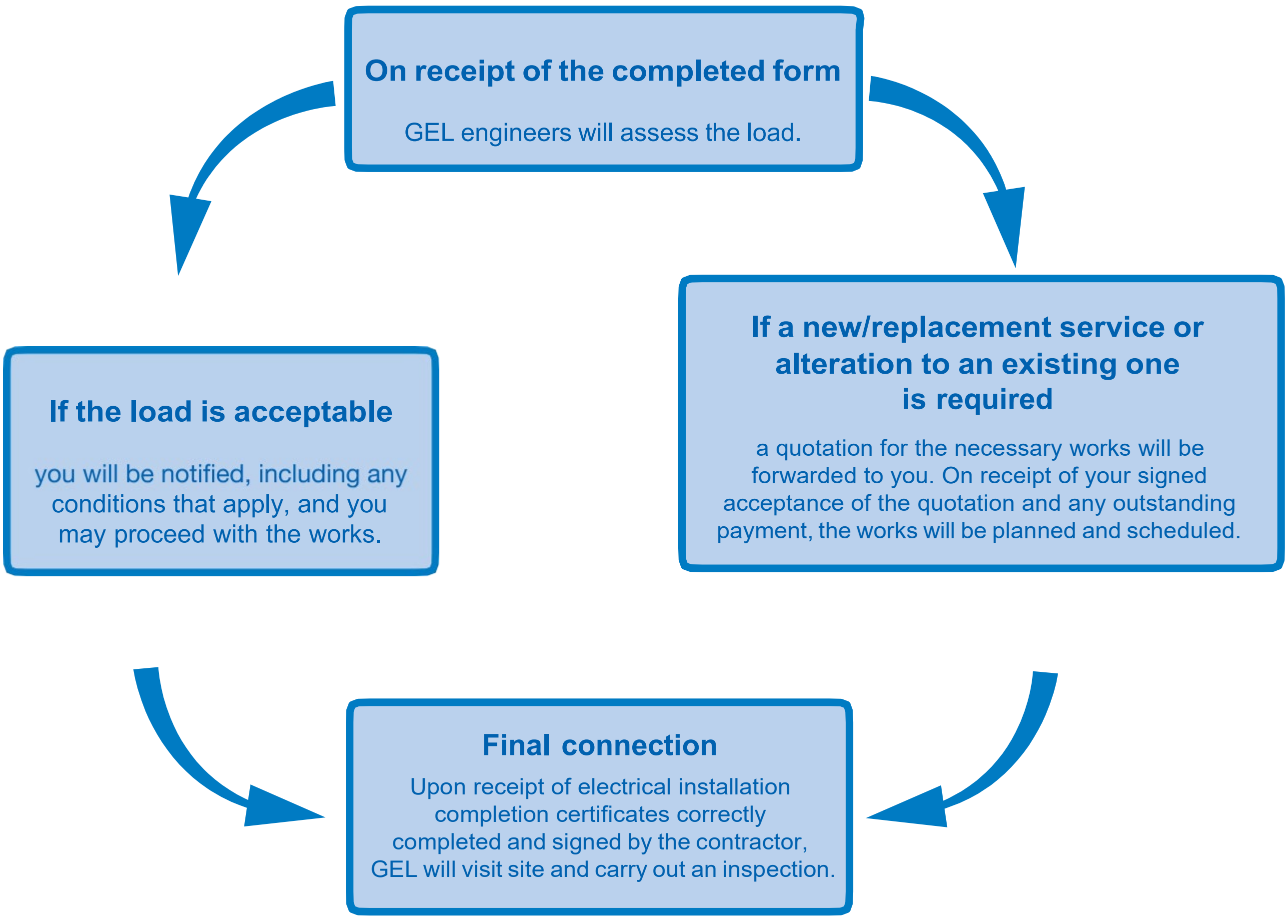


Fig 11.1 An overview of the GEL application process

Note: A site plan and building layout must be enclosed with all applications for new builds and alterations to existing service positions.

Appendix

GEL application form; *New Supply, Additional Load and/or Alterations to Supply*

This Additional Load Form (ALF) can be found at: www.electricity.gg/my-account/alf-or-new-connection/

Only an inspector appointed by GEL is permitted to make a connection to the GEL network, and before such a connection is made, the inspector must verify that the installation is safe to connect to the GEL network. Therefore, connection will only proceed once the inspector has successfully completed and signed the appropriate GEL electrical safety forms.