



## Houseboats and recreational craft by Mark Coles

There is some confusion as to which standards are applicable to the electrical installations of vessels used as dwellings or for recreation. This article looks at the standards for installations of houseboats and recreational craft.

### Houseboats

There can be many different permutations of vessel but, essentially, a houseboat is a permanently moored vessel used as a dwelling which will not move from its berth other than for long-term relocation. There are no other stated definitions for sizes of houseboats but, under these circumstances, the electrical installation of a houseboat in the United Kingdom will need to comply with BS 7671.

The following is extracted from the scope of Section 709, Marinas and similar locations, Regulation 709.1 of BS 7671:2008:

**NOTE 3:** *The electrical installations of houseboats shall comply with the general requirements of these (BS 7671:2008) Regulations together*

*with the relevant particular requirements of Part 7.*

Although houseboats are dwellings they do not fall within the scope of Part P of the Building Regulations in England and Wales nor are they subject to the requirements of the Building Regulations (Scotland), whether stationary, moving or landed. The Building Regulations apply only to what the regulations define as *buildings* and it was decided some 15 years ago that houseboats would not be regarded as buildings. The same criteria applies to caravans and mobile homes, whether stationary or moving.

The main reason is practicality. Houseboats and mobile homes are generally manufactured offsite, often abroad and, hence, it would be impossible in most cases for building

control officers to carry out building control functions to ensure that the houseboats were manufactured to the standards in the Building Regulations. There are, of course, still dangers associated with the installation and use of gas and electricity.

### Electrical supplies

As with electrical installations of buildings, electrical supplies to vessels can be derived from many different sources, e.g. the public distribution network, privately owned transformer, local generation including SSEG, etc.

In the case of electrical supplies obtained from an on-shore origin, the method of connection will need to meet the requirements of Section 709, *Marinas and similar locations*, of BS 7671. Supplies to houseboats from the public network will need to comply with the ESQCR and are outside the scope of BS 7671. Such supplies are uncommon because of increased electric shock risks associated with a harsh, wet environment.

The requirements of Section 709 of BS 7671:2008 were looked at in issue No. 23 of *Wiring Matters*, Summer 2007. The article can be downloaded from this url: [www2.theiet.org/Publish/WireRegs/WiringMatters/](http://www2.theiet.org/Publish/WireRegs/WiringMatters/)

### Other craft

BS 7671 does not apply to domestic electrical installations of vessels other than houseboats.

Note that whilst not an electrical installation standard, the *Recreational Craft Directive* became mandatory on 16th June 1998 and requires that most new recreational craft and some second-hand craft brought into Europe, which are sold or placed on the market in any country in the European Community, comply with a number of Essential Requirements. Information on the Recreational Craft Directive can be obtained from the Department of Business Enterprise and Regulatory Reform at

[www.berr.gov.uk/files/file11294.pdf](http://www.berr.gov.uk/files/file11294.pdf)

The following looks at the type of vessel and the relevant standards that apply.

### 1. Small craft - Extra-low-voltage d.c. installations to ISO 10133

ISO 10133:2000 is an international standard which specifies the requirements for the design, construction and installation of extra-low voltage direct current (d.c.) electrical systems which operate at nominal potentials of 50 V d.c. or less on recreational craft of hull length up to 24 m. Some parts of the installation, such as engine wiring as supplied by the engine manufacturer, is not within the scope of the standard.

#### Electrical supply

Such installations will be supplied by installed batteries, often charged by self-limiting generators.

#### Voltage drop

The standard requires that all d.c. equipment is to function over a voltage range at the battery terminals as follows:

- for a 12 volt system - 10.5 V to 15.5 V
- for a 24 volt system - 21 V to 31 V

An exception is permitted where the equipment manufacturer specifies a higher minimum voltage. The specified minimum voltage shall then be used in the calculation of the conductor size.

Clause 4.6 of the standard permits a maximum 10 % voltage drop of the nominal battery voltage for any appliance - when every appliance in the circuit is operating at full load.

#### Cables

Cables to ISO 6722-3 and 6722-4 are specified, however, the parts of this standard have been consolidated into ISO 6722 and the latest version, of

which, is 2006. The standard's full title is *Road vehicles -- 60 V and 600 V single-core cables -- Dimensions, test methods and requirements*.

### Testing

Informative Annex C is quite sparse in terms of its testing recommendations:

- continuity test of circuits, particularly ring and protective circuits
- insulation resistance testing at 500 V d.c. for each circuit

No minimum or maximum values are stated.

### 2. Small craft - Alternating current installations to ISO 13297

ISO 13297:2000 is an international standard which specifies the requirements for the design, construction and installation of low-voltage alternating current electrical systems which operate at nominal voltages of less than 250 V single phase on recreational craft of hull length up to 24 m; the standard does not cover three-phase installations.

#### Electrical supply

The standard recognises the following methods of electrical supply:

- a single shore-power cable
- multiple shore-power cables
- inverter supplying a.c. from the craft's d.c. system
- on-board a.c. generator(s) supplying the required system load
- combination of shore-power cable(s) and on-board generator(s) used simultaneously provided the craft's circuitry is arranged such that the load connected to each source is isolated from the other

#### Protection

There are requirements for protection against overcurrent and residual or earth fault currents in this standard. RCDs are also termed ground-fault



circuit interrupters (GFCI) which reflects the use of the standard in the USA.

In un-polarized systems, double-pole circuit-breakers are required and fuses should not be installed.

The standard calls for a manually reset trip-free circuit-breaker to be installed within 0.5 m of the “source of power”, which could include a shore mounted socket-outlet, with an RCD having a maximum operating current of 30 mA and should operate within 100 ms.

Where this cannot be met, overcurrent protection on the primary side of isolation and polarization transformers up to 125 % of rated primary current is also required reflecting US practice. GFCIs (RCDs) are also specified for each receptacle (socket-outlet) located in the galley, toilet, machinery space or weather deck are to be protected by an RCD with a rated residual operating current  $I_{\Delta n}$  not exceeding 10 mA; the operating time is not specified.

### Cables

Fixed wiring cables are required to have a minimum rating of 300/500 V, with flexible cords having a minimum rating of 300/300 V. Note that no standard number for cables is referenced. The standard requires that the CSA of the protective conductor is not less than that of the live conductors of the circuit.

Live and protective conductors of the a.c. system are to be identified by colour in compliance with IEC 60446:

- line conductors - black or brown
- neutral conductors - white or light blue
- protective conductors - green or green with a yellow stripe

### Testing

Informative Annex C recommends that following system tests be performed upon completion of the a.c. installation:



- residual current device (RCD) testing
- continuity test of circuits, particularly ring and protective circuits
- insulation resistance testing at 500 V d.c. for each circuit
- polarity test at distribution and at each outlet

No minimum or maximum values are stated.

### 3. Small Vessels to IEC 60092-507 Ed 2

IEC 60092-507 Ed 2 (revised standard published in 2007) includes requirements for the design, construction and installation of electrical systems for small inland waterways and seagoing vessels for both commercial and recreational use.

The standard applies to vessels up to 50 m or with a maximum gross tonnage of 500 GT.

The following types of electrical systems and sub-systems installed on board a small vessel are recognised by the standard:

- d.c. at nominal voltage not exceeding 50 V
- single-phase a.c. nominal voltage not exceeding 250 V
- three-phase a.c. nominal voltage not exceeding 500 V

### Electrical supply

The standard recognises that the craft can be supplied by on board generation or by batteries provided that there is sufficient capacity to

Standard	Title	Applies to:
BS 7671:2008 17th Edition of IEE Wiring Regulations	Requirements for electrical installations	Permanently moored houseboat
IEC 60092-507 2nd Edition 2007	Electrical installations in ships – Small vessels	Commercial and Recreational Vessels, for inland waterway or seagoing, of up to 50 m or with a gross tonnage not exceeding 500 GT, with electrical systems comprising individually or in conjunction extra-low voltage 50 V d.c.max, low voltage single phase a.c. 250 V max, low voltage three phase a.c. 440V max.
ISO 10133 2nd Edition 2000	Small craft – Electrical systems – Extra-low-voltage d.c. installations	Pleasure craft needing to comply with Recreational Craft Directive with hull length up to 24 m supplied by extra-low voltage 50 V d.c. max
ISO 13297 2nd Edition 2000	Small craft – Electrical systems – Alternating current installations	Pleasure craft needing to comply with the Recreational Craft Directive with hull length up to 24 m supplied at low-voltage a.c. 250 V single-phase max
BS 7671:2008 17th Edition of IEE Wiring Regulations	Requirements for electrical installations	Marinas or similar locations

**Table 1: Which standard applies to which vessel**

supply all essential services simultaneously.

Equipment is required to function within the following parameters:

- frequency  $\pm 5\%$
- voltage +6 -10%
- single harmonic distortion  $< 3\%$
- total harmonic distortion  $< 5\%$

For d.c., the essential services of the vessel shall remain functional to the minimum voltage at the battery terminals.

For shore supplies the revised standard was drafted in conjunction with revisions to IEC 60364-7-709, on which Section 709 - Marinas and Similar Locations of BS 7671 was based. Both IEC standards cross reference each other for consistency in the provision and protection required for small vessels connecting their electrical systems to a shore supply.

#### Protection

The standard details degrees of

environmental protection required in various locations, the calculation of minimum ventilation requirements for fixed battery installations, the treatment of neutral conductors and associated earthing, the protection against electric shock on a.c systems with voltage exceeding 50V including the use of RCDs and protection against overcurrent and fault current.

As standards should not conflict, it would be pertinent to note that the reference to automatic disconnection of supply to a final circuit or equipment the use of RCD is recommended:-

*A residual-current protective device will provide a substantial degree of personal protection in most circumstances in locations where the risk of accidental contact is increased. On vessels with relatively small single-phase a.c electrical installations powered intermittently from a shore supply, a single RCD protecting the whole of the vessel's a.c system is commonly fitted. It should be noted that*

*not every marina or boat yard have RCD-protected shore supply power outlets as standard. The residual current device should have a rated residual operating current not exceeding 30 mA and an operating time not exceeding 40 ms at a residual current of 150 mA.*

#### Cables

Cables are to meet the requirements of IEC 60092-350 and be installed to IEC 60092-352. The minimum voltage requirements for cables is 600 V for 120/230 V systems and 1000 V for 400/440 V systems.

#### Testing

The standard has requirements for comprehensive electrical testing after installation:

- insulation resistance
- circuits and appliances tested under operating conditions for suitability
- voltage drop
- internal communication circuits
- continuity of protective conductors

### Vessels over 24 m

A short section dealing with particular additional requirement for vessels over 24m length is provided for essential services, capacity of batteries, treatment of earthed neutral (TN) and non-earthed systems (IT), navigational aids and steering gear.

### Summary of applicable standards

Table 1 summarises the standards quoted and shows which standard applies to which vessel.

### Legal requirements

Those working on the electrical installations of vessels must comply with the Electricity at Work regulations 1989. No competent-person schemes currently exist to mirror the requirements of the Building Regulations where marine contractors or their employees are assessed for competency. The Maritime and Coastguard Agency (MCA) have requirements for the operation of pleasure vessels and information can be obtained from their website at [www.mcga.gov.uk](http://www.mcga.gov.uk). Note that pleasure vessels carrying more than twelve passengers are deemed to be passenger ships and will need to comply with the *Passenger Ship Regulations*.

The British Marine Electrical

Federation (BMEA) is the trade association for the leisure marine industry and have issued a Code of Practice for Electrical and Electronic Installations in Small Craft (4th Edition 2001, updates to August 2006) which provides industry-approved guidance on such installations and interpretation of ISO 10133 and ISO 13297. Information can be obtained from [www.britishmarine.co.uk](http://www.britishmarine.co.uk).

### Further information

ISO (International Organization for Standardization) is the world's largest developer and publisher of International Standards. ISO is a network of the national standards institutes of 157 countries, one member per country, with a Central Secretariat in Geneva, Switzerland, that coordinates the system. Generally, IEC (International Electrotechnical Commission) develops electrical installation standards but occasionally, ISO undertakes this work.

Further information and reading can be found in the following publications with source locations shown:

- BS 7671:2008 Requirements for Electrical Installations, IEE Wiring Regulations, Seventeenth Edition

- The Electricity Safety, Quality and Continuity regulations (ESQCR) - [www.berr.gov.uk/files/file15239.pdf](http://www.berr.gov.uk/files/file15239.pdf)
- Recreational Craft Directive - [www.berr.gov.uk/files/file11294.pdf](http://www.berr.gov.uk/files/file11294.pdf)
- ISO 10133:2000, 2nd Edition - Small craft - Electrical systems - Extra-low-voltage d.c. installations
- ISO 6722:2002 - Road vehicles - 60 V and 600 V single-core cables - Dimensions, test methods and requirements
- ISO 13297:2000 - Small craft Electrical systems - Alternating current installations
- IEC 60446 4th Edition 2007 - Basic and safety principles for man-machine interface, marking and identification - Identification of conductors by colours or alphanumeric
- IEC 60092-507 Ed 2 2007 - Electrical installations in ships – Small vessels
- IEC 60092-350 Ed. 3.0 2008 - General construction and test methods of power, control and instrumentation cables for shipboard and offshore applications
- IEC 60092-352 IEC 60092-352 Ed. 3.0 2005 - Choice and installation of electrical cables
- Electricity at Work regulations 1989 [www.opsi.gov.uk/si/si1989/Uksi\\_19890635\\_en\\_1.htm](http://www.opsi.gov.uk/si/si1989/Uksi_19890635_en_1.htm)
- Electricity at Work regulations (Northern Ireland) 1991- [www.ulster.ac.uk/health+safety/policy\\_audit/policy/PDFS/3.10.pdf](http://www.ulster.ac.uk/health+safety/policy_audit/policy/PDFS/3.10.pdf)
- The Maritime and Coastguard Agency - [www.mcga.gov.uk](http://www.mcga.gov.uk)
- British Marine Electrical Federation (BMEA) - [www.bmea.org](http://www.bmea.org)

Finally, please note that this article provides an overview of a number of standards and in no way implies that all technical requirements are referenced, covered or included.

### Thanks

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