

# MARINAS AND SIMILAR LOCATIONS

We look at the requirements for electrical installations in marinas, together with the risks associated, including corrosion resulting from circulating galvanic currents and supplies to marinas, in particular the special concerns regarding Protective Multiple Earthing.

By Geoff Cronshaw



The 17th Edition of the Wiring Regulations (BS 7671:2008) introduced additional sections on special locations that were not included in the 16th Edition from 2008.

Among the special locations introduced were requirements for Marinas and similar

locations contained in section 709 of BS 7671.

There are particular risks associated with electrical installations in marinas. Obviously, the environment of a marina or yachting harbour is harsh for electrical equipment.

The water, salt and movement of structures accelerate deterioration of the installation. The presence of salt water, dissimilar metals and a potential for leakage currents increases the rate of corrosion. There are also increased electric shock risks associated with a wet environment, by

reduction in body resistance and contact with earth potential. The risks specifically associated with craft supplied from marinas include:

- i. open circuit faults of the PEN conductor of PME supplies raising the potential to true earth of all metalwork (including that of the craft, if connected) to dangerous levels;
- ii. inability to establish an equipotential zone external to the craft;
- iii. possible loss of earthing due to long supply cable runs, connecting devices exposed to weather and flexible cord connections liable to mechanical damage.

Particular requirements to reduce the above risks include:

- i. prohibition of a TN-C-S system for the supply to a boat (Regulation 709.411.4);
- ii. additional protection by 30mA RCDs in both the craft and the marina installation (Regulation 709.531.2);
- iii. outlets to be installed at not less than 1m above the highest water level. (Regulation 709.553.1.13 does give certain exceptions.)

There are also additional requirements to meet the conditions of external influences.

## SUPPLIES

Regulation 709.313.1.2 states that the nominal supply voltage of the installation for the supply to small vessels, recreational crafts or houseboats shall be 230 V a.c. single-phase, or 400 V a.c. three-phase.

Where the supply system is protective multiple earthed ►

◀ (PME), Regulation 9(4) of the Electricity Safety, Quality and Continuity Regulations 2002 prohibits the connection of the neutral to the metalwork of any caravan or boat. While the PME supply may be fed to permanent buildings in the marina, supplies to small vessels, recreational craft or houseboats must have a separate earth system. A TT system having a separate connection with Earth, independent of the PME earthing system will meet this requirement.

### What is Protective multiple earthing?

The Electricity Safety, Quality and Continuity Regulations 2002 (as amended) permit the distributor to combine neutral and protective functions in a single conductor provided that, in addition to the neutral to Earth connection at the supply transformer, there are one or more other connections with Earth. The supply neutral may then be used to connect circuit protective conductors of the customer's installation with Earth if the customer's installation meets the requirements of BS 7671.

This protective multiple earthing (PME) has been

almost universally adopted by distributors in the UK as an effective and reliable method of providing their customers with an earth connection. Such a supply system is described in BS 7671 as TN-C-S.

Whilst a protective multiple earthing terminal provides an effective and reliable facility for the majority of installations, under certain supply system fault conditions (external to the installation) a potential can develop between the conductive parts connected to the PME earth terminal and the general mass of Earth. The potential difference between true Earth and the PME earth terminal is of importance when:

- i. body contact resistance is low (little clothing, damp/wet conditions), and/or
- ii. there is relatively good contact with true Earth.

Contact with Earth is always possible outside a building and, if exposed-conductive parts and/or extraneous-conductive-parts connected to the PME earth terminal are accessible outside the building, people may be subjected to a voltage ▶

First characteristic numeral		Second characteristic numeral	
(a) Protection of persons against access to hazardous parts inside enclosures		Protection of equipment against ingress of water	
(b) Protection of equipment against ingress of solid foreign objects			
No.	Degree of protection	No.	Degree of protection
0	(a) Not protected (b) Not protected	0	Not protected
1	(a) Protection against access to hazardous parts with the back of the hand (b) Protection against foreign solid objects of 50 mm diameter and greater	1	Protection against vertically falling water drops
2	(a) Protection against access to hazardous parts with a finger (b) Protection against solid foreign objects of 12.5 mm diameter and greater	2	Protected against vertically falling water drops when enclosure tilted up to 15°. Vertically falling water drops shall have no harmful effect when the enclosure is tilted at any angle up to 15° from the vertical
3	(a) Protection against contact by tools, wires or such like more than 2.5 mm thick (b) Protection against solid foreign objects of 2.5 mm diameter and greater	3	Protected against water spraying at an angle up to 60° on either side of the vertical
4	(a) As 3 above but against contact with a wire or strips more than 1.0 mm thick (b) Protection against solid foreign objects of 1.0 mm diameter and greater	4	Protected against water splashing from any direction
5	(a) As 4 above (b) Dust-protected (dust may enter but not in amount sufficient to interfere with satisfactory operation or impair safety)	5	Protected against water jets from any direction
6	(a) As 4 above (b) Dust-tight (no ingress of dust)	6	Protected against powerful water jets from any direction
No code		7	Protection against the effects of temporary immersion in water. Ingress of water in quantities causing harmful effects is not possible when enclosure is temporarily immersed in water under standardized conditions.
No code		8	Protection against the effects of continuous immersion in water under conditions agreed with a manufacturer

Table 1: IP characteristic numerals



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**Advertising Sales** D Thomasson +44 (0)1438 767224 dthomasson@theiet.org | **Editor** G D Cronshaw +44 (0)1438 767384 gcronshaw@theiet.org |

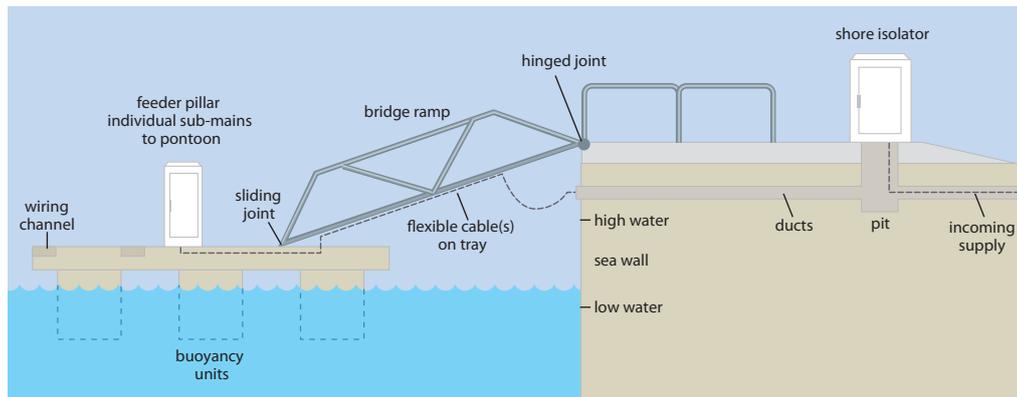
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### Typical wiring arrangement from shore to pontoon

◀ Final circuits intended for fixed connection for the supply to houseboats shall be protected individually by an RCD having the characteristics specified in Regulation 415.1.1. The device selected shall disconnect all poles, including the neutral.

An RCD is a protective device used to automatically disconnect the electrical supply when an imbalance is detected between live conductors. In the case of a single-phase circuit, the device monitors the difference in currents between the line and neutral conductors. If a line to earth fault develops, a portion of the line conductor current will not return through the neutral conductor. The device monitors this difference, operates and disconnects the circuit when the residual current reaches a preset limit, the residual operating current ( $I_{\Delta n}$ ).

An RCD on its own does not provide protection against overcurrents. Overcurrent protection is provided by a fuse or a circuit-breaker. However, combined RCD and circuit breakers are available and are designated RCBOs. Unwanted tripping of RCDs can occur when a protective conductor current or leakage current causes unnecessary operation of the RCD. An RCD

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

Regulation 709.533 has requirements for protection against overcurrent. Each socket-outlet shall be protected by an individual overcurrent protective device, in accordance with the requirements of Chapter 43.

A fixed connection for supply to a houseboat shall be protected individually by an overcurrent protective device, in accordance with the requirements of Chapter 43.

#### Isolation

BS 7671:2008 (2011) IET Wiring Regulations recognises four distinct types of isolation and switching operation:

- i. isolation
- ii. switching off for mechanical maintenance
- iii. emergency switching
- iv. functional switching.

Regulation 709.537.2.1.1 requires at least one means of isolation shall be installed in each distribution cabinet. This switching device shall

disconnect all live conductors including the neutral conductor. One isolating switching device for a maximum of four socket-outlets shall be installed.

#### Types of wiring system

Cables must be selected and installed so that mechanical damage due to tidal and other movement of floating structures is prevented.

Regulation 709.521.1.4 recognises that the following wiring systems are suitable for distribution circuits of marinas:

- i. Underground cables
- ii. Overhead cables or overhead insulated conductors
- iii. Cables with copper conductors and thermoplastic or elastomeric insulation and sheath installed within an appropriate cable management system taking into account external influences such as movement, impact, corrosion and ambient temperature
- iv. Mineral-insulated cables with a PVC protective covering
- v. Cables with armouring and serving of thermoplastic or elastomeric material
- vi. Other cables and materials that are no less suitable than those listed above.

Regulation 709.521.1.5 does not permit the following wiring systems on or above a jetty, wharf, pier or pontoon:

- i. Cables in free air suspended from or incorporating a support wire, e.g. as installation methods Nos. 35 and 36 in Table 4A2
- ii. Non-sheathed cables in conduit, trunking etc., e.g. as installation methods Nos. 4 and 6 in Table 4A2
- iii. Cables with aluminium conductors
- iv. Mineral insulated cables.

Regulation 709.521.1.7 requires that underground distribution cables shall, unless provided with additional mechanical protection, be buried at a sufficient depth to avoid being damaged, e.g. by heavy vehicle movement.

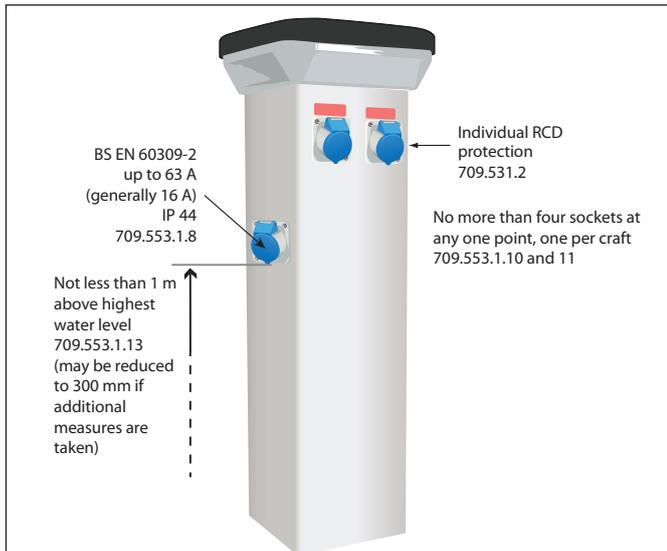
Regulation 709.521.1.8 requires all overhead conductors to be insulated.

Poles and other supports for overhead wiring shall be located or protected so that they are unlikely to be damaged by any foreseeable vehicle movement.

Overhead conductors shall be at a height above ground of not less than 6m in all areas subjected to vehicle movement and 3.5m in all other areas.

#### Distribution boards, feeder pillars and socket outlets

Socket outlets when mounted on floating installations or jetties should be fixed above the walkway and preferably not less than 1m above the highest water level. This height may be reduced to 300mm if appropriate additional measures are taken to protect against the effects of splashing (IPX4), but care should be



taken to avoid creating a low-level obstacle which may cause risk of tripping on the walkway. When mounted on fixed jetties they should be mounted not less than 1m above the highest water level.

**Corrosion**

As mentioned previously the immersion of metal components of a craft in water, particularly in salt water, provides the natural mechanism of galvanic corrosion. Where there are dissimilar metals on the electro-chemical series in proximity the detrimental effect of galvanic couples can be exacerbated and for this reason small vessels, recreational craft, houseboats, ships and many immersed metal structures are provided with sacrificial anodes (zinc for salt water) to which the more valuable/essential immersed metal parts such as propellers, shafts, hull fittings and fixings are electrically bonded and the sacrificial anode(s) preferentially deplete as a consequence of providing galvanic corrosion protection to such immersed parts.

Section 709 of BS 7671:2008 is based on European CENELEC Harmonisation

Document HD 60364-7-709. Annex A of the document contains examples of methods of obtaining a supply in a marina. HD 60364-7-709 recognises that there is an additional risk of electrolytic corrosion resulting from circulating galvanic currents in the protective conductor from the shore supply to a vessel when connected to a shore supply.

There have also been reports of increased rate of depletion of the sacrificial anodes of recreational craft which are connected on a longer-term basis to shore supplies, which is believed by some observers to be associated with the connection of the recreational crafts protective earth terminal (to which immersed components and sacrificial

anodes are bonded) to the shore supply earth in a marina or similar location.

HD 60364-7-709 recognises the use of an isolating transformer to prevent galvanic currents circulating between the hull of the vessel and the metallic parts on the shore side. The current standard for isolating transformers is BS EN 61558.

It is important to point out that all equipment must comply with the relevant standard.

Regulation group 511 of amendment 1 of BS 7671:2008 has requirements for compliance with standards. Extract below:

**511 COMPLIANCE WITH STANDARDS**

*511.1 Every item of equipment shall comply with the relevant requirements of the applicable British Standard, or Harmonized Standard, appropriate to the intended use of the equipment. The edition of the Standard shall be the current edition, with those amendments pertaining at a date to be agreed by the parties to the contract concerned (see Appendix 1).*

*Alternatively, if equipment complying with a foreign national standard based on an IEC Standard is to be used, the*

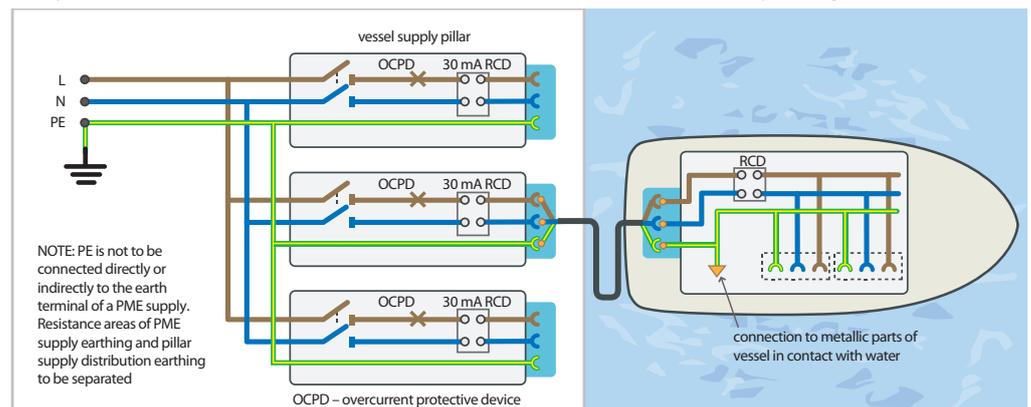
*designer or other person responsible for specifying the installation shall verify that any differences between that standard and the corresponding British Standard or Harmonized Standard will not result in a lesser degree of safety than that afforded by compliance with the British Standard.*

*511.2 Where equipment to be used is not covered by a British Standard or Harmonized Standard or is used outside the scope of its standard, the designer or other person responsible for specifying the installation shall confirm that the equipment provides the same degree of safety as that afforded by compliance with the Regulations.*

Equipment installed on board a small vessel or recreational craft does not come under the control of the wiring regulations (BS 7671) and would be required to comply with the appropriate standard.

**Conclusion**

It is important to be aware that this article only gives an overview of electrical installations in marinas and similar locations. For more information refer to section 709 of BS 7671:2008 incorporating Amendment 1. ■



**Connection to mains supply with single phase socket outlet**