

## Water Heating UK – 14<sup>th</sup> May 2016

### Hot Water Storage Systems for Heating by Solid Fuel Appliances - General Requirements and Test Methods

#### 1.0 Introduction

All hot water storage systems installed in the UK have to meet the appropriate regulatory requirements, the most significant of these being the UK Water Regulations and Building Regulations Parts L and G.

The main area of interest in this document is Building Regulation G which covers the safety of hot water storage systems and is centred on the fundamental principle that the temperature of the stored water should not exceed 100°C.

Whilst mains pressure storage systems are the popular choice for systems heated by gas, oil or electricity, it is still unusual for them to be heated by solid fuel and this situation is aggravated by the misconceptions that the G3 Building Regulations do not permit the use of solid fuel unvented systems, and there currently being no available standards covering the use and test of primary storage systems.

This document seeks to provide an overview of what criteria shall be met for the unvented system to meet the relevant statutory requirements, whilst also not putting at risk the safety of the occupants of the dwelling or the solid fuel appliance which is being used; either as the only heat source or in conjunction with other heat sources. Manufacturers' who are members of Hot Water Association and meet the requirements of the HWA charter may present their hot water storage system to HETAS for recognition, review and listing in the HETAS guide under this standard for approved listing.

For the purposes of this document we can broadly divide the products into four types as follows.

- Vented Secondary Storage (typically BS1566 copper cylinders)
- Vented Primary Storage
- Unvented Secondary Storage (typically to EN12897)
- Unvented (sealed system) Primary Storage

#### Vented Secondary Storage cylinders

These products are already widely used within solid fuel system designs and would not normally require separate testing/certification for use with solid fuel systems. The most important safety feature of these products is the open vent; which provided the vent connection and associated pipework, and are of sufficient diameter to provide a high degree of safety.

It should however be borne in mind that G3 still applies and the installation should still make provision for an additional over temperature control.

In the case of indirect heating by an open vented solid fuel boiler system then this can be regarded as the second level of over temperature control since the vents on the primary and secondary system operate independently of each other.

In the case of an auxiliary immersion heater being fitted, as is fairly common for summer use, then the immersion heater must have a non-auto-resetting cut out in addition to the normal "comfort" thermostat.

#### Vented Primary Storage

Whilst these produce high pressure hot water the actual stored primary water is vented. Whilst these can be indirectly heated it is more common for the store to be directly heated by the solid fuel appliance, this is often the preferred choice when used in conjunction with several appliances when the store also acts as a “neutraliser”.

In situations where the store is indirectly heated by the solid fuel appliance then the situation is more or less identical to that in a vented secondary store.

In the more common directly heated stores then there needs to be an additional level of over temperature protection such as a two port valve on the primary operated by an over temperature thermostat on the store and means must be found to safely shut down the heat source or dissipate the heat elsewhere.

### Unvented Secondary Storage

In these systems the preferred method of over temperature protection is the Temperature relief valve which discharges the cylinder contents should the storage temperature exceed 95°C. In addition to this a second over temperature cut out should be provided, typically set between 80°C and 85°C. In the case of immersion heaters then this is a simple non-manually resetting cut out in series with the electrical supply. For indirect systems it is normally a combination of a cut out and two port valve.

As in the case of vented thermal stores then it could be argued that if the indirect primary circuit is vented then this in itself could be considered as one of the two level of over temperature control.

As in the previous example requirements of G3 can be easily satisfied in terms of the safety of the stored hot water but means must be found to safely shut down the heat source or dissipate the heat elsewhere.

### Unvented (sealed system) Primary Storage

This is a growing market area in the UK although already a popular option in continental Europe. The UK's G3 Building Regulations recognise the existence of these products but discourage (as opposed to forbidding) the use of temperature relief valves. The reason for this is twofold in that unless a special double check valve arrangement is used then the Water Regulations preclude the permanent connection of a water supply to the “non-potable” primary circuit. This system is however successfully used by at least one major manufacturer who supplies the appropriate hardware for the water connection.

The second reason is that discharge of the primary water would waste significant amounts of expensive system inhibitor.

The normal way of overcoming this situation is the use of a second fully independent energy cut out wired to a motorised valve or perhaps to the circulating pump if there is no chance of gravity circulation.

Another alternative is the use of what is effectively a quench coil arrangement to cool the contents of the store, this can be achieved using the domestic hot water heat exchanger normally fitted inside the appliance.

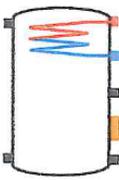
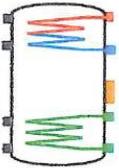
## 2.0 Scope & Normative References

### 2.1 Scope

This technical specification details the relevant requirements relating to the appropriate safety testing, instructions and marking of thermal storage vessel systems in compliance with the current requirements detailed within Local UK Building Regulations Part G and associated product standards.

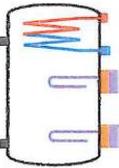
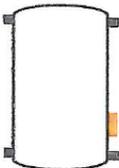
This specification is applicable to metallic primary storage systems as detailed in Table 1 below. These thermal storage vessels are designed specifically for the efficient and safe integration or linking of a number of heat sources, including solid fuel, and in providing primary hot water for central heating purposes in domestic dwellings.

Table 1 – Categorisation of Thermal Storage Vessels

Key	Vessel Type	Standard
	<b>Direct Thermal Store</b> – for heating hot water on an unvented or vented system with flow and return connections for both boiler and space heating circuits. A boss may be provided for fitting a back-up immersion heater either in a factory or on-site	Test to TS-2015-12-HWATS
	<b>Indirect Thermal Store</b> – for heating hot water with flow and return connections for both boiler and space heating circuits. A boss may be provided for fitting a back-up immersion heater either in a factory or on-site	Test to TS-2015-12-HWATS

As well as direct/indirect thermal storage systems covered under this specification, there are further primary storage technologies on the market that may be required under current regulation to undertake separate certification/testing for use with solid fuel systems. These additional technologies are detailed in Table 2 below;

Table 2 – Additional Categories of Thermal Storage Vessels

Key	Vessel Type	Standard
	<b>Electric Combination Boiler</b> – direct electrical thermal store for heating and hot water with flow and return connections for space heating and with one or more immersion heaters are factory fitted	Test as Boiler
	<b>Storage Tank</b> – thermal store acting as a buffer tank for external heat source with flow and return connections for space heating and external heat source. Provision may be made for one or more immersion heaters for back up purposes	Test to EN12897

## 2.2 Normative References

The following documents, in whole or in part, are relevant for the application and use of HWA thermal stores systems and should be referenced in conjunction with the requirements laid out in this specification;

Water Regulations Advisory Scheme: "Water Regulations Guide", Second Edition 2000

Hot Water Association: "Performance Specification for Thermal Stores", 2010

Building Regulations 2000: Approved Documents L1 & L2, "Conservation of Fuel & Power", 2009

Building Regulations 2000: Approved Document G, "Sanitation, Hot Water Safety & Water Efficiency", 2009

Building Regulations 2000: "Domestic Building Services Compliance Guide", 3<sup>rd</sup> Edition 2013

BS EN 12897:2006, Water Supply – "Specification for Indirectly Heated Unvented Storage Water Heaters"

BS 1566-1:2002+A1:2011, Copper Indirect Cylinder for Domestic Purposes. Open Vented Copper Cylinders. Requirements & Test Methods.

BS EN 12977-3:2008, Thermal Solar Systems and Components. Custom Built Systems. Performance Test Methods for Solar Water Heater Stores.

BS EN 14336:2004, Heating Systems in Buildings. Installation & Commissioning of Water Based Heating Systems.

CIBSE Solar Heating Design and Installation Guide.

### 3.0 Basis for assessment

It should be noted that the following section is in effect an assessment of the suitability of the hot water storage product to be used in conjunction with solid fuel appliances against the G3 requirements in Approved Document G. In particular;

G3 (2) A hot water system, including any cistern or other vessel that supplies water to or receives expansion water from a hot water system, shall be designed, constructed and installed so as to resist the effects of temperature and pressure that may occur either in normal use or in the event of such malfunctions as may reasonably be anticipated, and must be adequately supported.

G3 (3) A hot water system that has a hot water storage vessel shall incorporate precautions to;

- a. Prevent the temperature of the water stored in the vessel at any time exceeding 100 C; and
- b. Ensure that any Discharge from safety devices is safely conveyed to where it is visible but will not cause a danger to persons in or about a building

Whilst this assessment provides a means of assessing the safety of the hot water store it does not necessarily ensure the safety of the solid fuel appliance and if in doubt the advice of the solid fuel appliance manufacturer should be followed.

### 3.1 Pre-Assessment Requirements

Before assessment and safety testing is to be carried out, the hot water storage product shall be confirmed as meeting the UK Water Regulations as required by Building Regulations.

Primary storage systems shall also meet the insulation requirements of section 4.3.1 or 4.3.2 of the Hot Water Association Performance Specification for Thermal Stores

To confirm satisfactory compliance with HWA requirements, manufacturers shall satisfy the requirements of the HWA charter and third party certification will only be eligible to those who currently hold membership with the HWA.

### 3.2 Quality Assurance Internal Factory Production Control

The manufacturer shall establish, document and maintain a permanent Factory Production Control system and identify areas of responsibility to ensure that the products placed on the market conform to the stated performance characteristics at the time of test. The FPC system shall cover procedures, regular inspections and tests and/or assessments, as well as checking the raw materials and other material components, the equipment, the production process and the product.

This factory in which the product is manufactured shall be covered under the principles of ISO 9001 standard and hold the relevant compliance documentation on file to confirm this. Products shall also be subject to periodic audits to demonstrate compliance with the requirements of the HWA charter.

### 3.3 Check of the safety and risk assessment

The manufacturer shall undertake a risk assessment covering all potential hazards of the vessel and the measures how to avoid or control them via a safe method. The assessment shall also determine and minimise the risks associated with the installation of multiple technologies on the thermal storage vessel, be documented and should be carried out as part of the system design. All instructions and associated documentation

should also be analysed to ensure that the installer does not install the appliance in a way that is deemed unsafe.

#### 4.0 Test

The basis for assessment will be carried out in two phases. Phase1 will be a theoretical assessment using the matrix below as a guide to determine the appropriate over temperature protection device that shall satisfy the requirements within G3 of the Building Regulations for the various combinations of thermal storage vessels.

		Open Vent on cylinder/store	Open Vent on primary circuit	ECO 1 plus motorised 2 port valve (Note1)	ECO 2 plus motorised 2 port valve (Note 2)	Temperature relief valve	Quench coil in store
Vented Cylinder	Indirect					Note 3	
	Indirect					Note 3	
	Indirect					Note 3	
	Direct					Note 3	
Vented Primary Store	Indirect						
	Indirect						
	Indirect						
	Direct	Note 4					
Unvented Cylinder	Indirect						
	Indirect						
Unvented primary Store	Indirect						
	Direct						
	Direct						
	Direct						

- Note All control valves used as safety devices should fail safe in the event of a power failure.
- Note 1 This can also be used for normal temperature control
- Note 2 Where the additional device is used as a "final" level of safety then the valve should be dedicated to the cut out.
- Note 3 This follows the guidance of [water regulations R20.6](#)
- Note 4 Whilst not a statutory requirement , consideration should be given to providing an additional level of protection other than the open vent

The matrix above identifies the different classes of thermal storage systems and the levels of temperature protection safety integrated that can be associated with them. For the assessment procedure, the assessor will determine the relevant category the appliance technology falls under from the appropriate options in the left hand column of the matrix, and asses that the product incorporates the required levels of protection from the highlighted options given. A product will only be deemed as compliant if the storage class type coincides with the relevant temperature safety provisions highlighted in green.

Phase 2 will be a physical assessment by heating the product using a simulated solid fuel appliance usually in the form of a buffer tank heated by a controlled heat output.

The test cylinder / thermal store shall be representative of production in design, materials and equipment. For cylinders / thermal stores in a product range which have the same constructional design, the assessment will be carried out on a representative product or products so the full product range can be assessed. The range of product to be assessed shall be agreed by either with the notified testing institute or the certification body and evidenced by way of a declaration from the manufacturer so that interpolation of results are determined.

This appliance will be run at the maximum nominal heat output recommended by the manufacturer for use with the vessel as stated within manufacturer’s instructions.

It is important that the temperature/flow characteristics of the “simulated” appliance are equal to or greater than the maximum rating against which the product is to be assessed, hence the need for a buffer tank to maintain the flow conditions.

## 4.1 Test Procedure

Due to the large number of possible designs the assessor will sometimes need to modify the exact procedure to suit but the overall test principle is to attempt to heat the product to as high a temperature as possible to ensure that at least two levels of temperature control are activated successfully before it reaches 99°C.

This procedure will first be carried out using each possible heat source (or simulation of the heat source) then using all possible combinations of heat source together if appropriate. The testing shall be carried out or overseen by a third party representative to confirm that the principles in EN 17025 are followed and ensuring all materials used in construction are in conformity with the requirements of the Quality Control System and that the results of all necessary test conform to those requirements.

### 4.1.1 Initial Test Setup

The test rig shall be set up and configured to the correct method following the installation procedure detailed in manufacturer's instructions, connected to a controlled simulation of the heating circuit by way of buffer tank of an appropriate size to the vessel. In normal installations, the solid fuel circuit would have its own heat leak safety control however for the purposes of the test this shall be omitted as to ensure a overheat situation can be achieved.

### 4.1.2 Testing

To confirm expected stated performance, a procedure to supply heat at the maximum rating recommended by the manufacturer for use with the vessel as stated within manufacturer's instructions and ensure that the normal "comfort" thermostat operates correctly to halt the temperature rise.

Once normal operation is confirmed, the control thermostat is removed or by passed and heating allowed to continue until the first level of over temperature operates, again halting the temperature rise. Pressure and temperature shall be monitored and recorded to the point of operation of safety devices.

Once the first safety control is confirmed the first level over temperature control is then removed or by passed and heating continues to the point where the second or final level of protection should operate before the store reaches 99°C. Pressure and temperature shall be monitored and recorded to the operation of safety devices.

In the case of appliances requiring pressure relief valves then at no time during the above procedures shall the valve discharge water.

The test duration shall be repeated at least 3 times, on consecutive test runs or at least until test values can be deemed repeatable. The appliance will be deemed to have passed assessment when confirmed that the claimed levels of protection have been activated and are sufficient in maintaining the temperature within the store to not exceed past 99°C on the three consecutive simulation test runs.

### 4.1.3 Testing results

Performance results shall be tabulated for normal operations and all safety devices.

## 5.0 Instruction Manual

### 5.1 Installation Instructions provided by the manufacturer

Each storage vessel must be accompanied by a set of installation and operating instructions. The installation instructions shall be in the national language and clearly contain at least the following information;

- Statement that all local regulations, including those in reference to national standards need to be complied with when installing the product; including provisions surrounding electrical safety
- Statement that the vessel is suitable for use with a solid fuel appliance and any limitations in heated water output.
- Technical & Performance data of the product including maximum operating pressure, operating temperature & nominal water content volume, heat output of exchanger and standard heat loss of vessel
- Schematic drawing of the vessel; including indication and size of inlet/outlet for each factored permissible technology
- Details on the different levels of protection present in confirming the vessel does not exceed the maximum operating temperature
- The safety clearances and protective measures that are to be taken in order to protect the buildings construction
- The configuration of all temperature controls and safety devices; including immersion heating if applicable
- Details on the correct installation methods
- Details on the correct method and procedure regarding commissioning of the vessel, including handover and ensuring the vessel is left in a condition that is deemed safe for use
- The installer shall be reminded that appliances link to the storage vessel should either be fitted with a heat sink or quench pipe system for its own protection
- Details on any spare parts and contact information for support if required

### 5.2 Operating Instructions

The operating instructions shall contain references to the following;

- Name & Contact Details of the Manufacturer
- The correct measures to be taken in the event of the vessel malfunctioning and procedure to follow
- Applicable service and maintenance recommendations and necessary maintenance intervals

Other marketing documentation, including sales brochures, shall not contain any information that is in contradiction with the guidance given within the operating instructions

## 6.0 Marking

Each appliance shall be permanently marked in a place that is accessible so that the information is legible when the appliance is situated in its final location, and shall contain the following information;

- The name, trademark or identification mark of the manufacturer
- The model type and serial number
- Maximum operating pressure (bar) and temperature of the vessel, heat exchangers and domestic hot water system (°C)
- Nominal water content of the storage vessel (l)
- Maximum heat output of dedicated domestic hot water heat exchanger (kW)
- Stand heat loss measurements of vessel (Wh)