



WATER HEATERS ON BOATS

Debunking the Myth

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First published 18th September 2013

This Ed. 1.2 Released 6th October 2023

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Acknowledgments

Introduction

Recent research by the author into the domestic gas industry in the marine sector has revealed no single being or entity fully understands the rules and law regarding the installation of instantaneous gas water heaters (IWH). 77% of registered gas engineers interviewed have the wrong idea (<https://www.youtube.com/watch?v=jbkKHT0ZOmQ>). Reading any boater's forum shows widespread confusion and misinformation is rife (e.g. <https://www.canalworld.net/forums/index.php?/topic/119648-gas-water-heaters/>).

This discussion paper outlines the legal position in the UK, and shows the commonly held belief that an open-flued water heater can't be installed, is completely wrong.

It's a simple fact; a suitable¹ open-flued IWH can be installed on any boat irrespective of age.

This fact is clearly, demonstrably and obviously supported by UK law, the prescient British Standard and the Boat Safety Scheme (BSS), and this document shows why.

¹ Chinese-made instantaneous gas water heaters of the sort available on eBay, which are cheap and readily available, are not suitable for use on boats. These are usually designed for outdoor use and are not intended to be used with a flue. Most are over 14kw, making their installation in spaces intended for sleeping accommodation generally illegal. On finding these on a boat a registered gas engineer would have to follow the industry unsafe situations procedures. Note the BSS has no mandatory fail item concerning these heaters on private vessels providing they pass the relevant checks, although in most cases these are likely be an Advisory fail item at 8.10.1A.

Main Section

1. Background

There is much misunderstanding regarding the installation of IWH and it is first important to understand where the misunderstanding comes from.

Open-flued instantaneous gas water heaters are in widespread use on inland waterways boats in the UK, and makes such as Paloma, Morco, Rinnai, Ferroli are commonly seen. An open-flued IWH takes combustion air from the cabin, while a room-sealed appliance takes combustion air from outside the vessel, via a sealed duct. Both expel products of combustion to the outside via a flue.

In the UK, the Gas Safety (Installation and Use) Regulations 1998 outlines the UK legal position pertaining to gas safety, and what can or cannot happen legally to premises that fall under its scope.

ISO 10239:2017 is the current prescient International and British Standard relating to domestic gas system design and installation on small craft. This provides installers worldwide with a harmonised best-practice guide.

PD 54823:2016 is a published document that provides specific UK gas safety guidelines for boats, but in the case of appliance selection, this is subservient to ISO 10239 as it makes clear in Section 1 (Scope).

The various guidance documents for the marine sector for the last 44 years can be chronologically arranged as follows:

BS 5482-3:1979

BS 5482-3:1999

ISO 10239:2000

PD 5482-3:2005

ISO 10239:2008

ISO 10239:2014

PD 54823:2016

ISO 10239:2017 (no technical changes from the 2014 version)

2. ISO 10239

ISO 10239 is first released in 2000, and states at clause 7.4 that all new and replacement appliances must be room-sealed. ISO 10239:2000 becomes the prescient British Standard, and if a gas engineer or boatbuilder works to ISO 10239 from 2000 it is true that an open-flued IWH should not be installed (note, however, that there is no legal requirement to use this standard).

BS 5482-3:1999 becomes PD 5482-3:2005 and has guidance for replacing existing open-flued IWH intended to assist UK engineers who encounter an existing installation, but ISO 10239 has the say on new appliances. It seems that the ISO standard wanted to prevent fitment of open flues, while the PD document continued to offer engineers guidance to assist those consumers with an existing installation; a noble and useful cause.

These two documents are the origin of two commonly held beliefs in the marine sector, which are as follows:

Belief A:	All new appliances on a boat must be room-sealed (except cookers)
Belief B:	Open-flued water heaters can only be installed if replacing an existing appliance

Figure 1 - Commonly held beliefs about appliances

There was, for some time, limited half-truth in these statements, although UK law has never outlawed open-flued water heaters on boats (something discussed later). ISO 10239 remained clear that appliances on boats must be room-sealed in its next release in 2008. However, this changed in ISO 10239:2014 which states open-flues are OK for both new and replacement installations. It's fair to say that the 14 year legacy left by ISO 10239 between 2000 and 2014 was a significant time to allow Belief A to become set in stone. Belief B similarly followed due to the PD document.

The change was subtle but is unescapable when analysing ISO 10239. Comparing the two extracts below from ISO 10239:2000 in Figure 2 and ISO 10239:2014 in Figure 3 shows the clear difference. Figure 2 below shows room-sealed appliances only in year 2000:

7.4 All unattended appliances shall be of the room-sealed type (see 3.4 and 3.8), with air-intake ducting and flues for outgoing products of combustion terminating outside the craft, including any areas that can be enclosed by canopies.

Figure 2 - Appliance extract ISO 10239:2000

However, Figure 3 shows a different, more developed requirement in 2014:

- 7.4.2** All appliances designed to function unattended shall have a combustion system in which either:
- incoming combustion air passes through sealed ductwork connected to the enclosed combustion chamber and terminating outside the craft, including any areas that can be enclosed by canopies, or
 - mechanisms are incorporated in the appliance to prevent backdrafting from the exhaust and oxygen depletion in interior spaces.

Figure 3 - Extract from ISO 10239:2014, appliance flue requirements

The key in Figure 3, is that it states two options are permissible:

- A. The appliance must be room-sealed, **or**
- B. The appliance can be open-flued but must have a safety device in the flue

A Morco D61B, for example, has a 'spillage safety device' in the draught-diverter, meaning that after a period of 14 years "prohibition" this heater (to name one) can again be installed on any vessel. Belief A and B are from 2014 onward extinct, and still are today. The revision of ISO 10239 is underway, and might be out 2024 or 2025, and open-flues are set to remain permitted on the same basis as in Figure 3.

Unfortunately, the change in position in ISO 10239:2014 was missed by numerous entities: agencies, organisations, technical writers, colleges, training centres, gas engineers, boatbuilders and the public in general, who, in the main, still hold beliefs A and B to be true, nearly 10 years on.

3. PD 54823:2016

PD 54823:2016 completely misses the change in ISO 10239:2014 and creates its own view, broadly speaking appliances must be room-sealed only unless replacing an existing water heater. Bear in mind this is now a totally wrong position to take, because the prescient (and earlier) BS EN ISO 10239:2014 says it's fine (as shown in Figure 3).

Unfortunately, gas engineers have historically received training on permitted flue types based on this incorrect position in PD 54823:2016, as opposed to ISO 10239. Training centres teach engineers that they can only fit open-flued water heaters as replacements to existing installations, backed up by a risk assessment as instructed by PD 54823:2016. This of course completely contradicts UK law and ISO 10239 from 2014 onwards.

As a result, this has penalised boaters who have been known to have to remove IWH to meet 'RCD compliance' by over-zealous and misinformed surveyors and engineers. Research by the author into this has led to significant revision of industry training materials, as seen by this published amendment to UK gas training textbooks:

https://www.shop.niceic.com/pdf/a/700/Corrigendum_March%202021.pdf

Reading PD 54823:2016 easily shows it defers to ISO 10239 in all matters, but in particular with appliance selection as shown in Figure 4.

7 Appliances

Any additional appliance should be installed in accordance with BS EN ISO 10239:2014.

Any replacement appliance should meet the appliance requirements of BS EN ISO 10239:2014.

Figure 4 - Extract from PD 54823:2016, appliance selection

There is therefore a contradiction in PD 54823:2016 – on the one hand it says open-flued IWH only as replacement, on the other it says defer to ISO 10239, which in turn says open-flues are fine. It's a significant error, in all likelihood exacerbated by the 14 year ISO position.

This error in PD 54823:2016 has been put to BSI, but the answer comes back that the document was revised by a committee of experts, however, the document is deeply flawed and the depth of knowledge and quality of the review has to be questioned. More can be read about this here:

http://www.smallcraftservices.com/resources/TECH_MEMO/Problems%20with%20PD%2054823%20v1.3.pdf

Registered gas engineers remain nervous about fitting open-flued water heaters; recent research by the author (<https://www.youtube.com/watch?v=jbkKHT0ZOmQ>) shows 77% of 30 engineers wrongly stated they could not fit them, because they believe it's illegal; it's simply not the case.

4. GSIUR 1998

GSIUR states a non-room-sealed heater can be installed in a room intended to be sleeping accommodation as long as it is less than 14kw, and incorporates a safety shut-off in case of excess build-up of products of combustion (it extends this requirement to adjoining rooms, so in reality 14kw is the maximum possible in a typical inland waterways boat, although if completely separated with no interlinking vent, there is no prohibition to kw size). 14kw is no problem when considering ratings for typical European open flued water heaters, which are generally around below 12kw (the commonplace Paloma Mk V being 11.6kw, although ironically the manufacturer states in the handbook this appliance is not suitable for use in a boat).

UK law states this at Regulation 30, with the key section highlighted in Figure 5 below:

Under regulation 30(2), non-room-sealed appliances used for water heating, space heating and central heating of 14 kW or more gross heat input should not be installed in accommodation designed for sleeping in, such as bedrooms, bed- sitting rooms and the sleeping areas of caravans. **However, non-room-sealed heating appliances of less than 14 kW gross heat input may be fitted in these rooms/areas provided they incorporate a device which turns off the gas supply before a dangerous level of fumes can build up (regulation 30(3)).** An instantaneous water heater that is not room-sealed may not be installed in any room unless it incorporates such a device

The prohibitions in regulation 30 each extend to any cupboard or compartment which is accessed from the accommodation or room concerned (see regulation 30(4)). They also extend to any cupboard, compartment (eg cubicle) or space adjoining the accommodation or room concerned, where ventilation for safe operation of the appliance is provided via the accommodation or room concerned. Spaces adjoining the accommodation or room concerned where there is no air vent from

the space into the room, ie which are provided with ventilation for safe operation of an appliance from another source, are not included in the prohibition

Figure 5 - Extract from GSIUR 1998 Reg 30 Guidance Note

It is important to note that GSIUR (also at Regulation 30) absolutely prohibits the installation of open-flued appliances in a room containing a bath or a shower, due to the inherent risk of CO poisoning. A good example of some academic work on this is by Simpson, D and Calnan, M (1973, *Bathroom gas water heaters and the risk of carbon monoxide poisoning*, Medical Research Division, Health Education Council, Bristol).

GSIUR states at Regulation 30, shown in Figure 6:

(1) No person shall install a gas appliance in a room used or intended to be used as a bathroom or a shower room unless it is a room-sealed appliance.

Figure 6 - Extract from GSIUR Reg 30

This means it is illegal in UK law to install an open-flued appliance in a bathroom. When such an installation is encountered, Regulation 34 of GSIUR makes it clear that a gas engineer must take action in line with the *Gas Industry Unsafe Situations Procedure*, and also points out in paragraph 286 that continued use of an unsafe appliance “is an offence”.

It is not solely open-flued water heaters that can be found in bathrooms on boats. LPG-fired incinerator toilets have been introduced to the market in recent years, although no training module for gas safe registered engineers exists as it does with cookers and boilers etc. The manual for the “Cinderella Gas-fired Travel Toilet” contains the following warning in the instruction manual, as shown in Figure 7:

- **Strictly speaking the toilet is not a room-sealed appliance.** *The kilowatt input for the flued appliance is 2.4kW. Accordingly, a very small degree of high and low-level ventilation will be required for the toilet compartment; comparatively easy to achieve about the toilet door (less than 1sq" high level and less than 1sq" low level).*

Figure 7 - Extract from Cinderella Gas Toilet manual “Draft V3 – 8.2.2022”

It follows that as the appliance is declared by the manufacturer as being non-room-sealed, that it is illegal to install it in a room containing a bath or a shower as the extract in Figure 6 proves. This is obviously a problem for a toilet.

Note: GSIUR applies to all liveaboard boats, and rental boats e.g. tenanted and holiday hire boats. This is detailed in Regulation 2 (3)(c) and further explained in paragraph 67. In premises outside the scope of GSIUR, the Health and Safety at Work Act applies, which is detailed in GSIUR in paragraphs 79 and 80. GSIUR states even at premises outside its scope competence is still required. Also note the Merchant Shipping Act was recently amended, bringing all powered vessels in UK waters, including inland waters, within scope (effective 31/03/23), meaning that it is an offence for a boat owner or user to allow an unsafe situation to exist. This is explained in MGN 684 (M) available here:

<https://www.gov.uk/government/publications/mgn-684-m-safety-of-powered-watercraft/mgn-684-m-safety-of-powered-watercraft>.

5. The Boat Safety Scheme

The BSS accept open-flued appliances on hire and private boats irrespective of age and date of build. This is easily verifiable by reading the 2021 requirements here (see check items 8.10.1 – 8.10.4), which apply to both private and hire vessels:

<https://www.boatsafetyscheme.org/media/299267/bss-examination-checking-procedures-core-2-9-interim-final.pdf>

One factor that causes confusion in the industry is the dated position towards non-private vessels (e.g. workboats) which are covered by the 2002 “standards”, which can be seen here: <https://www.boatsafetyscheme.org/media/152984/2002%20ecp%20non-private%20craft%20original%2002.pdf>

It is worth noting that this document is on the process of being reviewed, and in all likelihood will adopt the same position as the 2021 requirements for other vessels.

Standard 8.2 in the 2002 document is clear as shown in Figure 8; all appliances must be room-sealed except cooking appliances:

Standard 8.2 *LPG Appliances shall be room sealed with the exception of cooking appliances. (NOTE: see paragraph 11.25).*

LPG appliances shall include a test fitting. (NOTE: see paragraph 11.26).

A satisfactory flame picture shall be present at each appliance burner when all appliance burners in the system are operating at maximum rate.

8.2.1 Identify all non-cooking LPG appliances and visually check they are room-sealed.

Figure 8 - Extract from BSS 2002 Standards

Paragraph 11.25 quoted in Figure 7 goes on to say that as long as the vessel was manufactured prior to 3rd January 2000, it can have a replacement open-flued appliance to an existing installation. This is clearly trying to mirror the requirement introduced by ISO 10239:2000 (as shown in Figure 2), with the date of 3rd Jan 2000 presumably being the inception date for ISO 10239:2000. In the 2000 edit of the BSS Standards shown in Figure 9, the BSS actively encourage removal and upgrade of existing non-room-sealed appliances:

Existing installations In addition to cooking appliances, existing installations may include LPG appliances which are not room sealed. Exemptions are in place to assist the owner of an existing vessel. As soon as the system requires any changes it must be brought up to the current Standards.

Owners are strongly advised to bring existing installations up to the new Standards in the general course of boat maintenance. Due consideration should be given to the life expectancy of existing LPG appliances and the efficacy of continued parts replacement in order to keep an appliance in service. Without due consideration to these factors owners put themselves, their families and anyone on board at risk.

Replacement of LPG appliances When LPG appliances other than cooking appliances in an existing installation are replaced only room-sealed models must be installed.

Figure 9 - Extract from BSS Standards, 2000

Unfortunately, when ISO 10239:2014 came out permitting open-flues (as shown in Figure 3), no amendment was made to the 2002 BSS Standards. The perverse situation still exists where UK law and ISO 10239 state open-flued appliances are OK, but the BSS says they are not OK on workboats. This is further complicated by the fact the BSS says open-flues are fine on private and hire boats (even in bathrooms).

For a period of time the 2000 Standards applied to all classes of boats undergoing BSS examinations (between 2000 and 2005). These conflicting positions and confusions have led to heaters being unnecessarily removed from boats. Note: the BSS introduced a new set of private boat guidelines in 2005, which do not discriminate on flue type or boat age / installation age, and this ended the issue of open-flues for private boatowners in terms of BSS certification.

Here's one criticism levelled at the (gas safe registered) author in writing in 2009 by a (non-gas safe registered) pre-purchase surveyor and prominent compliance consultant who had assessed a vessel recently certified:

I was somewhat taken aback to see an LPG multi-point water heater on the aft bulkhead. As I am sure you aware, in existing installations, the BSS allows boaters to fit replacement water heaters in the absence of any direct room-sealed replacement. But, it does not allow the fitting of non-room-sealed water heaters in new installations.

It is of course incorrect. In 2009, the BSS had changed to its risk based approach, this being adopted in 2005. On private boats like the one in question, the BSS did not have any opinion on whether the heater was existing or new, room-sealed or open-flued, just as it does not today. Unfortunately, the legal, safe, BSS-compliant open-flued IWH was ordered to be removed by the purchaser's surveyor as a condition of sale. The surveyor was just as confused as the rest of the sector.

One unfortunate reality affecting our sector is that the BSS do not prohibit open-flued appliances in bathrooms, despite any legal contraventions, presumably because their risk liability as decided by the Navigation Authorities is to 3rd parties, and an open-flued IWH in

a bathroom presents a 1st party risk (e.g. if a fault occurs it will poison the users, but not the neighbours).

The 1st party / 3rd party risk approach is not popular with marine professionals, who regularly discuss it, finding it unpalatable that even an owner's guest aboard is not considered a 3rd party, and could be unknowingly exposed to a dangerous installation. The risk approach means that a water heater leaking flue gas into the cabin is an Advisory check, and no repair is required. Changing this and other risks to a mandatory requirement was one area covered in March 2022 in an open letter by BSS examiners and others to the BSS owners

(http://www.smallcraftservices.com/resources/TECH_MEMO/Open%20letter%20BSS%20and%20navigation%20Authorities.pdf). The BSS owners did not agree there is a problem that is their responsibility, stating in their (unpublished) reply:

The Trust's legal team have not identified and [SIC] relevant changes in the regulatory or wider legal environment that would require the changes to the scope or coverage to the Scheme that are being requested

And:

There is no vicarious responsibility of the navigation authorities to the boat owner's guests. Boat owners are duty-bound not to knowingly or negligently place their crew (guests) at risk.

6. The RCD / RCR

It's often discussed that the Recreational Craft Directive (RCD) or post-Brexit the Recreational Craft Regulations (RCR) have certain 'mandatory requirements'. One commonly heard thing is people stating that open-flued IWH are "not RCD compliant". This is simply another massive misunderstanding.

Both the RCD and RCR have a list of essential requirements that must be met, for example that a gas system is installed correctly. It does not, however, state how that must be achieved; it is for the installer / boatbuilder to achieve, and if necessary, prove a safe standard of work. One way of attaining that is of course to follow a British Standard, such

as BS EN ISO 10239, but there are other routes. British Standards are of course guidance documents and might provide best practice guidance, but are not law.

It is the case that ISO 10239 is harmonised to the RCD (but not the RCR). This is supposed to mean that installing a gas system to ISO 10239, in turn means that the essential safety requirements of the RCD for gas systems have been met by default (although it does not guarantee a safe gas system at all, see here

[http://www.smallcraftservices.com/resources/TECH MEMO/ISO%2010239%20v%20ER%205.5.pdf](http://www.smallcraftservices.com/resources/TECH_MEMO/ISO%2010239%20v%20ER%205.5.pdf)).

This harmonisation means that if ISO 10239 changes at all, then those changes are relevant to the RCD essential requirements. Essentially, in the case of the flue type change in 2014 discussed earlier, any new boat being built from 2014 onwards, where ISO 10239 was used, could be fitted with an open-flued IWH and be, by default, 'RCD compliant'.

However, the truth is that it would also have been fine prior to 2014, because UK law allows an open-flued appliance as demonstrated earlier. The installer or boatbuilder would not have been able to declare the boat to ISO 10239 on the declaration of conformity, but as they don't have to it's not a problem. They could have used other means to show they met the essential requirements of the RCD, such as GSIUR, customs and practice, BSS guidelines. Now, as shown, they can use ISO 10239 and have an open flued IWH. However the subtlety of the above is often lost amongst the noise of (factually inaccurate) popular opinion borne of poor advice.

Summary

The UK boating community and gas industry has got itself in a complete mess regarding open-flued IWH. There has been a lack of diligence with regard to guidelines, training and safety documents.

UK law permits the installation of a an open-flued IWH on a boat of any age, but in most cases it will need to be less than 14kw, and always incorporate a safety shut-off in case of excess build-up of products of combustion, to be installed in a boat. This is clearly stated in Regulation 30 of GSIUR.

BS EN ISO 10239:2014 and 2017 permits the installation of an open-flued water heater, both as a replacement or new appliance, to an existing or new boat of any age. This is clearly stated at clause 7.4.2 in the document.

PD 54823:2016 contains errors and is contradictory, and can't be relied on as a valid source of information in regards to IWH or flues, but as the document states, it defers to ISO 10239 for both new and replacement appliances, meaning it's therefore fine.

The BSS does not discriminate on flue type or boat age at all where private and hire vessels are concerned. The BSS has a dated policy within the 2002 standards that pertain to non-private vessels, currently being revised.

Boat users now have a legal responsibility to ensure they do not endanger another party, under the revised scope of the MSA, as shown in MGN 684 (M).

Figure 10 below provides a summary of who allowed open-flued IWH and when, just as a final illustration, set against the pale green top band of UK law, where no prohibition has ever existed.

OPEN-FLUED APPLIANCES PERMITTED TRACKER												
Scheme / Instrument	Year of Enactment or Introduction											
	1979	1996	1999	2000	2002	2005	2008	2013	2014	2016	2017	2021
UK LAW / GSIUR	Can Install	Can Install	Can Install	Can Install	Can Install	Can Install	Can Install	Can Install	Can Install	Can Install	Can Install	Can Install
ISO 10239	Scheme Not In Existence	Scheme Not In Existence	Scheme Not In Existence	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Can Install	Can Install	Can Install	Can Install
BS 5482-3 / PD54823	Can Install	Can Install	Can Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Can Install	Can Install	Can Install	Can Install
BSS PRIVATE	Scheme Not In Existence	Can Install	Can Install	Can Not Install	Can Not Install	Can Install	Can Install	Can Install	Can Install	Can Install	Can Install	Can Install
BSS NON PRIVATE	Scheme Not In Existence	Can Install	Can Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install
BSS HIRE BOAT	Scheme Not In Existence	Can Install	Can Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Can Install	Can Install
KEY	Can Install	Can Install	Can Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Can Not Install	Scheme Not In Existence

Figure 10 - Who allowed open flues and when

Notes to Editors

Tom Keeling is a Chartered Engineer and Chartered Marine Engineer working as an inland waterways-based marine surveyor. He has run his independent consultancy businesses in this sector for many years, specialising in the survey of steel hull boats.

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