Guidance on Safe Operation of Hot Water Boilers

Ref: BG02

A joint document by The Combustion Engineering Association
and the Safety Assessment Federation

SAFed

CEA
Combustion Engineering Association

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Foreword

This document, Guidance on the Safe Operation of Hot Water Boilers (BG02) has been developed and written by the Combustion Engineering Association (CEA) in consultation with the Safety Assessment Federation (SAFed) and other stakeholders within the boiler systems and water treatment industries to help designers, owners, managers and operators of new and existing boiler systems make health and safety and environmental improvements in the industry.

This first edition of BG02 incorporates up-to-date information and best practices relating to the operation of hot water boiler plant; steam boilers are covered in a separate document (BG01). The first edition of BG01 included hot water boilers, but in response to feedback from users of the document, this separate guide for hot water boilers was created.

This publication should not be regarded as an authoritative interpretation of the law, nor a mandatory legal requirement. However, if the guidance provided is followed, it will normally be regarded as sufficient to comply with the relevant health and safety duties.

Cover image courtesy of Bosch Thermotechnology Ltd

Acknowledgements

The Combustion Engineering Association (CEA) is an educational charity, which promotes the science of combustion engineering in the commercial/industrial sector. The CEA is concerned with industry good practice and the safe and efficient operation of combustion related plant and equipment.

Safety Assessment Federation (SAFed) is a trade association, which represents the independent engineering inspection and certification industry in the UK. SAFed's primary aim is to promote safety and reduce accidents in the workplace. SAFed supports corporate social responsibility through compliance with the law and adopting best industry practice.

A special note of thanks to members of the CEA and those who have committed a generous amount of their time, freely, to contribute to this guide, particularly:

- BOSCH
- Energy and Environmental Solutions
- Coal Hill Associates
- Deep Water Blue Ltd

In this document the following words convey specific meaning:

Should: Compliance with this clause is not essential where supported by risk assessment and/or design calculation.

Shall: Compliance with this clause is required in order to claim compliance with this document.

Must: Compliance with this clause is a legal requirement within the United Kingdom.

Unless otherwise stated, all pressures refer to gauge pressure.

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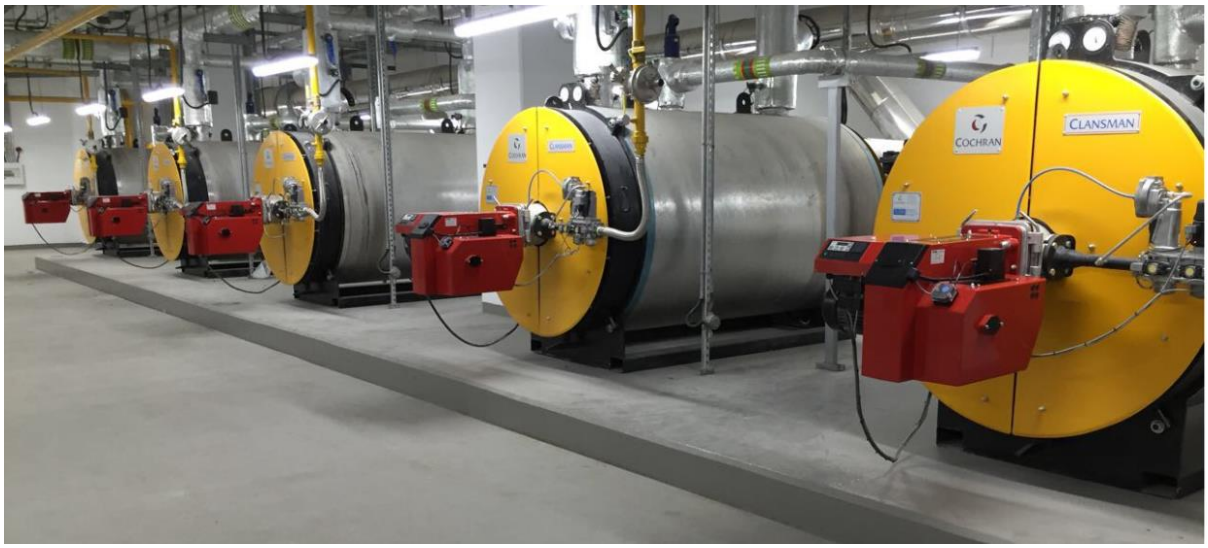
1 INTRODUCTION

Guidance on the Safe Operation of Hot Water Boilers (Ref: BG02) is a guidance document intended to assist the designers, owners, managers, operators, maintenance personnel and Competent Persons (CP) of new and existing low temperature and high temperature industrial shell hot water boiler systems in addressing the following issues:

- The safe and efficient use and operation of the boiler installation;
- Determining adequate supervision and maintenance requirements (levels and competence) that are consistent with the installed plant and its location;
- Reducing the likelihood of explosion or other dangers from events such as:
  - Loss of water;
  - Over-pressure;
  - Overheating e.g. due to excessive scale;
- Using efficient boiler operation to avoid the excessive pressure/thermal cycles and load swings which can accelerate boiler fatigue or failure;
- Ensuring the provision of the correct water treatment and monitoring of the system and boiler water to minimise corrosion, scale and avoid microbiological fouling (biofouling), as these problems can result in energy wastage, poor system performance, and the need for early replacement of plant and components.
- Compliance with the various legal requirements, in particular that for periodic examination by a CP in accordance with a Written Scheme of Examination (WSE) for high temperature hot water boilers.



Typical hot water boiler installation
Image courtesy of Cochran Ltd

2 SCOPE

This document applies to all industrial hot water boilers (normally shell boilers), including mobile hot water boilers and waste heat boilers, that fall into the following categories:

- Low Temperature Hot Water boilers (LTHW): boilers where the shut-off temperature of the safety temperature limiter does not exceed 110 °C, with a design pressure up to 16 bar gauge; and
- High Temperature Hot Water boilers (HTHW): boilers where the shut-off temperature of the safety temperature limiter exceeds 110 °C, with a design pressure up to 32 bar gauge.

Relevant Standards

There is a tradition of referring to boilers operating in the range 100°C – 120℃ as Medium Temperature Hot Water Boilers (MTHW). While carrying out research for this Guide, it was noted that legally speaking, hot water boilers are divided into only two categories, those where the limiter set point does not exceed 110°C, and those where it does.

The authors are aware that design standards may appear to contradict this opinion; EN 14394 for example allows for the limiter to be set as high as 120°C, but note that all such standards include additional requirements for plant with a limiter set above 110°C and we are therefore content that separate advice for MTHW systems is not needed.

A boiler working at 110°C can be designed to, for example, EN 14394, and have a safety cut out at say 120°C, and would therefore fall within the scope of PED/PSSR. The standard has the following text in the scope to cover this:

"This European Standard (EN 14394) specifies requirements for boilers with normal operating temperatures between 100 °C and 110 °C and has a "dual structure":

• For boilers where the shut off temperature of the safety temperature limiter does not exceed 110 °C the Pressure Equipment Directive (PED) requires" Sound Engineering Practice",

• For boilers where the shut off temperature of the safety temperature limiter exceeds 110 °C this European Standard specifies the requirements of the PED as stated in Annex ZB."

EN 14394 6.3.7 includes "…*for heating boilers with a temperature TS > 110 °C the requirements of EN 12953-8 shall be met*."

EN 12828 includes in the scope "*In case of heating systems with maximum operating temperatures over 105 °C other safety aspects than those described in 4.6 may apply*."

Exclusions

The following boilers are **specifically excluded** from the scope of this Guidance Document:

- Shell and tube steam boilers
- Water tube boilers;
- Boilers with a capacity exceeding 37 MW nett rated thermal input;
- Domestic and commercial boilers with a rated capacity less than 1000 kW;
- Electric immersion boilers, electrode boilers and steam coil heated boilers;
- Hot water coil boilers.

However, just because these boilers are outside of the scope of BG02, this does not mean that the regulations and general principles in this document should not be followed where suitable and applicable.

3 LEGISLATION

Boiler systems are required to comply with different legislation, including a number of health and safety and environmental Acts and regulations, which are aimed at ensuring that new and existing boiler systems are continually operated and maintained in a safe manner.

The principal sets of health and safety legislation that support the Health and Safety at Work etc. Act 1974 and apply to the use of boiler systems covered by this guidance are:

- The Management of Health & Safety at Work Regulations 1999 (MHSWR);
- The Pressure Equipment (Safety) Regulations 2016 (PER);
- Gas Appliance Regulations 2016 (GAR);
- The Pressure Systems Safety Regulations 2000 (PSSR);
- The Provision and Use of Work Equipment Regulations 1998 (PUWER);
- The Gas Safety (Installation and Use) Regulations 1998 (GSIUR); and
- The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR).

With the exception of MHSWR, GAR and PER, all the regulations listed above are supported by Approved Codes of Practice (ACoP) and Guidance produced by the Health and Safety Executive (HSE), and available as free downloads from www.hse.gov.uk.

There are numerous sets of environmental legislation applicable to hot water boilers, including the Clean Air Act, the Industrial Emissions Directive, and the Environmental Permitting Regulations (including the Medium Combustion Plant Directive). Relevant legislation is addressed in later text.

Refer to Appendix 1 for a list of currently applicable legislation. It is the reader's responsibility to ensure that they refer to the latest available version of any legislation or guidance.

3.1 The Management of Health and Safety at Work Regulations 1999 (MHSWR)

The Management of Health and Safety at Work Approved Code of Practice (ACoP – L21) has been withdrawn and is no longer available. If you are looking for information on how to manage risks in your business, HSE has a suite of guidance that will be able to help. Each level of guidance on HSE's website offers appropriately targeted information, focussed on making compliance as straightforward as possible.

If you need basic information or are getting started in managing for health and safety, then the best place to look is *Health and safety made simple: The basics for your business* (INDG449). You should also consult: *Safe management of industrial steam and hot water boilers. A guide for owners, managers and supervisors of boilers, boiler houses and boiler plant* (INDG436).

MHSWR apply to every employer and self-employed person who carries out any work activity whether or not they own or use a pressure system (all future references to employers in this guidance should be read to include self-employed persons).

They impose a duty to manage all risks from any work activity, not only within the workplace itself, but also any risks to all persons (including any non-employees) who may be affected by the activity in question.

Regulation 3 requires the completion of a suitable and sufficient risk assessment of the work activity in order to properly identify and adequately manage any risks. This is of central importance. The risk assessment must identify sensible measures to control identified risks that may otherwise result in injury or danger.

Risk assessments for boiler systems are covered in more detail in the next section.

3.2 The Pressure Equipment (Safety) Regulations 2016 (PER) – HTHW boilers only

PER applies to the design, manufacture and conformity assessment of pressure equipment and assemblies of pressure equipment with a maximum allowable pressure >0.5 bar.

All new and substantially modified pressure equipment (**including hot water raising plant containing a relevant fluid**) comes within the scope of PER and they must comply with its requirements before they may be supplied for use.

The Regulations do not apply to:

- Excluded pressure equipment and assemblies (specified in Schedule 1 to PER); or
- Pressure equipment and assemblies placed on the market before 29 November 1999; or
- Pressure equipment or assemblies placed on the market on or before 29 May 2002 if they comply with the safety provisions in force in the UK on 29 November 1999 and do not bear a CE marking (unless required by another Community Directive or any indication of compliance with PED).

Schedule 2 of PER details the essential safety requirements (ESR) that qualifying vessels must satisfy. Additionally, there are details of how the different products are classified, the technical requirements that must be satisfied, and the conformity assessment procedures that must be followed.

To comply with the ESRs the manufacturer must either produce a technical file that addresses each ESR in turn, or manufacture the equipment using standards that have been listed in the EU's Official Journal which give a 'presumption of conformity' to specific ESRs.

The Directive on Pressure Equipment (PED - 2014/68/EU) was adopted on 15 May 2014 and all of its provisions entered into force on 19 July 2016, replacing the previous Directive 97/23/EC. The Directive was implemented into UK law by The Pressure Equipment (Safety) Regulations 2016 (SI 2016 No.1105).

The Regulations apply to pressure equipment and assemblies with a maximum allowable pressure PS greater than 0.5 bar, although there are a number of exclusions which are set out in regulation 4 and Schedule 1 to the Regulations. "Pressure equipment" means vessels, piping, safety accessories and pressure accessories. "Assembly" means several pieces of pressure equipment assembled to form an integrated, functional whole. These regulations do not apply to pressure equipment placed on the market before 8 December 2016.

The Department for Business, Energy and Industrial Strategy has produced a guide to the Pressure Equipment (Safety) Regulations 2016 and this can be downloaded from gov.uk.

Notes

For assemblies other than those referred to in Article 4.2 (a) of PER, if the manufacturer intends them to be made available on the market (i.e. assemblies intended for the generating of warm water as referred to in Article 4.2 second sub paragraph) they must be subjected to either an EU-type examination (Module B – Design Type) with respect to their conformity with the essential requirements referred to in sections 2.10,2.11, 3.4, 5(a) and 5(d) of Annex 1 of the PER , or to full quality assurance (Module H).

Furthermore PER specifically advises that "*By way of derogation, assemblies intended for generating warm water at temperatures not greater than 110 °C which are manually fed with solid fuels and have a PS·V greater than 50 bar·l shall comply with the essential safety requirements referred to in points 2.10, 2.11, 3.4, 5 (a) and 5 (d) of Annex I*".

3.3 Gas Appliance Regulation (GAR).

The scope of the GAR applies to appliances burning gaseous fuels used for heating and hot water production. Regulating, controlling and safety devices, and sub-assemblies thereof, intended to be incorporated into appliances or assembled to constitute appliances – so-called fittings - are also covered. From 21 April 2018 compliance with the new requirements was mandatory.

The GAR contains in its Annex I the essential requirements that an appliance or a fitting must meet when it is placed on the EU market. It does not indicate how these requirements must be met, thus leaving flexibility to manufacturers as regards technical solutions to be adopted.

The responsibility for ensuring compliance currently rests with the manufacturer. Under the new regulation, the duties of compliance have been expanded to include people who import and distribute gas appliances, particularly 'own brand' gas appliance suppliers. As such, they will need to meet similar obligations as manufacturers do.

Manufacturers will be required to perform and document a risk assessment for their gas appliance or fitting, in particular identifying risks that may occur through foreseeable user behaviour.

The new regulation includes products currently excluded under the old directive, including gas-fired high temperature water boilers used for space heating.

Gas appliance fittings, such as safety and controlling devices, will also need the CE mark and be subject to the same conformity assessments as appliances.

The GAR stipulates a maximum 10-year validity period on type examination certificates from the first date of issue. It also requires the Notified Body and the manufacturer to stay informed of changes to the "state-of-the-art" and update appliances as needed to ensure they still meet essential regulatory requirements.

Appliances specifically designed for use in industrial processes carried out on industrial premises, for use on aircraft and railways as well as for research purposes for temporary use in laboratories are excluded.

3.4 Pressure Systems Safety Regulations 2000 (PSSR) – HTHW boilers only

PSSR set out the main legislative requirements to ensure the continued safety of the pressure systems in use (which includes HTHW boilers). The PSSR applies to all in service pressure equipment containing a relevant fluid. These regulations may require hot water boiler systems to have a Written Scheme of Examination.

A relevant fluid as defined by PSSR requires a vapour pressure greater than 0.5 bar above atmospheric pressure when in equilibrium with the vapour at the actual temperature of the liquid. Hot water should only be considered a relevant fluid at a temperature of 110 °C and above. However, steam is a relevant fluid at any pressure. In the case of pressurised hot water systems operating in excess of 100 °C and up to 110 °C the user should incorporate suitable controls in order to ensure that the system is not liable to contain steam under operating conditions.

In some systems, including those where hot water is not a relevant fluid, there may be a pressurising or expansion vessel containing air or nitrogen that will require assessment in accordance with the PSSR. Where the product of the pressure in the vessel (in bar) and the volume of the gas space (in litres) is ≥ 250 bar litres, owners or users should ensure that the examination requirements of the PSSR are met. Protective devices for the vessel may be fitted elsewhere in the system.

Where hot water systems do not come under the PSSR it is still important that suitable controls and limiters are fitted to ensure safety in operation and these Guidelines also apply to these lower temperature systems.

These Guidelines are not intended as a specification for boiler controls in new installations. Such controls should be in accordance PER and should comply with the requirements of relevant Harmonised European Standards supporting the directive. Where existing installations do not meet the requirements and recommendations in these Guidelines, a risk assessment should be undertaken to determine whether the controls and limiters fitted provide an acceptable level of safety.

Duty Holders

PSSR applies to two clearly defined categories of people (**duty holders**). These are the

- '**Owner'** – an employer or self-employed person who owns a pressure system. Where the employer who owns the system does not have a place of business in Great Britain, or an agent in Great Britain who would take responsibility, then the user (see below) will be responsible; and the
- '**User'** – the employer or self-employed person who has control of the operation of the pressure system.

The distinction between '**Owner'** and '**User'** can be important in certain circumstances in determining the duty holder responsible for ensuring compliance with certain regulations under PSSR. However, in general, owners carry more responsibility in relation to mobile systems, while users have responsibilities in relation to installed systems. Shell boilers are considered to be 'installed systems' for the purposes of the regulations.

The user/owner of an HTHW boiler is responsible for complying with the following requirements of PSSR:

- Safe Operating Limits (SOL) have been set and are not adjusted without informing the Competent Person (CP) and manufacturer where appropriate;
- The system containing a relevant fluid is never operated unless a current Written Scheme of Examination (WSE) is in place. Any requirements of this scheme e.g. a report of the last examination, must also be satisfied (Regulations 8 & 9);
- The items identified in the WSE are examined by a CP in accordance with the requirements of the scheme;
- The results of all tests and examinations shall be recorded (see Log Sheets, Appendix 4) and retained for a suitable period. A period of at least two years is recommended for retention of records of routine tests (see section 8);
- All repairs and modifications must be carried out by people suitably competent in such work (Regulation 13, PSSR, ACoP Para 176). You must discuss and agree any changes with the "Competent Person" and include any changes within your written scheme of examination (WSE) (ACoP Para 89). The details of such work shall be retained for the life of the plant;
- The statutory technical documentation and other records must be kept and where required, be made available for examination;

All records may be kept on-site or at a designated central location but wherever they are kept, they must be secure and easily accessible, and records must be transferred when the ownership of a system changes (Regulation14, PSSR).

The user must give operational employees adequate instruction so that the boiler can be operated safely (Reg 11 and para 145 ACoP).

The user/owner of pressurised hot water systems falling within the scope of the PSSR is required by the regulations to operate and maintain the pressure system in order to ensure safety of personnel. For hot water systems not falling within the scope of the PSSR, it still remains an essential requirement of health and safety legislation for operators to be appropriately trained in the use of boiler controls. Operators should also be fully conversant with the associated protective devices and with all other relevant aspects relating to the safe operation of the system.

For hot water boilers these should include (para 152) instructions covering:

- water treatment.
- precautions to be taken when emptying a boiler;
- precautions to ensure positive isolation and depressurisation of one boiler from a common header;
- precautions to be taken before carrying out maintenance operations;
- procedures to be followed in the event of a shortage of water, bursting of tubes or other event requiring the boiler to be shut down.

Temporary Boiler Plant

Companies who hire out hot water boilers that operate above 110ºC are usually hiring out a pressure system. Para 39 of the PSSR ACoP says that a boiler [fitted with skids] may be installed temporarily to maintain supply to the site during the replacement of an existing boiler, but such an installation should not be treated as a mobile system.

So mobile boilers are not in fact mobile plant for the purposes of PSSR, and where a person supplies an installed system by way of lease or hire, and agrees in writing to be responsible for discharging the duties of the user, all the provisions of regulations 8(1) and (2), 9(1), 11(1), 12 and 14 must be followed (Reg3(5)) and the requirements of PSSR Schedule 2 must also be followed.

CEA *BG08 - Guidance on Temporary Steam and Hot Water Boiler Plant* contains detailed information regarding the safe installation and use of temporary boiler plant.

3.5 Provision and Use of Work Equipment Regulations 1998 (PUWER)

Any employer who either provides equipment for use at work (including boiler systems) or has control over the way and manner in which equipment is used at work has a legal responsibility to comply with the relevant provisions of this regulation. An important, often overlooked, requirement under PUWER is that a maintenance logbook, when provided, must be kept up to date.

Under PUWER, all employees required to use equipment at work must be trained and competent to do so (Reg 9). This will therefore extend to the training and competence of operators and managers of boilers, all ancillary plant, and any water treatment plant used for the boilers.

Other parts of PUWER of relevance to boiler systems cover such topics as equipment suitability, maintenance, inspection, information & instructions, and control systems. This is not an exhaustive list.

3.6 The Construction (Design and Management) Regulations 2015 (CDM)

Although installing or replacing a hot water boiler might not be a large enough project on its own to be notifiable under CDM, the principles of the regulations should still be followed, and if the hot water boiler is part of a major installation the regulations will apply in full and must be considered at every stage of the project from conceptual design through installation to maintenance and ultimate demolition.

Clients must appoint a Principal Designer and a Principal Contractor to ensure that the CDM Regulations are properly followed.

3.7 The Dangerous Substances & Explosive Atmospheres Regulations 2002 (DSEAR).

A risk assessment under DSEAR must be undertaken. DSEAR applies to all boilers (not just gas) as incorrect combustion can lead to an explosive atmosphere in the boiler itself or indeed in a separate combustor or CHP engine exhaust.

The owner of the system may assist the manufacturer by providing information from an assessment of the probability of the presence and the likely persistence of a potentially explosive atmosphere in the proposed working environment.

Equipment supplied for use in a potentially explosive atmosphere must also satisfy the relevant requirements of the *Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 2016*.

3.8 The Gas Safety (Installation and Use) Regulations 1998 (GSIUR)

GSIUR deals with the safe installation, maintenance and use of gas systems, including gas fittings, appliances and flues, mainly in domestic and commercial premises, e.g. offices, shops, public buildings and similar places. The regulations generally apply to any 'gas' as defined in the Gas Act 1986 (amended by the Gas Act 1995), apart from any gas comprising wholly or mainly of hydrogen when used in non-domestic premises. The requirements therefore include both natural gas and liquefied petroleum gas (LPG).

The Regulations generally apply to all domestic and commercial installations of gas appliances (usually described as residences where people could sleep or places where members of the public may be present), including any gas fired hot water boilers in those locations, and they specify the way gas appliances are installed and maintained and the training and assessment of persons who can be deemed competent to work on such systems.

Registration of organisations, and competent employees in those organisations, are required through Gas Safe in order to demonstrate a suitable level of safety training in gas work has been achieved.

GSIUR do not apply in full to certain sectors, namely gas installations in factories, electricity generating stations, mines, quarries, construction sites, agricultural premises and means of propulsion. However, even if working at premises to which GSIUR does not apply, competence in carrying out gas work safely is required in order to comply with the general duties in sections 2 and 3 of the HSW Act.

ACS training for those who work on domestic gas installations is not always suitable for the larger commercial and industrial installations, so the CEA have developed a training and assessment scheme that fills this gap and ensures that persons working on gas equipment in locations where GSIUR do not normally apply are suitably trained and assessed as being competent. The Industrial Gas Accreditation Scheme (I-GAS) is supported by CEA members and the wider gas industry, and certification is available at several different levels to cover all the necessary safety requirements across a wide range of industrial gas installations.

3.9 The Environmental Permitting (England and Wales)(Amendment) Regulations 2018

All combustion plants rated between 1 MW and 50 MW nett rated thermal input will be required to comply with the Medium Combustion Plant (MCP) Directive which has been transposed into UK legislation through changes to *The Environmental Permitting (England and Wales)(Amendment) Regulations 2018, The Pollution Prevention and Control (Scotland) Amendment Regulations 2017*, and *The Pollution Prevention and Control (Industrial Emissions) (Amendment) Regulations (Northern Ireland) 2018*.

This legislation requires the registration of all new combustion plants put into first use after 19 December 2018 and the registration of existing combustion plant before 1/1/24 for plants individually 5 MW and above, and 1/1/29 for plants rated from 1 MW to <5 MW. Where more than one new plant is on a site the new plants will be aggregated to a single MCP.

From the date of first use (in the case of new plants) and from 1/1/25 (for existing 5-50 MW plants) and 1/1/30 (for existing 1-5 MW plants) the emissions from those combustion plants must not exceed specified emission limit values (ELV) for NOx, SOx and dust (total particulates), and these will be measured at specified intervals along with CO (no limits currently set for CO). Plants rated 20 MW and above will be measured annually, and plants below 20 MW will be measured every 3 years.

The Environment Agency (EA) in England and their equivalents in the devolved UK administrations will administer the new legislation and will consult with Local Authorities where there may be a combustion plant in or close to a Local Air Quality Management zone. This may mean tighter ELVs will be applied. Sites that currently have environmental permits for other activities will have any MCPs added to their permits at the due date.

The EA have produced detailed guidance on how these regulations will be applied.

Image courtesy of Cochran Ltd

4 LEGAL RESPONSIBILITIES

4.1 Risk assessments – for new and existing sites

Regulation 3 of MHSWR requires that a 'suitable and sufficient' risk assessment be carried out before any work activity commences. Its purpose is to determine whether any risks are present and, if they are not adequately managed, what further control measures are required. The significant findings of the risk assessment must be recorded where there are 5 or more employees.

The control measures must have the primary aim of eliminating the risks. Where elimination is not possible, the control measures must aim to reduce the risks to a level as low as is reasonably practicable (ALARP). Regulation 4 and Schedule 1 of MHSWR sets out the principles of prevention.

The responsibility for the risk assessment lies with the employer although he may do this using input or assistance from various sources such as boiler manufacturers and control system experts, or have the entire risk assessment carried out on his behalf by someone competent to do so.

For a boiler, the risk assessment should consider issues such as:

- The likelihood and severity of injuries from:
    - Burns from hot water, steam, burners and flues;
    - Electric shock;
    - Fuel escape;
    - Fire;
    - Asphyxiation, and toxic effects from combustion products;
    - Falls from height;
    - Impact by a moving vehicle (particularly sites using solid or liquid fuels)
- The location of the boiler with respect to:
    - Numbers of persons likely to be affected;
    - Proximity to industrial premises/workers;
    - Proximity to the public especially vulnerable populations - such as in nurseries, schools, hospitals, care homes etc.;
    - The potential impact on neighbouring sites due to an incident;
- Capability of safety-related systems;
- Level of supervision;
- The positioning of alarms and the associated response times;
- The presence of other dangerous materials;
- The adequacy of boiler house ventilation and flue integrity;
- Environmental effects, e.g. noise, pollution;
- Effect of chemicals on workers, the environment and others, e.g. water treatment chemicals;
- Operational risks:
    - Mechanical or water damage to plant or equipment;
    - Water-side explosion due to catastrophic failure of the pressure envelope;
    - Combustion explosion caused by unspent fuel;
    - Failure of the water treatment equipment (if fitted) to deliver properly treated water to the boiler;
    - Speed of response to loss of hot water to process.

Since risk assessments must assess the existing control measures, they should also consider information regarding:

- Manning and supervision (see section 5.9);
- Type and reliability of controls and the integrity of safety-related systems;
- Additional controls for remote or unsupervised boiler operation.

Risk assessments must be reviewed periodically, after any accident or incident, and when there is a significant change e.g. a system variation, change in operating parameters or manning levels etc. The outcome of any reviews must be recorded.

As an example, an owner moving to a less frequent level of supervision of the boiler must, as a first step, review the boiler design and the current risk assessment to take account of the planned change in manning levels. The results of the risk assessment will be used to determine any measures necessary to ensure that the boiler remains safe to use and to operate. Such measures may include:

- The proper formulation and correct application of all modifications and installations to ensure they have sufficient safety integrity to adequately mitigate the risk of a dangerous occurrence;
- Amendment of procedures where appropriate to ensure the plant continues to be operated safely;
- Ensuring all personnel on-site & off-site and in surrounding property remain safe.

4.2 Written scheme of examination (WSE) -HTHW boilers only

A system containing a relevant fluid (including HTHW boilers) must never be operated unless a current Written Scheme of Examination (WSE) is in place. The definition of 'relevant fluid' in relation to hot water boilers and their associated equipment was covered in section 3.4 above.

The requirement for a WSE is set out in Regulation 8 of PSSR. The user/owner is ultimately responsible for ensuring that the scope of the WSE covers all relevant parts of the boiler system, and they should select an organisation with sufficient knowledge and expertise on the systems in question to carry out the CP duties on that system.

The CP role and responsibilities are covered in the PSSR ACoP. A brief summary is provided in section 5.3.

The WSE must include the name of the CP who certified the scheme as suitable, the date of the certification and the following information:

- All parts which require examination by the CP;
- Justification for excluding items from examination;
- All protective devices;
- The nature and frequency of the examinations required;
- Details of any preparatory work required by the user/owner in order for the examinations to be completed;
- Details of any requirements for the initial examination;
- Details of any repairs and modifications where the CP needs to be involved.

Where there is more than one WSE for a single pressure system, (e.g. one for the boiler house and another covering the site) the respective responsibilities for each part of the pressure system must be clearly identified. The boundaries of each WSE must be adjacent to each other with no physical gaps.

4.3 Examinations in accordance with the WSE (Thorough Examination) – HTHW boilers only

Regulation 9 of PSSR requires that all pressure systems be periodically examined by a Competent Person (CP) in accordance with a WSE, itself being drawn up by a CP.

The user/owner is responsible for ensuring their boilers meet this requirement. Where the WSE specifies any preparatory work, they are also responsible for ensuring that this is completed before the examination.

As soon as possible following examination, the CP will prepare a report of examination for the user/owner. The report will also include, amongst other information, the following:

- Whether any repairs are required and the date by which they must be completed;
- The latest date by which the next examination must be carried out;
- Whether any modifications are required to the WSE.

Note that the CP may also specify the manner and procedures which these modifications should take. The CP may also specify the nature of the required modifications to the scheme.

If any of these issues are raised in the report of examination, the user/owner must:

- Ensure that the boiler is not used or supplied if the date set for any repairs or examinations passes without these being completed;
- Make the required modifications to the WSE and have it re-certified by a CP;
- Ensure the boiler is not used or supplied if the date set for the modifications to the WSE passes without these being implemented and certified by a CP.

4.4 Summary of responsibilities

The user/owner of a boiler system is ultimately responsible for ensuring the system complies with all the relevant Health & Safety legislation (not just those responsibilities mentioned above).

While third parties, e.g. maintenance contractors, can be used to assist in achieving compliance with these legal obligations, the overall and legal responsibility remains with the user/owner and cannot be contracted out although there is scope for certain duties to be transferred (as set out in a written agreement) between the owner and user.

Useful help and advice on ensuring boiler systems remain safe to operate can be obtained from a number of sources, such as the CP carrying out the periodic examination of the boiler, or from the equipment manufacturer.

5 PERSONNEL AND RESPONSIBILITIES

5.1 User/owner

These legal terms have earlier been defined in section 3. The distinction between these terms is important as it will determine the duty holder responsible for ensuring compliance with certain regulations under PSSR where this is relevant. Similarly the duties have been outlined in sections 3 and 4 above.

In general, the legal responsibilities of the user/owner cannot be transferred e.g. by an employer to an employee. In situations where more than one employer or self-employed person may have an interest in the operation of a plant, paragraph 46 of the ACoP to the PSSR provides guidance as to who is the user. It may however be prudent to take legal advice on the matter in this type of situation as it must be clear to all parties who is responsible under the Regulations.

5.2 Competent Person (CP)

A Competent Person (CP) is defined in Regulation 2, PSSR as "a competent individual person (other than an employee) or a competent body of persons corporate or unincorporate and accordingly any reference in these Regulations to a CP performing a function includes a reference to him performing it through his employees."

From Paragraph 10 of the PSSR ACoP this term refers to the organisation employing the person who carries out these duties. Therefore, the legal duty to comply rests with a CP's employer, and not with an individual, unless that person is self-employed.

A CP is required to undertake two distinct functions under PSSR:

- To draw up, certify or review the written scheme of examination; and
- To carry out the examinations in accordance with the scheme and to produce a report after each examination.

These roles may be undertaken by the same or more than one organisation. The user/owner remains responsible for selecting a CP who possesses sufficient expertise in the particular system and is capable of carrying out the duties in a proper manner. A CP is also able to act in an advisory role and advise on other aspects of PSSR such as the scope of the written scheme and establishing the safe operating limits of pressure systems.

In addition to the above legally defined personnel, there are also a number of other personnel involved in the day to day safe operation of boilers. These are discussed below but it should be borne in mind, these may not be terms that have a legal definition.

5.3 Employers

Under the Health & Safety at Work etc Act 1974 (HSWA), employers have general duties, amongst other things, to provide safe places of work and adequate training for staff. This general duty on employers is also required under other legislation such as such as MHSWR and PUWER. **This legal responsibility cannot be transferred to employees or third parties.**

5.4 Employees managing the operation of boiler plant

Employers must appoint sufficient suitably trained and competent persons to be responsible for the safe management and operation of boilers and boiler systems. These supervisors or managers must be adequately trained to carry out all the duties they are expected to perform at each specific site. The authority of a person in a management position should be commensurate with the duties and responsibilities of that person.

The duties of boiler managers may include but are not limited to:

- Ensuring compliance with relevant laws;
- Risk assessment and risk management;
- Ensuring that manning levels are sufficient;
- Ensuring that plant is maintained correctly;
- Oversight on boiler operators;
- Oversight on contractors;
- Defining and maintaining competencies;
- Management of personnel;
- Record keeping.

5.5 Competent Boiler Operator

It is a legal requirement for the user/owner to appoint sufficient competent and experienced persons to be responsible for the daily safe operation of the boiler system. These boiler operators must be adequately trained to carry out all the duties they are expected to perform at each specific site. The training should enable the operators to recognise when the limits of their own expertise are reached and when to call for assistance.

For HTHW boiler installations, the duties of boiler operators may be quite extensive and require significant knowledge, training and experience. For many LTHW installations the duties are significantly less onerous, but any supervision by the end user should be in accordance with manufacturer's instructions.

The duties of the boiler operator should be determined as a logical outcome of a site specific risk assessment. These may include, but are not limited to:

- Shutdown of a boiler in an emergency or if it is unsafe;
- Implementing the boiler manufacturer's instructions with regard to attendance when starting up from cold, and for all the other aspects of boiler operation, use, maintenance and cleaning etc.
- Carrying out all functional tests of limiters & controls where required, before the boiler is left unattended and at all specified frequencies and in the specified manner. Records of all these tests must be maintained;
- Carrying out the recommended water quality tests, routine water treatment, recording the results and making adjustments where necessary in accordance with established standards (BG04, BS 2486:1997, BS EN 12953-10, BSRIA BG 50/2013 or the manufacturer's instructions). This should be in addition to any testing contracted out to a water treatment specialist; note that the user/owner remains responsible and the water treatment specialist contractor shall have specific and demonstrated expertise in the treatment of water for hot water systems;
- Tests on ancillary equipment;
- Checking the burner and associated equipment;
- Responding to alarms and taking appropriate action;
- Identification of maintenance requirements and faults;
- Investigation of abnormal operating conditions;
- Appropriate supervision of contractors;
- Recording the results of checks and tests and boiler house visits.

EN12171 advises for LTHW boilers that a maintenance record is kept, instructions for safety and emergency procedures are provided, and users are informed of economical and energy conscious operation of the boiler. It also notes that LTHW heating systems may not require a trained operator, but that refers to the operation of the boiler (which may be largely automated) and not its maintenance which will require trained and competent persons to be utilised.

5.6 Personnel monitoring boiler alarms from on-site and off-site locations

Persons whose function is to monitor alarms shall ensure that the boiler is safe in response to an alarm condition, or shut it down in response to a site emergency from a location deemed appropriate by a risk assessment.

Where alarms for boilers are sent to persons at locations other than at the boiler house, all such persons must possess sufficient training and information to take the appropriate action in the event of an alarm condition before calling for the assistance of a competent boiler operator. In some cases, this may involve the emergency shutdown of the system.

Untrained persons and persons whose only function is to monitor alarms shall not enter a boiler house during an emergency unless there is a system or procedure in place to ensure that such access is safe. Only trained persons should enter during an emergency and this entry process should include a dynamic risk assessment to ensure their personal safety.

Untrained persons and persons whose only function is to monitor alarms shall not reset a boiler following a lock out.

5.7 Maintenance personnel

All maintenance personnel must possess sufficient training to be able to carry out their expected duties. Maintenance personnel must only carry out the maintenance work for which they have been trained and are deemed competent. Suitable training courses and maintenance services for maintenance personnel can usually be provided or recommended by manufacturers of boilers, burners, fittings or control equipment.

5.8 Contractors and sub-contractors

Contractors are employed on many sites to perform specific specialist tasks or manage the day to day operation of the hot water boiler plant.

The contracting out party (normally the user/owner) shall ensure that the chosen contractor is competent to perform the required tasks. Suitable and sufficient oversight should be exercised on contractors to ensure that:

- legal requirements and legally imposed duties are met;
- works are undertaken in a safe manner;
- plant is left in a safe condition (whether usable or otherwise) during and after works;
- relevant tests and checks are performed on the plant before it is returned to service.

5.9 Manning and supervision of boiler houses

Manning and supervision levels in boiler houses shall be established as a result of a detailed boiler house technical risk assessment, firstly at the design stage and then revised later as the operation of the boiler house evolves. In simple terms, the more automation, measurement and control that is installed the lower the manning requirements might be, BUT this has to be taken in context with other issues such as the location of the boilers, the likelihood of water quality issues, leaks, risks associated with loss of hot water to processes and the risks associated with actually getting competent operators to the boilers in adverse weather, as just a few examples.

It is essential to fit adequate instrumentation during the installation phase to enable accurate commissioning of the systems and subsequent assessment to ensure efficient operation. The needs will vary greatly dependent upon the system installed. Time and finance should be set aside at the outset of the installation phase to ensure that this area is adequately covered.

Furthermore, different operating scenarios may dictate different supervision levels for the same level of automation. A boiler needs to be fully manned whenever it is in a vulnerable state, for example during start up unless controls allow the boiler to be started from cold unmanned. However it may be assessed as safe for daily visits during production periods and safe to leave for the weekend when the site is out of production but alarms are still monitored locally. LTHW boilers might be left alone for significant periods, according to the manufacturer's instructions.

Arrangement drawings in Appendix 3 are **not associated with any particular level of supervision** - they are provided to guide designers and users/owners of hot water boiler plant in the direction of possible boiler control and measurement arrangements, and do not represent final solutions for any particular circumstance. A detailed risk assessment is the only way to establish the manning requirements for your plant.

For all levels of manning, hot water boilers shall not be warmed through from cold or put on the range unless suitable controls are fitted, installed and routinely tested. However, hot water boilers shall not be reset after a lockout without the competent boiler operator present to observe all limiters and alarms, and take the necessary actions.

Boiler plants which incorporate systems which significantly exceed the minimum requirements of the law and include the highest level of automation and monitoring may in certain circumstances still need to be fully manned, and this may be for reasons of hot water production security to process or other considerations.

Note the definitions used in this section and elsewhere:

- **Competent Boiler operator** - Someone who has attended a recognised training course with assessment, is familiar with the boiler system on site and has sufficient knowledge & experience to operate the boiler system safely.
- **Suitably Trained and Instructed Person** – Someone who has been trained to respond to specific boiler house alarms by taking agreed actions which include contacting the duty Competent Boiler Operator.
- **Check the boiler** - carry out all documented tests and inspections relating to the boiler and ancillary plant according to local procedures, recording all necessary readings and actions, and making reports of actions and interventions as appropriate.

Local control and alarms

Where the risk assessment determines that the boilers cannot be left alone, a competent boiler operator shall be in the immediate vicinity of the boilers at all times whilst the boilers are operating. They shall be within earshot and sight of alarms, and able to attend the boilers immediately.

This type of supervision is required when the boiler controls are extremely basic or the boiler is in a vulnerable state, e.g. on start-up or after an unexpected alarm. It is also commonly used when firing solid or unusual liquid fuels, or if there is an unacceptably high risk with the location of the boilers.

Automatic shut down on limiters with alarms

For HTHW boilers, if the boilers can, and actually do, automatically shut down safely as a result of any malfunction or incident, a competent boiler operator shall be able to attend the boiler house within the time specified in a risk assessment of the installation, but ideally not more than 4 hours.

Someone at the premises shall be able to hear or see if the boiler is in alarm at all times. Electronic call devices may be used if accepted by risk assessment.

The boiler operator may have other duties, but they should be present for activities specified by the manufacturer, and may have specific boiler operational duties such as testing alarms and water quality tests. A period of not more than 72 hours between routine visits is recommended.

For LTHW boilers, the risk assessment will determine the level and speed of response to boiler alarms. Boiler installations with spare capacity may well provide an uninterrupted service with one boiler failed, but a competent operator should attend within 24 hours to assess the plant and reset or repair faults. Manufacturer's instructions for routine attendance shall be followed.

Remotely monitored fail safe with alarms

If HTHW boilers are monitored from a remote monitoring position all the time they are operating then a competent, trained boiler operator shall attend the boilers at least once in every 72 hours; they might not be based on site. A trained and instructed person at the remote monitoring location shall have the ability to respond to an alarm and summon a competent boiler operator.

The boilers must have advanced controls and monitoring, such as high/ low pressure limiters, high integrity water detection probe, flame detection units and temperature control and limiters. The boilers shall automatically shut down safely as a result of a limiting device activating (high temperature for instance), or because of a malfunction or an incident. The boiler and system water chemistry shall be checked at a periodicity identified through a boiler water treatment risk assessment, in accordance with BG04.

All the main boiler operational data and alarms shall be visible or audible at the remote monitor at all times. This could be a manned control room, either on site or off site, or a contracted monitoring centre where the trained and instructed person has the ability to confirm the boiler has shut down and summon a competent boiler operator. In the event that the system monitoring the boiler status fails or loses its capability to communicate, the system shall sound an alarm.

HTHW boilers with steam cushions will require special consideration and a risk assessment may indicate more frequent attendance and/or additional control and monitoring devices are required.

This level of supervision will typically suit sites with multiple boiler houses where operations are centrally monitored, for example, or energy management contractors who operate many sites from one central location. Speed of response to alarms might be a critical part of the risk assessment.

For LTHW boilers that are remotely monitored, local risk assessment and plant criticality will determine the frequency of monitoring and the speed of response. Manufacturer's recommendations shall be followed.

6 TRAINING

Employers must ensure that all personnel possess sufficient knowledge of the boiler systems on which they work to perform their duties properly. Every employer shall ensure that any of his employees who supervises or manages the use of work equipment has received adequate training for purposes of health and safety (PUWER Reg 9).

Any training shall form part of a structured scheme taking into account the particular types of boiler on site and the full range of maintenance tasks required for safe operation of the boiler. All training should be a structured on-going process which is updated to keep pace with developing technology, equipment and legislation. The level of competence required (and the corresponding training requirements) must be reviewed when a system is modified, e.g. increased automation or remote supervision. The training shall be delivered by personnel possessing the appropriate practical experience, assessment skills, and knowledge of the working environment.

The employer must ensure that all managers and operators and other relevant personnel are regularly assessed through work audits. Training must also be reassessed periodically. All training shall be validated by assessment (written and/or oral) and the results of the assessment recorded.

The Boiler Operation Accreditation Scheme (BOAS) is recognised by the Health and Safety Executive, the UK insurance industry, the Safety Assessment Federation (SAFed) and industry members and provided through the Combustion Engineering Association. Training Providers accredited under the Boiler Operation Accreditation Scheme (BOAS) are accredited to the industry standards.

Training in provision and application of water treatment for closed heating systems is available via members of the Combustion Engineering Association.

6.1 Training courses

There are a number of courses available at various levels. It is recommended that operators and managers achieve the national industry standards for:

- Certified Industrial Boiler Operator (CertIBO) for operators; or
- Diploma in Boiler Plant Operation Management (DipBOM) for managers.

These qualifications form part of the Boiler Operation Accreditation Scheme (BOAS) which covers hot water boilers, both for LTHW and HTHW.

The level of training and assessment for operatives and managers should be tailored to the equipment an individual is expected to operate and the duties that are expected to be performed while operating that equipment, either normally or under exceptional circumstances.

Generic boiler system training courses can be used to provide basic information at varying levels. All training courses should involve site-specific elements. Courses should include the following topics:

- Boiler operation including start-up and shut-down;
- Boiler & burner controls and failure modes, taking account of fuels used;
- Boiler water analysis;
- Actions to be taken in an emergency, and the consequences of inappropriate action;
- Responsibilities of all parties involved and legal aspects;
- Site specific training plus documented written and oral examination on completion of the course.

For hot water boiler systems operators and managers, Category 1 BOAS courses cover the following in more detail:

- Basic heat & heat transfer concepts
- Draught & combustion
- Boiler/ system water analysis
- Control & instrumentation
- Safety & legal requirements
- Energy efficiency
- Environment
- Boilers & auxiliaries
- Operation
- Fuel concepts

Candidates who only operate LTHW boilers will not be assessed on PER and PSSR, but the concepts may be discussed during the course; all other elements are generally the same for both LTHW and HTHW boilers.

BOAS courses cover these basic requirements for boiler operators and managers in general terms, but further training for specific activities is highly recommended. In particular, boiler house operators and managers should be encouraged to undertake enhanced training in boiler water testing (in accordance with BG04), industrial gas operations (I-GAS), manufacturer specific training for burners and combustion systems, and bespoke training for the operation and daily maintenance of any other plant items provided in their boiler house, for example.

6.2 Training records

Employers must ensure that all relevant training and assessment records are maintained and kept securely, including details of content and results of re-assessments. Appropriate audit records must be maintained and kept securely. Such evidence of training may be required to be viewed by enforcing authorities.

Image courtesy of Bosch Thermotechnology Ltd

7 DESIGN AND INSTALLATION

All new HTHW boilers and substantially modified HTHW boilers must be designed to satisfy all relevant requirements of the Pressure Equipment (Safety) Regulations (PER) 2016. When repairs or modifications, including changes to control systems or commissioning of a new system are undertaken, the risk assessments must be reviewed with a view to eliminating the risks or reducing them to a level as low as reasonably practicable (ALARP).

For hot water boilers, the heating system shall be designed, installed and operated in a way that does not put personnel at risk, or damage the building or other installations, and with due consideration to minimise energy use. The heating system shall be designed with due consideration to installation, commissioning, operation, maintenance and repair of components, appliances and the system. At the planning stage or during the progress of design work, the following items shall be agreed upon and decisions documented:

- clarification of the responsibilities of the designer and the installer and whether or not a qualified operator is required;
- compliance with relevant local and statutory regulations, and whether PSSR or MCPD will apply, for example;
- thermal characteristics of the building for calculation of heat requirements and possible improvements of energy conservation;
- external design temperature and internal design temperature;
- method of heat load calculation;
- energy source, primary fuel type and emissions to air;
- whether a permit is required for the combustion plant;
- consideration of solid fuel supply, ash removal and disposal, if required;
- location and size of fuel storage and access thereto, if required;
- position of the heat generator, bearing in mind access for maintenance, means of flueing and provision of combustion air;
- type, location, dimensions, construction and suitability of chimney and flue terminal, if required;
- choice of suitable pressurisation;
- position of feed and expansion cistern for open vented systems or expansion vessel, filling point and pressure gauge for sealed systems;
- facilities for filling and draining the system, and for testing the water condition;
- electrical power requirements;
- type and position of heat emitters;
- control of heating and attached system, including frost protection;
- route and method of installing piping and insulation;
- provisions and specification for balancing the system;
- provision for measurement of energy consumption;
- surface temperatures of exposed heating system surfaces.

7.1 Design considerations

Many trades and professions are involved in the design, construction, operation and maintenance of a boiler system, so it is essential that all equipment, instrumentation and controls are designed and installed by suitably qualified and experienced personnel in accordance with the manufacturers' instructions.

The design shall be based on the results of a risk assessment and relevant information from the appropriate design standards which provide further detail on the construction of shell boilers and their equipment. Boiler system designs shall address the following safety issues as a minimum:

- Boiler house ventilation - ensure adequate air supply for combustion. Designs shall comply with IGEM UP/10, IGEM UP/16 and BS 6644 as appropriate;
- The source of the boiler feed water, its effective treatment, if required and means for efficient monitoring of the water treatment plant, all in accordance with BG04, BS 2486:1997, BS EN 12953-10, BSRIA BG 50/2013 or the manufacturer's instructions;
- Electrical installation - designs to comply with BS 7671 IET Wiring Regulations.

  Note: Consideration should be given to the operating environment, ensuring that cable type, size, routing and connections will prevent erroneous operation & maintain the required integrity of the control system;
- Boilers that fail-safe, i.e. ensure boilers enter a safe mode under automatic control without requiring manual intervention. They shall also have a control integrity appropriate to their mode of operation;
- Critical alarms relating to plant safety shall default to lock-out and require manual reset as defined by BS EN 12953-6 for HTHW boilers.
- Controls for LTHW boilers shall be as per EN12828.
- Interruption of the electrical supply to water level and firing control equipment shall cut off the boiler automatically. Automatic restart shall only be possible if the normal requirements for start-up are met and the boiler system has been designed to do so.
- Boiler warm up shall be rapid with a separately pumped primary circuit. Only the primary circuit operates until the boiler is "up to temperature". Individually pumped boilers can also operate in similar manner dependent on circuit design.

Other considerations in boiler design include:

- Appropriate types of controls and safety-related systems;
- Site manning levels & competency;
- Testing and maintenance requirements;
- Normal, extreme and transient conditions including safe start-up and shut-down;
- Emergency procedures;
- Access for operation and maintenance;
- Relevant aspects of the Construction Design and Management Regulations (CDM).

For guidance, typical arrangements of boiler controls are outlined in the appendices. They are intended to be used in conjunction with the findings of a risk assessment, and represent suggested typical arrangements of certain hot water boiler installations – they should not be used as design solutions or procurement specifications for new plant.

7.2 Control systems

Safe and efficient operation depends on the boiler remaining within safe parameters during operation. A wide range of additional equipment that can be fitted to the boilers is available to help ensure this.

Control equipment includes the various sensors, limiters, control devices, relief devices and gauges as well as the communication and alarm systems. The level of control and monitoring will depend on a variety of factors. In general, boilers with automatic control and remote monitoring systems will require more monitoring and control equipment than a locally manned boiler system.

New safety-related systems shall be designed, documented and applied according to the requirements of BS EN 61508 so that safety functions are determined, i.e. the Safety Integrity Level (SIL) of each safety function is specified and the measures used to achieve the specified SIL for each safety function are described. BS EN 50156, *Electrical Equipment for Furnaces and Ancillary Equipment* provides information on the application design and installation of electrical equipment.

Every employer shall ensure that, where appropriate, work equipment is provided with one or more readily accessible emergency stop controls (PUWER Reg 16).

7.2.1 Lack of water and flow limiting devices

Unintentional steam generation or evaporation, and exceeding the allowable metal temperature, shall be prevented within the hot water boiler. The minimum circulating flow rate of water through the boiler shall be ensured by means of a flow limiter which shall be provided to cut off and lock out the heat supply if the actual flow falls below the minimum allowable flow rate. This limiting device shall be installed close to the hot water boiler.

LTHW boilers are not normally fitted with high integrity “no-water level” probes. However, to safeguard against lack of water as per EN12828, boilers installed into sealed heating systems shall be equipped with a water level limiter or other device, e. g. minimum pressure limiter or flow controller, thus providing interlock protection against excess temperature rise on the heat emitting surface of the heat generator.

A water level limiter or other appropriate device is not required with generators up to 300 kW nominal heat output if it is ensured that an unacceptable temperature rise cannot occur when there is lack of water. If the generator is located higher than most of the heat emitters, a water level limiter or other appropriate device shall be used for all heat generators. For open vented systems, instead of the water level limiter, a low pressure limiter shall be sufficient when the allowable heat output is less than or equal to 1,5 MW.

HTHW boilers shall be provided with water level limiters to cut off and lock out the heat supply in the event of loss of water. For hot water systems operating with an internal steam cushion, the requirements for water level limiters shall be the same as for steam boilers (see BG01 section 7.2.1).

For hot water boilers operating with an internal steam cushion, the requirements for LWL shall be the same as for steam boilers, except that the sinking time shall be the time taken for the water level to sink from the lowest water level (LWL) to the highest point of the heated surface (HHS) in the case of interruption to the water circulation and at the allowable heat output.

Water level indicators shall be fitted to all expansion tanks associated with pumped pressurisation units which are open to the atmosphere or which are operating with a steam or gas cushion in direct contact with the system water or the expansion water.

In the case of expansion tanks which are open to atmosphere or are operating with a steam or gas cushion in direct contact with the system water or the expansion water, a water level limiter LZA shall be installed.

In the case where the expansion vessel is provided with a membrane which is keeping the water compartment separated from the atmosphere or a gas cushion, a permanent indication of the water content of the vessel is achieved by transmitting the weight of the vessel to a controller, or by a similar method.

“LWL” (low water level) shall be marked on each hot water boiler operating with either an internal steam cushion, a closed expansion vessel with a steam cushion, a gas cushion or an open expansion vessel associated with pumped pressurisation systems.

A water level limiter (LZA)- is not required if the expansion vessel is supplied with a gas and a water compartment which are separated by a membrane protecting the hot water system from gas or air penetration.

7.2.2 Combustion control devices

The system shall incorporate the following (as applicable according to fuel type):

- Ignition flame and main flame detection and safety systems;
- Forced draught and induced draught fan proving systems and interlocks;
- Air and flue damper position proving systems;
- Flame detectors. High-integrity devices are required on all systems where the combustion system does not progress through a restart at least once per day;
- Systems to monitor the correct ratios of fuel and air;
- Interlocks where simultaneous alternative fuel combustion is not permitted.

7.2.3 Pressure and temperature devices

With the exception of open vented systems, all hot water boilers shall be fitted with a maximum and minimum pressure limiter to cut off and lock out the heat supply to ensure that the pressure is maintained within the allowable limits. EN 1282 specifies that sealed heating systems shall be equipped with a water level limiter or other device (minimum pressure limiter or flow controller) to provide interlock protection against excess temperature rise on heat emitting surfaces.

A suitable pressure indicator is recommended on all pressurised boiler systems so that the operating pressure can be determined. This should be calibrated at appropriate intervals. The range of the gauge should exceed the maximum working pressure by at least 25% and it is useful if the maximum allowable pressure is clearly marked.

Each pressurised boiler requires at least one safety valve sized for the rated output of the boiler. On open vented systems a safety valve is essential where the vent could become blocked by freezing or where valves in the system could isolate the vent. There should be no intervening valves between the boiler and its protective safety valves or between the safety valve and its point of discharge to atmosphere.

A high pressure limiter is recommended for pressurised boiler systems to lock out the burner at a pressure below the safety valve setting. A suitable margin above normal operating pressure should be incorporated to avoid spurious operation.

In order to prevent unintentional system water evaporation or steam generation, a system with external pressure generation shall be equipped with a minimum pressure limiter PZA which shall activate a self-closing valve on the excess pressure relief line of the pressurization equipment.

The PZA shall be installed either in the expansion line or, in case of pressurization systems equipped with pumps, next to the pressure sensor of the controller.

For plants with external pressure generation and open venting systems, a temperature limiter shall be provided to cut off and lock out the heat supply if the allowable flow temperature is exceeded.

Open vented systems shall be directly connected to the atmosphere.

Closed systems shall not be connected to the atmosphere. They are subdivided into:

- internally pressurised systems where the pressure is generated by the saturation pressure corresponding to the flow temperature; and
- externally pressurised systems where the pressure is generated by such systems as gas cushions, pressure pumps, or external steam cushions.

If required, provision shall be made that the temperature of the water returned to the hot water boiler does not fall below a value to be determined by the manufacturer, except for periods of start-up and shut down.

Each hot water boiler system shall be provided with an expansion space which shall be dimensioned in accordance with standards, and shall be capable of compensating for temperature-dependent volume changes in hot water generating plant in order for the heat dissipation system to stay within the design limits. An external expansion vessel or tank shall be used unless the steam space in the hot water boiler is used as the expansion vessel. The plant, and particularly these expansion vessels or tanks, including their lines, shall be protected against freezing.

Where a shut-off device is installed between the hot water boiler and the expansion vessel, it shall be capable of being locked in the open position.

To ensure safe operation of the hot water boiler the internal diameter of the feed and expansion lines shall be determined by the use of applicable standards.

A temperature indicator is recommended on all heating systems so that the operating temperature can be determined. A return temperature indicator is recommended on all heating systems so that the water return temperature to the boiler can be determined and is essential where the boiler manufacturer has specified a minimum return temperature.

A temperature limiter, independent of the temperature controller, is essential for all hot water heating systems. The supply of fuel to the burner should be shut off or other action taken to prevent heat input to the boiler at a temperature at least 6 °C below the saturated steam temperature corresponding to the pressure at the highest point in the system. For solid fuel fired boilers or other systems where residual heat could cause larger temperature rises this margin should be at least 10 °C.

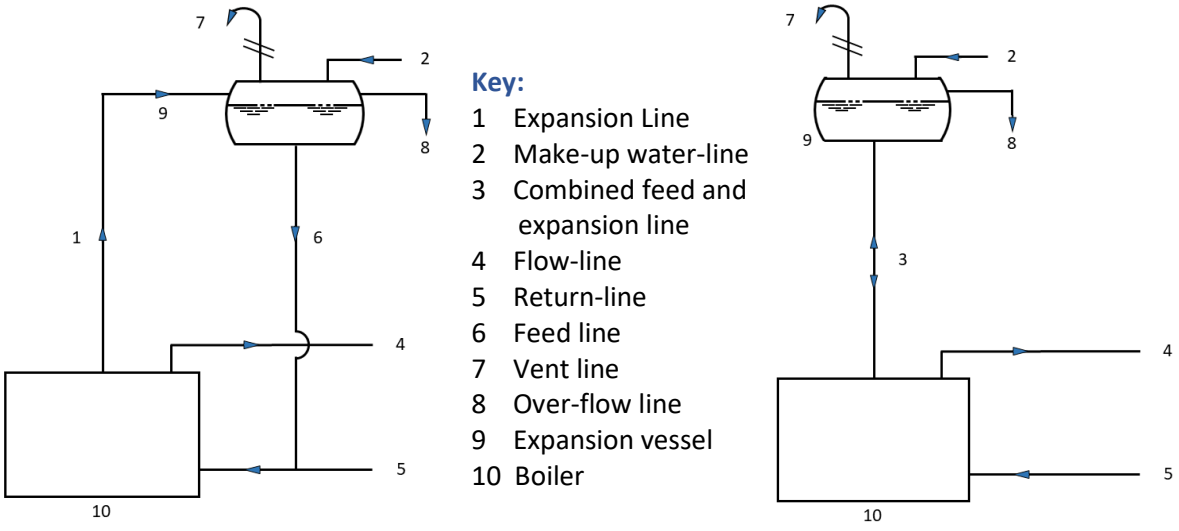


Figure a Figure b

LTHW boilers in an open vented system with separate feed line and expansion line (a) and system with combined feed and expansion line (b).

LTHW boilers in an open vented system shall be connected to an expansion cistern, which is installed at the highest point of the heating system. Expansion cisterns shall be dimensioned so that changes in water volume due to heating up and cooling down can be accommodated.

Expansion cisterns which are directly passed through by heating water should be avoided due to the high oxygen input.

Open vented system expansion cisterns shall be provided with a cistern vent and overflow pipe that cannot be blocked. The overflow pipe shall be dimensioned so that it can safely drain off the maximum mass flow rate entering the system, which can be achieved by selecting the overflow pipe to be one DN-size larger than the filling pipe.

Expansion cisterns, safety pipes, open vents and overflow pipes shall be designed and arranged to protect against freezing.

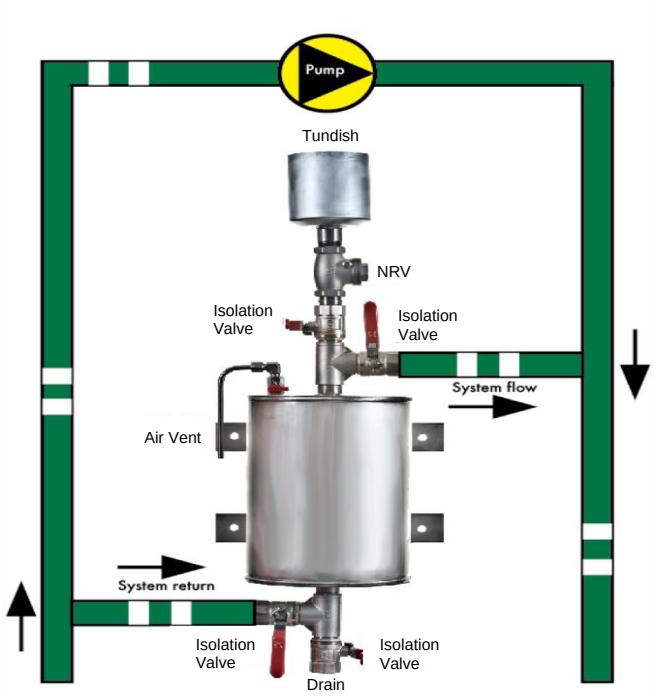
7.2.4 Water treatment plant

The system shall incorporate the following (as applicable for the equipment and the manning level):

- Means for treating incoming water, if applicable;
- Means for safely collecting boiler water samples from appropriate locations;
- Means for delivering solid or liquid water treatment chemicals at appropriate points in the system with measurement and control devices to alarm if chemical dosing is low or out of specification, chemical stocks are low, or chemical dosing plant has failed (dosing pump faults, leaks, etc.);
- Equipment for on-site measurement and testing of raw water, pre-treatment plant and boiler water parameters.
- Means of collation and interpretation of waterside, pre-treatment and raw water test results, either by paper log or electronic web-based means.
- Side stream filtration systems or similar systems for removal of suspended solids.

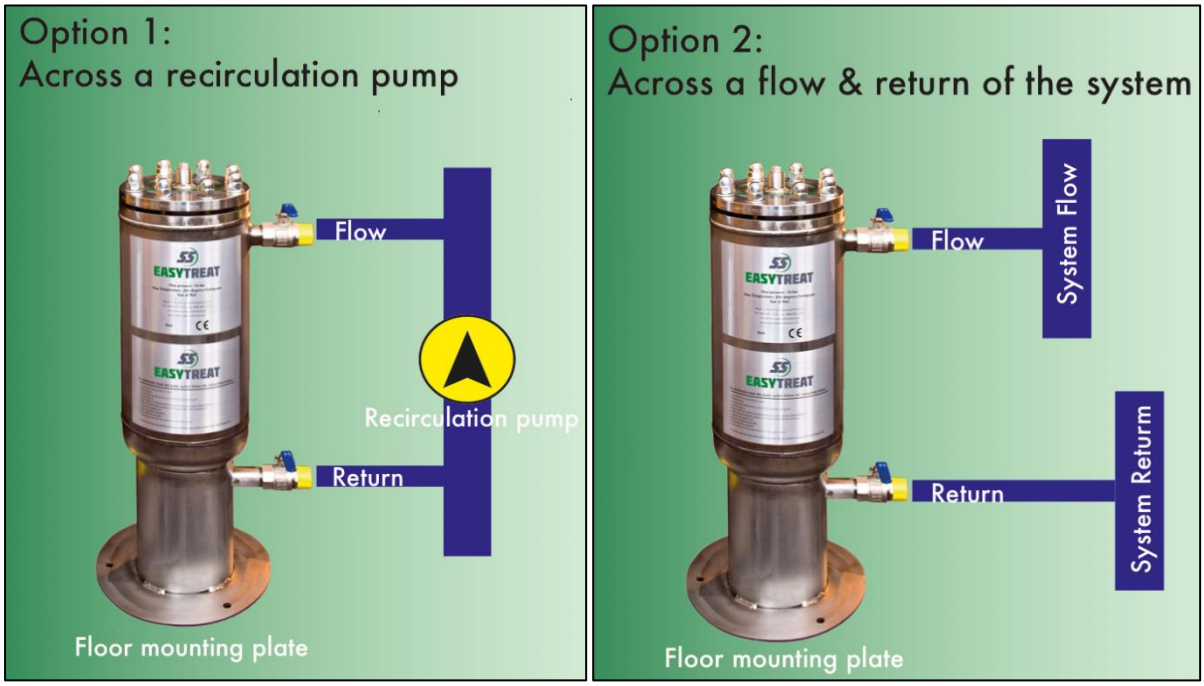
Increasing time between boiler house visits will increase the quantity and quality of the waterside monitoring and alarm equipment that is required.

Typical Dosing Pot Installation



Typical Test Reagents for Site Waterside Testing and Control

Typical Solid Feeder Installation



Typical Chemical Dosing System

Water Treatment Images courtesy of Deep Water Blue Limited

7.2.5 Chimneys and flues

The safe handling of the products of combustion from steam boilers must be carefully considered. Poor combustion, and poorly constructed chimneys and flues, can give rise to life threatening accumulations of CO and other pollutants, and the emissions to atmosphere from combustion processes must be managed in accordance with environmental legislation such as the Clean Air Act and the Medium Combustion Plant Directive.

All new steam boiler installations will be notifiable under local planning requirements and larger installations (>1 MWth) will be subject to environmental permitting regulations and require a permit to operate. Chimneys will need to be designed to cope with the expected products of combustion under normal and abnormal operating conditions, and in certain conditions may need to be fitted with explosion relief in the chimney or associated ducting if the design risk assessment identifies this as a potential hazard.

Structural requirements may require the advice of specialists in supporting the loads, providing safe access to work on the chimneys, and providing access platforms for emissions monitoring activities.

Where multiple fuels can be burned in a single furnace or multiple flues enter a single chimney there may be a need for interlocked dampers and interlocked fuel supplies to provide for safe operation under all possible combinations of firing. These should be rigorously tested at appropriate intervals.

Chimney inspections

Inspection of a chimney and its linings is a highly specialised task and should only be entrusted to a steeplejack who is an accredited member of a National body. Detailed specifications for the scope of the inspection should be agreed in advance, and it is recommended that the entire inspection process is photographically recorded. The presence and condition of lightning conductors and the integrity of holding down arrangements are key items to be included in the inspection.

Formal inspections of chimneys will normally take place every two to three years unless there is some obvious issue such as excessive corrosion, cracking, evidence of subsidence in the foundations, or items falling off the chimney. Other potential issues caused by blockages which prevent products of combustion from exiting the flue may be less easy to observe but could result in significant damage and danger.

Chimneys that are in highly polluted areas or coastal locations will require more frequent inspections, and burning fuels with a high sulphur content will similarly require additional observations to be made, especially if the boilers and flues are often allowed to cool down, increasing the likelihood of acid attack.

Site operators can carry out routine visual inspections of the general structure and its supports at more frequent intervals to help ascertain if a more detailed inspection is necessary. Unscheduled chimney inspections and repairs arising from failures or damage can cause lengthy plant shutdowns and other disruption to services, so planned inspections are essential.

In the UK, chimney manufacturers generally put an information plate at the foot of the chimney providing the recommended inspection intervals and other information - refer to BS 4076 (1989). Older chimneys or those without comprehensive records should be surveyed as part of an inspection and relevant measurements and construction details recorded.

Inspections may include the requirement for the chimney to be cleaned, and the handling of any waste arising must be entrusted to approved contractors.

7.3 Communications and alarms

The number and type of alarms will depend on a number of variables, and a review of the design and risk assessments must be undertaken to validate this decision. Boiler systems shall be designed such that boilers will always remain in a safe condition and will shut themselves down upon critical alarm, without manual intervention.

A lock-out condition requires that the boiler be attended and can only be reset locally. Some typical alarms are indicated in the arrangements in Appendix 3.

Risk assessment for certain industries and activities is likely to indicate that there is benefit in also relaying alarms and providing an emergency shut-down facility at a remote location e.g. for boilers that are left unattended for a defined period of time.

Where the risk assessment shows that the existing alarms are inadequate for the proposed operation, new alarms will be required in order that boiler operators can be summoned and take appropriate action. The following should be considered:

- The response time for personnel to investigate and rectify alarm conditions shall be considered as part of the design of the control system; where a competent boiler operator is unable to attend the boiler within a reasonable time, a remote shut-down and lockout facility shall be provided;
- Alarms shall be clearly audible and visible where persons who are trained to take the appropriate action can hear or see them;
- It shall be possible to ascertain the current status of the boiler from the remote location; this may be as simple as a green light to indicate a no-fault condition or as complex as full boiler telemetry. The level of information required at the remote location shall reflect the level of knowledge of individuals at that remote location; e.g. it is unlikely to be appropriate to provide full boiler telemetry in a gate-house or reception area while more detailed information could be of use to those in, say, an engineer's office;
- The integrity and testing of communication links between the boiler house and remote locations, and the action to be taken by the automated system on the loss of that communication shall be considered as part of the design of the control system. An "auto-dialler" is not considered a robust means of monitoring a boiler unless it is capable of checking the integrity of the communications system, or taking action in the event of a loss of communication, or incorporates a means of remotely determining the boiler status and remotely shutting it down.

7.4 Gas detection, fire detection and automatic fuel shut-off systems

Automatic fire detection and fuel shut-off is mandatory for all oil-fired plant. Burners shall include automatic shut-off valves on all fuel trains, and the control system shall close these valves when a fuel is not in use, and in the event of a fault condition. Dual or multi fuel systems shall include interlocks to prevent simultaneous use if the burner or boiler is not designed for this.

The need for gas detection and automatic fuel shut-off systems will be determined during the risk assessment; generally speaking, modern boiler houses are regularly attended and well-ventilated spaces, making it unlikely that an accidental release of natural gas of sufficient volume to create a flammable atmosphere will develop. Further information is available from IGEM/UP/16 and IGEM/SR/25.

Gas detection systems will be necessary where forced inlet and/or extract ventilation systems are employed, and where the gas is not sufficiently odorised (e.g. producer gas, or bio-gas) as leaks are likely to go unnoticed by boiler operators. Similarly it may be necessary to consider CO and H_2S detection in certain circumstances (e.g. where CHP engine exhaust ducting passes through a boiler house).

The positioning of gas detection systems is of vital importance to ensuring their correct operation; the use of certain gases such as LPG will require careful consideration. Always consult the equipment manufacturer on the correct placement of sensors.

It is recommended that emergency push buttons at boiler room entrances isolate all fuels and power to the burners using the fuel train safety shut-off valves rather that the fitting of an extra automatic isolating valve. In most control systems it is possible to achieve this remotely so causing the system to go to lockout.

7.5 Typical control arrangements

The notes and diagrams in Appendix 3 describe different typical hot water boiler arrangements that might apply to different installations. **They are not definitive drawings of actual installations and must not be interpreted as being compliant with any particular circumstance – a boiler house technical risk assessment and BG04 boiler water treatment risk assessment will always be required for every boiler house. They should not be used as procurement instructions for particular boiler installations**.

The levels of attendance and manual testing will depend on the boiler and equipment layouts. They must be considered in conjunction with the findings of a risk assessment and information on the type and level of manning that is intended to be employed. It is more important that the target levels of monitoring and supervision are met rather than having a boiler that matches the example in the diagram. Different operating scenarios may well dictate different levels of supervision for the same level of automation.

The relationship between automation levels and supervision levels is discussed in more detail in Section 5.

Image courtesy of Dunphy Combustion Limited

8 BOILER OPERATION

This section details the requirements for operating the boiler and the various regular checks and procedures that should be carried out on hot water boiler systems.

Employers must ensure that site-specific risk assessments are carried out for each boiler and site to determine:

- the appropriate types of controls and limiters; and
- the particular site manning and supervision levels

to ensure that all risks remain as low as reasonably practicable. Additionally, all HTHW boilers must be examined and tested by the CP before first use (PSSR Reg 8 (3)c).

8.1 Boiler instructions

Boiler instructions shall as a minimum include the following:

- Instructions for the safe operation of hot water boiler systems to comply with applicable standards and regulations;
- Instructions on safety and emergency procedures to be followed, and procedures for foreseeable emergencies (such as fire or severe leakage);
- The recommended checks required including water treatment equipment performance and water quality test results, and operating temperatures and pressures;
- A recommendation that an operational record should be kept, including events and those involved, fuel deliveries (where applicable), routine inspections carried out, actions taken in cases of malfunction, and maintenance interventions;
- A recommendation that a maintenance record is kept, and that all maintenance is carried out by competent persons;
- How to warm through boiler systems starting from cold in a controlled manner, and how to add boilers to the range;
- Information on the safe systems of work, including appropriate standards of isolation that should be implemented for any work on the boiler systems;
- How to protect off-line boilers against corrosion, freezing and sudden thermal shocks;
- For HTHW boilers, the requirement to notify any significant planned change in boiler operating conditions (e.g. reduction in operating pressure or increase in cyclic operation) to the Competent Person prior to making such change, so that the Written Scheme of Examination can be reviewed and, if necessary, amended to reflect the new operating regime.

System re-starts following lock-out must only be made by a suitably experienced and competent boiler operator. Repeated attempts to re-start boiler plants must not be made except as part of a controlled fault identification process.

8.2 Recording of controls, limiters and water quality tests

Clear, written instructions describing how and when to carry out routine tests must be kept on-site and be followed by suitably trained and competent boiler operators. Where the boiler controls may be operated off-site, under IEC 61508, these instructions must also be available at the point of control and operated by a person competent to do so.

Routine testing of controls, limiters and water quality is essential to ensure continued safe, reliable and efficient operation. It can help prevent the following dangers:

- Lack of water which can expose the furnace or fire tubes, and lead to metal overheating and catastrophic boiler failure;
- Scale, excessive sludge deposits and dissolved solids which can quickly build up in a boiler. These can cause boiler overheating which can ultimately cause boiler or system failure;
- Faulty combustion controls which can allow the uncontrolled presence of fuel, air and an ignition source, which can result in fires or explosions.

The tests and their frequency shall be based upon:

- Risk assessment of the plant and boiler system;
- Manufacturers' or modifiers' instructions; and
- The controls and manning levels.

A record of such tests shall be maintained to keep an audit trail of the boiler operation. Examples of daily and weekly boiler log sheet contents are given in Appendix 4.

Examples of the type of records and documents that shall be kept and made available for scrutiny include:

- Technical Boiler House Risk assessment;
- Boiler Water Treatment Risk Assessment in accordance with BG04
- Boiler logbook;
- Water treatment test records;
- Combustion analysis records and emissions data;
- Manufacturer's records and instructions;
- Standard Operating Procedures;
- Emergency Procedures;
- Written Scheme of Examination (WSE) where applicable (for HTHW boilers)
- Examination reports (for HTHW boilers)
- Record of periodic tests (e.g. Non Destructive Testing (NDT), Hydraulic test); (for HTHW boilers);
- Records of servicing & modifications;
- Maintenance of controls;
- Training records for boiler operators, supervisors and managers, including water treatment training;
- Audit reports for boiler operators.

The use of loose-leaf logbooks is not recommended. Paper logs shall be securely bound, while electronic logs must comply with the requirements of BS 10008:2014: *Evidential weight and legal admissibility of electronic information. Specification.*

Careful consideration of where logbooks are stored is required. While it is useful for information flow between operators to keep the current logbook in the boiler house, there is a risk that the log itself could be lost in the event of a catastrophic incident. For that reason, only the current log should be stored near the boiler. Verified copies and older logbooks should be stored away from the boiler house.

Logbook entries shall be reviewed regularly by a senior person within the organisation; this may be a useful time to make appropriate copies for remote storage and prompt a review of the procedures and risk assessment.

8.3 Water level controls and limiters

The testing regime for hot water boiler controls needs to be specific to the type of equipment employed. As a minimum it shall verify the functionality of the controls and the associated alarms and limiters. This shall form part of the operating instructions for the boiler system.

The following items need to be considered when drawing up instructions:

- The manufacturer's recommended test methods must be carried out as a minimum;
- Any departure from the test frequencies proposed by designers or manufacturers must be supported by risk assessment;
- Only a competent boiler operator shall carry out the tests;
- If a boiler fails a functional test of the limiting devices it must be shut down and not brought back into service until such time as the fault has been repaired and the limiting devices successfully re-tested;
- Test results shall be logged (either electronically or manually) with boiler operator's name, date of test, plus any corrective action taken. Recording unsuccessful or routine test results is just as helpful as recording the actual fault and its remedy;
- Corrective action following alarms shall always be taken by the competent boiler operator;
- After tests have been completed, ensure that the water level and pressure is restored and that all valves are in the correct operating position. The boiler shall not be left alone until it is operating correctly.

While the recommended tests are useful for all boilers, a risk assessment may demonstrate that some tests should be carried out more frequently.

8.4 Burners and combustion tests

Combustion equipment must comply with the relevant standards (see Appendix 1, References). Maintenance and testing by a qualified person in accordance with manufacturer's instructions is essential to ensure safe and efficient operation.

Manufacturer's instructions for the operation of burners shall contain such information as is required for a boiler operator to use and test the equipment supplied.

Access to burner controls and safety related devices which are to be tested by operators shall not be obstructed by fixed panels or otherwise obscured.

Combustion tests shall also be carried out as appropriate to the type of system in operation. Certain tests, such as visual flame examination or furnace inspection may not be possible or practicable on some designs of boiler, so use of an alternative test such as measuring CO, CO_2 or O_2 may be appropriate.

Relevant systems must comply with the requirements of the Medium Combustion Plant Directive which places limits on emissions of NO_X, SO_X and particulates for all plant with a net rated thermal input of 1 MW to 50 MW; new plants will usually have the individual combustion units aggregated.

Some plants may need additional abatement systems in order to meet the Emission Limit Values (ELVs) in which case the abatement system shall be maintained in accordance with the manufacturer's instructions.

All tests shall be recorded on the log sheet and allowable limit data must be readily available. Suitably qualified persons shall investigate any problems and take corrective action.

All manufacturers' tests shall be carried out at recommended frequencies with special attention to:

- Testing flame surveillance equipment operation & recording the results. Prove lock-out and manually reset (but see note below). In a process where the burner is firing continuously, a self-checking photocell shall be used;
- Testing correct operation of forced ventilation and its interlocks and/or ensuring natural ventilation is to design standards and is unobstructed;
- On dual fuel installations, it is recommended that the changeover to the stand-by fuel should be tested monthly or as recommended by the burner manufacturer;
- Fuel leak and shut-off checks:
    - Gas - if a significant gas leak is suspected, the gas supply must be shut down immediately and be reported to the Responsible Person. Follow site procedures for any necessary evacuation of personnel and/or activation of audible hazard alarms;
    - Oil - visually inspect pipework, tanks, bunds and supply lines for leakage. Record and immediately report any leaks to maintenance personnel; bund alarms are recommended, particularly where sites are unattended for 72 hours.

Note: Some types of high integrity self-checking photocell need professional adjustment and setting, and the manufacturer's recommendations and timescales must be followed.

Should the Emission Limit Values of any environmental permit be exceeded, the user/owner must notify the relevant authorities as soon as possible. If the plant cannot be brought back within limits in a reasonable time, the plant must be taken offline.

Where shell boilers are fitted with new burners to cope with new or additional fuel types, the design, installation and commissioning of the new equipment must be carried out in accordance with all required legislation and guidance. As one example, if changing a heavy oil fired installation to gas firing, a full check of the ventilation requirements will be required and may involve modifications to the boiler house, and the environmental permit will need to be amended.

8.5 Solid fuel (coal and biomass) and alternative sources of heat

Whilst this guidance is primarily written for oil & gas, much of its contents are relevant for other sources of heat such as biomass and Combined Heat and Power (CHP). In this case, references to burners and fuel systems can be taken to mean the heat source and any associated fuel handling equipment.

Where a heat source cannot be completely removed quickly, for example in the case of a solid fuel fired boiler where fuel is already on the grate or in the case of a CHP where it is unsafe to regularly and repeatedly trip the engine, particular consideration shall be given to:

- The residual heat left in a boiler after a shut-down condition. The plant shall be designed so as to be able to accept this heat; and
- In some installations, there may be exceptional environmental or operational implications to testing of boiler controls. Testing regimes should be established to ensure that the controls and trips can be proven without tripping the plant except under controlled conditions as justified by a risk assessment.

8.6 Boiler / system water checks

A water treatment specialist with specific knowledge on hot water boiler systems shall undertake regular checks on the water treatment equipment and test the water quality. This should take place at least quarterly, as a minimum if an LTHW system is present and monthly if a HTHW system is present.

If scale, corrosion or biofouling are found in boilers, the water treatment system and associated processes, should be checked for correct operation and appropriate corrective action taken immediately.

In addition, a suitably trained and competent employee or the boiler operator shall make the following checks accordance with applicable standards or manufacturers recommendations:

- That any chemical dosing metering device is functioning and that there are adequate chemical stocks, both in the tanks and elsewhere on site;
- If dosing is to take place by either a dosing pot or EasyTreat solid chemical feeder, that the unit is fully operational and there are adequate chemical stocks, available on site;
- That in-house routine sample results are within their given parameters provided by the water treatment specialist and/or any recognised standard or guidance including, BG04, BS2486:1997, BS EN 12953-10, BSRIA BG 50/2013 or the manufacturer's instructions, and take remedial action when and where necessary. In-house routine testing is expected to include at least the following:
    - inhibitor reserve;
    - alkalinity tests;
    - pH;
    - hardness checks;
    - microbiological activity checks both general and species specific;
    - other tests as determined by the boiler water treatment risk assessment, in accordance with BG04.

For more detailed and specific guidance please see BG04, BS 2486:1997, BS EN 12953-10, BSRIA BG 50/2013 or the manufacturer's instructions.

Unless risk assessment demonstrates otherwise the minimum frequency of checks on the feed and boiler water shall be at least quarterly, if an LTHW system and monthly if a HTHW system.

Special consideration shall be given to the water treatment requirements for reserve boilers and boilers that are to be left unused for any period, an example being LTHW systems that are only used for winter heating purposes.

9 MAINTENANCE, REPAIR AND MODIFICATION

9.1 Maintenance

All hot water boilers and systems must be properly maintained and in good repair, so as to minimise risk to health and safety, and must take account of manufacturers' instructions in accordance with PUWER regulation 5.

All maintenance requirements and activities shall be fully documented, including the frequency that maintenance should take place.

9.2 Modification & repairs

Prior to any changes or modifications on hot water boilers and systems a risk assessment should be undertaken, and for HTHW boilers that fall under the PSSR requirements the effects of any modifications, repairs or adjustments to the pressure equipment must be assessed by the CP to determine whether a review of the WSE will be required; this assessment shall take place prior to the work being undertaken. The WSE itself must be reviewed at appropriate intervals (PSSR Reg 8) and it is recommended it is reviewed by the CP at each examination (PSSR ACoP Para 117).

Modifications and repairs to HTHW systems must comply with PSSR Regulation 13. It is sensible to consider these requirements for LTHW boilers also.

For significant repairs, the following points must be addressed:

- All alterations to the boiler must be documented and kept for the life of the boiler;
- Repairs and modifications may in and of themselves only address the symptom. The underlying causal factors which necessitated the repairs or modification must themselves also be addressed;
- Design of the repair must make reference to the original design code and other suitable guidance and achieve an equivalent standard;
- Materials must be suitable and closely match the properties of the original equipment;
- Workmanship must be in accordance with suitable standards including non-destructive examination where applicable;
- Significant repairs or modifications to boiler systems, changes in their operating pressure or changes in cyclic operation must be notified to the CP, the WSE reviewed, and the system thoroughly examined prior to coming back into use;
- Any alterations to the original specification of either the boiler system or the boiler house will require consideration and approval by the manufacturer and CP before instigating;
- Hot water leaks are dangerous and will waste energy. Identified leaks should be cordoned off and repaired as soon as practicable;
- It may be necessary to carry out modifications or repairs to the burner control and alarm systems. Significant modifications and repairs, where they affect integrity and/or safety of the system, its controls & software, shall be properly considered and the CP shall be kept fully informed of proposals.

Modifications to boiler installations may not directly affect the pressure envelope but could be just as significant. For example, MCP users/owners may find that the emissions limits in the MCPD are quite onerous for certain fuels and a change of fuel is proposed.

Designers and installers of new fuel systems and other modifications for boilers should ensure that all the necessary measures are taken to meet the legislative and standards requirements for the new equipment, and that comprehensive testing and commissioning of the installation by competent staff is undertaken and recorded.

9.3 Responsibility

The importance of adequate maintenance on boiler control and alarm systems cannot be over-emphasised. Responsibility can be divided between those who own and operate the boiler systems and those who maintain it. As this can be different in each case it is imperative that the limits of responsibility of each organisation are clearly defined in writing and understood by all parties.

In particular, it is important that the following points are noted:

- The user/owner is responsible for ensuring that all persons working on or with a boiler are competent to do so, including directly employed staff, agency staff, and contractors;
- Boiler operators must ensure that they hand over the boiler to maintenance personnel in a safe condition;
- On completion of maintenance, the checking of all controls, limiters and alarms shall be verified by the boiler operator in the presence of the maintenance personnel before the boiler is placed online;
- If the maintenance is carried out at the same time as the boiler examination, the controls, limiters and alarms will also be verified by the CP.

Image courtesy of Byworth Boilers

10 PERIODIC EXAMINATION OF HTHW BOILERS ONLY

The boiler must be examined in accordance with a WSE which will specify the parts to be examined, the types of examination required and the intervals between them. Depending on the circumstances and degree of expertise available the WSE may be:

- Written and certified by an independent CP; or
- Written and certified by the in-house CP (so long as they are sufficiently independent from the operating function); or
- Written in house but certified by an independent CP.

The examination itself has to be performed in two separate parts, firstly with the boiler and its fittings stripped down ("out of service") and then after it has been returned to operation ("in service" examination). The second part of the examination includes verifying the protective devices are functioning correctly and it must be performed as soon as reasonably practicable after the out of service examination. In any event, pre-checks on the functionality of controls and protective devices should have already been performed by the user/owner as soon as the boiler was returned to operation.

The protective devices that must be checked and/or tested include:

- Pressure gauge;
- Temperature limiter; followed by
    - Temperature controller;
- Safety relief valve
- Pressure limit switches;
- Water level controls/limiters;
- Flame detection device.

The user/owner must ensure that any necessary preparatory work is completed so that the CP can carry out the examination safely. After the examination, the CP will issue a report of examination and all recommendations contained in the report shall be implemented.

Other devices or controls not classed as protective devices in PSSR but which should still be checked and tested include:

- Fuel interruption lockout;
- Fuel proving systems;
- Control system power failure;
- Mains power failure;
- Critical alarms (including temperature alarms where fitted).

SAFed Guidance *PSG06: Examination of Pressure Systems in Accordance with Written Scheme of Examination*, and *PSG 07: Guidelines – on the PSSR SI 2000 No. 128 – Working examination requirements in WSE's* provides further information.

11 ENERGY AND ENVIRONMENT

11.1 Energy management

Energy management of boilers is sensible to minimise operating costs & emissions, to facilitate safe operation and to prolong plant life. Expert advice should be sought before any change in the operating parameters of a boiler which may affect the safety, environmental impact and efficient operation. This may include the following:

- Metering to monitor boiler efficiency;
- Water treatment;
- Combustion analysis and burner adjustment to reduce energy wastage & emissions;
- Energy improvement devices such as economisers, variable speed drives, flue gas dampers, advanced combustion control etc.;
- Plant scheduling and boiler optimisation to maximise plant efficiency.

The ability to carry out measurement is recommended to demonstrate efficient operation and compliant emissions.

Further guidance can be found in: Good Practice Guide 369: *Energy Efficient Operation of Boilers*, available from the Carbon Trust: www.carbontrust.co.uk. Certain large organisations (ones that employ at least 250 people, or have an annual turnover in excess of €50 million and a balance sheet in excess of €43 million) will also have to comply with the Energy Saving Opportunities Scheme (ESOS); most public sector bodies are excluded.

11.2 Environmental issues

All combustion plant has an impact on the environment through a combination of emissions to air, land and water.

Larger installations will be covered by permit issued by the Environment Agency, NRW, SEPA or NIHES. Individual combustion plants with a nett rated thermal input of between 1MW and 50MW will eventually all be covered by a permit issued under the Medium Combustion Plant Directive.

This permit will detail the boiler and its ancillary plant's effect on the environment and the permit conditions applied to the operator. It is illegal to operate the plant without a permit and outside these conditions.

Smaller plants will be regulated by local authorities under the Clean Air Act 1993 with the environmental agencies responsible for emissions to water courses. Local Authorities are principally concerned with the issues of nuisance, such as smoke and dust emissions, which will be regulated. However, operators still have a requirement to ensure that all products of combustion are adequately dispersed.

All hazardous waste products produced by a combustion plant must be removed by a licensed waste carrier. Water discharged to drains must comply with water utility restrictions, and a discharge temperature of greater than 43ºC is not allowed under the terms of the Water industry Act 1991.

Legislation and guidance can easily be found and downloaded from gov.uk, hse.gov.uk, or the CEA and SAFed web sites.

APPENDIX 1 - REFERENCES

The following is a list of applicable documents current at the time of preparation of this publication. The following should be noted:

- This is an indicative, not comprehensive list. Users should ensure they are working with the latest information available.
- Free copies of all legislation are available from gov.uk.
- Legislation marked with an asterisk is supported by Approved Codes of Practice and Guidance (ACoP) published by the HSE.
- Legislation marked with a double asterisk is supported by more than a single ACoP.
- The Electricity at Work Regulations (EAW) 1989 are supported by a Memorandum of guidance published by the HSE.

1. Health and Safety at Work etc Act 1974.
2. Management of Health and Safety at Work Regulations (MHSWR) 1998 SI 1999/3242.
3. Provision and Use of Work Equipment Regulations (PUWER) 1998* SI 1998/2306.
4. Electricity At Work Regulations 1989 - SI 1989/635
5. Confined Spaces Regulations 1997* - SI 1997/1713.
6. Control of Substances Hazardous to Health Regulations (COSHH) 2002* SI 2002/2667.
7. Dangerous Substances and Explosive Atmosphere Regulations (DSEAR)** SI 2002/2776.
8. Control of Noise at Work Regulations 2005 - SI 2005/1643.
9. Construction Design and Management Regulations (CDM) 2015* - SI 2015/51.
10. Supply of Machinery (Safety) Regulations (SMSR) 2008 - SI 2008/1597.
11. Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 2016 - SI 2016/1107.
12. Pressure Equipment (Safety) Regulations (PER) SI 2016/1105.
13. Pressure System Safety Regulations (PSSR) 2000* - SI 2000/128.
14. Gas Appliance Regulation (GAR) (Regulation (EU) 2016/426)
15. Work at Height Regulations 2005 SI 2005/735.
16. The Regulatory Reform (Fire Safety) Order 2005 – SI 2005/1541.
17. The Gas Safety (Installation and Use) (Amendment) Regulations (GSIUR) 2018 * SI 1998/2451.
18. The Environmental Permitting (England and Wales)(Amendment) Regulations 2018 SI2018/110 (MCPD).

19. L5 The Control of Substances Hazardous to Health Regulations 2002. Approved Code of Practice and guidance.

20. L22 Safe use of work equipment Provision and Use of Work Equipment Regulations 1998. Approved Code of Practice and guidance.

21. L101 Safe work in confined spaces. Confined Spaces Regulations 1997. Approved Code of Practice, Regulations and guidance.

22. L108 Controlling noise at work The Control of Noise at Work Regulations 2005 Guidance on Regulations.

23. L122 Safety of pressure systems. Pressure Systems Safety Regulations 2000. Approved Code of Practice.

24. L138 Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved Code of Practice and guidance.

25. L153 Managing health and safety in construction. Construction (Design and Management) Regulations 2015. Guidance on Regulations.

26. HSG253: The safe isolation of plant and equipment.

27. Permit-to-work systems HSE INDG98 ISBN 0 7176 1331 3

28. HSE Pressure Systems website http://www.hse.gov.uk/pressure-systems/index.htm

29. BEIS Pressure Equipment (Safety) Regulations 2016: Guidance

30. BG01 Guidance on Safe Operation of Steam Boilers. (CEA and SAFed)

31. BG03 Guidance on Industrial Steam Boiler Blowdown Systems. (CEA)

32. BG04 Guidance on Boiler Water Treatment. (CEA)

33. BG07 Guidance on Thermal Fluid Systems (CEA)

34. BG08 Guidance on Temporary Steam and Hot Water Boiler Plant (CEA)

35. PSG 3 Guidelines for the Operation of Hot Water Boilers (SAFed)

36. Water Treatment and Conditioning of Commercial Heating Systems Guide (ICOM)

37. BSRIA BG 50/2013 Water Treatment for Closed Heating and Cooling Systems ISBN 9 7808 6022 7243

38. BS 799: Part 4:1991 Specifications for atomising burners (other than monobloc type) together with associated equipment for single burner & multiburner installations.

39. BS 5410-2:2013 Code of practice for oil firing - Part 2: Installations over 45 kW output capacity for space heating, hot water and steam supply services.

40. BS 5925:1991 Code of practice for Ventilation principles and designing for natural ventilation.

41. BS 6644:2008 Specification for Installation of gas-fired hot water boilers of rated inputs between 70 kW (net) and 1.8 MW (net) (2nd and 3rd family gases).

42. BS 7671 Requirements for electrical installations. IET Wiring Regulations.

43. BS EN 298:1994 Automatic Gas burners Control systems for gas burners and gas burning appliances with or without fans.

44. BS EN 676:1997 Automatic Forced Draught Burners for Gaseous Fuels.

45. BS EN 746:1997 Part 2 safety requirements for Combustion and Fuel Handling Systems.

46. BS EN 12953 Shell Boilers.

47. EN 45510 Guide for procurement of power station equipment Part 3-2 Shell Boilers.

48. EN 303 – heating boiler with forced draughts burners.

49. BS EN 12828 :2012+A1:2014 Heating systems in buildings — Design for water-based heating systems.

50. BS EN 14336:2004 Heating systems in buildings- Installation and commissioning of water based heating systems.

51. BS EN 14394:2005 +A1:2008 Heating boilers with forced draught burners — Nominal heat output not exceeding 10 MW and maximum operating temperature of 110 °C

52. IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems.

53. Institution of Gas Engineers and Managers Utilisation Procedure IGE/UP/1A - Strength/tightness testing and direct purging (Small I&C) and IGEM/UP/1C - Strength/tightness testing and direct purging (Meters).

54. Institution of Gas Engineers and Managers Utilisation Procedure IGEM/UP/2 - Installation pipework.

55. Institution of Gas Engineers and Managers Utilisation Procedure IGEM/UP/10 Installation of gas appliances in industrial and commercial premises.

56. Institution of Gas Engineers and Managers IGEM/UP/12 Application of burners and controls to gas fired process plant.

57. Institution of Gas Engineers and Managers IGEM/UP/16 Design for Natural Gas installations on industrial and commercial premises with respect to hazardous area classification and preparation of risk assessments.

58. Institution of Gas Engineers and Managers IGEM/SR/25 - Hazardous area classification of Natural Gas installations.

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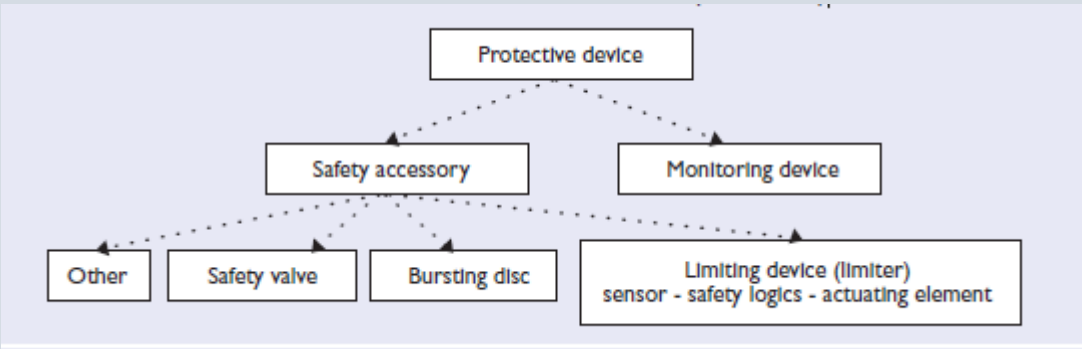
APPENDIX 2 - DEFINITIONS

Boiler system	Boilers, ancillaries and all related items including pipework. Additionally may include: fuel supply, water treatment, feed tank, flue, ventilation, blow down equipment, vents, monitoring, limiters and control equipment etc.
Boiler operator	Someone who has attended a training course with assessment, is familiar with the boiler system on-site and has sufficient knowledge & experience to operate the boiler system safely.
Cold boiler or steam system	At atmospheric pressure and a temperature low enough to prevent harm to persons working on the equipment.
Competent Person (CP)	Competent Person as defined in The Pressure Systems Safety Regulations 2000 (PSSR). The individual or organisation that certifies the written scheme of examination and/or carries out the required examinations in accordance with the WSE.
Control	Devices used for maintaining the variable to be controlled (e.g. pressure, temperature, water level) at a specific value (set point).
Controlled blow down	Manually lowering the water level within the boiler in order to perform tests of level controls, having due regard to any discharge constraints. Discharge temperature to drain should not exceed the permissible limit of 43°C.
Cut-out	A monitoring device, which on reaching a fixed value (e.g. pressure, temperature, flow, water level) is used to interrupt the energy supply and does not require manual reset when conditions return to normal.
Diversity	The provision of more than one different means of performing the required function, e.g. other physical principles, or other ways of solving the same problem.
Fail-safe	A limiter or control device is fail-safe if it possesses the capability of defaulting to remain in a safe condition or transferring immediately to another safe condition in the event of certain faults occurring, e.g. loss of power supply.
High-integrity	Refers to a control, limiter or cut-out system where a fault condition does not lead to loss of safety function (fail-safe). Components are high-integrity when they are of fail-safe design so that a single fault in any related part does not lead to loss of safety function. This may be achieved by fault avoidance techniques, self-monitoring, redundancy, diversity or a combination of these methods.
Limiter	A device that, on reaching a fixed value, e.g. pressure, temperature, flow, water level, is used to interrupt and lock-out the energy supply. Note: A limiting device comprises: • A measuring or detection function; and • An activation function for correction, or shutdown, or shutdown and lock-out, and which is used to carry out safety related functions as defined in the PED, on its own or as part of a safety (protective) system (e.g. sensors, limiters). If this is achieved by multi-channel systems, then all items or limiters for safety purposes are included within the safety (protective) system. • Protective devices and safety accessories according to Directive 97/23/EC (PED/PER) and (from PSSR) devices designed to protect the pressure system against system failure and devices designed to give warning that system failure might occur, including bursting discs.



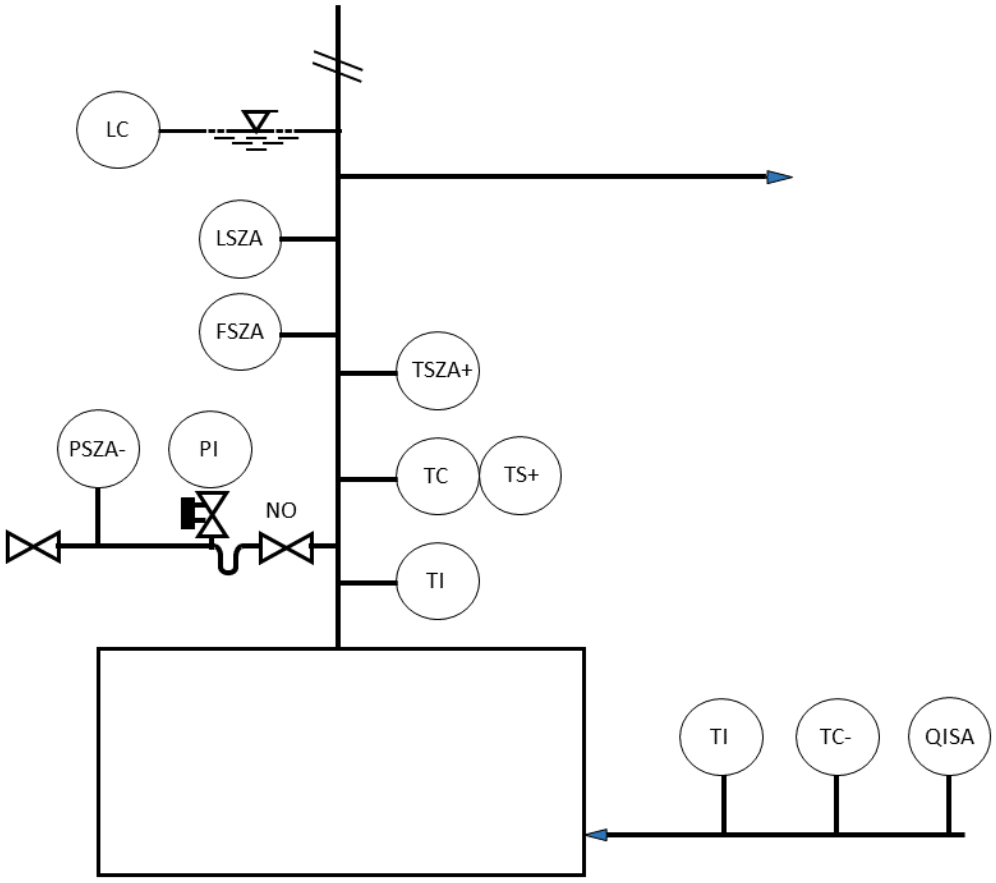
Lock-out	A safety shut-down condition of the limiter, such that a restart can only be accomplished by a manual reset of the limiter or by a manual reset of the safety logic and by no other means. This will be achieved by a competent operator taking account of the physical situation.
Maintenance personnel	Suitably trained persons who are responsible for undertaking maintenance on the plant.
Manned	A boiler operator is on-site during hours of boiler operation.
MAP	Maximum allowable pressure
Off-site monitoring	An off-site location with direct links to the boiler controls and alarms, where monitoring takes place. A competent boiler operator attends site to carry out checks and is available to attend site at all other times.
On-site	Physical presence on-site, not necessarily in the boiler house.
Owner	'Owner' in relation to a pressure system, means the employer or self-employed person that owns the pressure system or: if he does not have a place of business I n Great Britain, his agent or: if there is no such agent; the user (Regulation 2, PSSR).
Redundancy	The provision of more than one device or system which, in the event of a fault, will still provide the necessary facilities.
Self-monitoring	Regular and automatic determination that all chosen components of a safety system are capable of functioning as required.
Shell boiler	In a shell boiler, hot gases pass through the furnace and tube banks, the heat from the hot gases transfer via convection through the tubes and conduction into the water within the boiler shell. Also known as fire tube boiler, shell and tube boiler, package steam boiler, smoke tube boiler.
SOL	Safe operating limit.
Steam generator	Steam is made in a coiled tube surrounded by products of combustion. No perceptible water level in the tube.
User	The user of a pressure system - the employer or self-employed person who has control of the operation of the pressure system
Water-hammer	Dynamic shock loading resulting from the accumulation of condensate in steam pipework.
WSE	Written Scheme of Examination.

APPENDIX 3 – DIAGRAMS OF TYPICAL BOILER ARRANGEMENTS

Drawings in this Appendix are not associated with any particular level of supervision - they are provided to guide designers and users/owners of hot water boiler plants in the direction of possible boiler control and measurement arrangements, and do not represent final solutions for any particular circumstance.

The following diagrams are based on the recommendations from BS EN 12953 part 6.

Appendix 3.1 Open vented hot water system



Key:

LC Automatic water level controller

LSZA- Minimum water level limiter (- alarm). For boilers with an allowable heat output less or equal to 1.5MW, a low pressure limiter should be sufficient

FSZA- Minimum flow limiter (- alarm)

NO Stop valve locked in open position

PSZA- Minimum pressure limiter (- alarm)

PI Pressure indicator

TSZA+ Maximum temperature limiter (+ alarm). For solid fuels it may be necessary that an additional emergency cooling system be started

TC Temperature controller

TS+ High temperature controller (integrated function in the temperature controller)

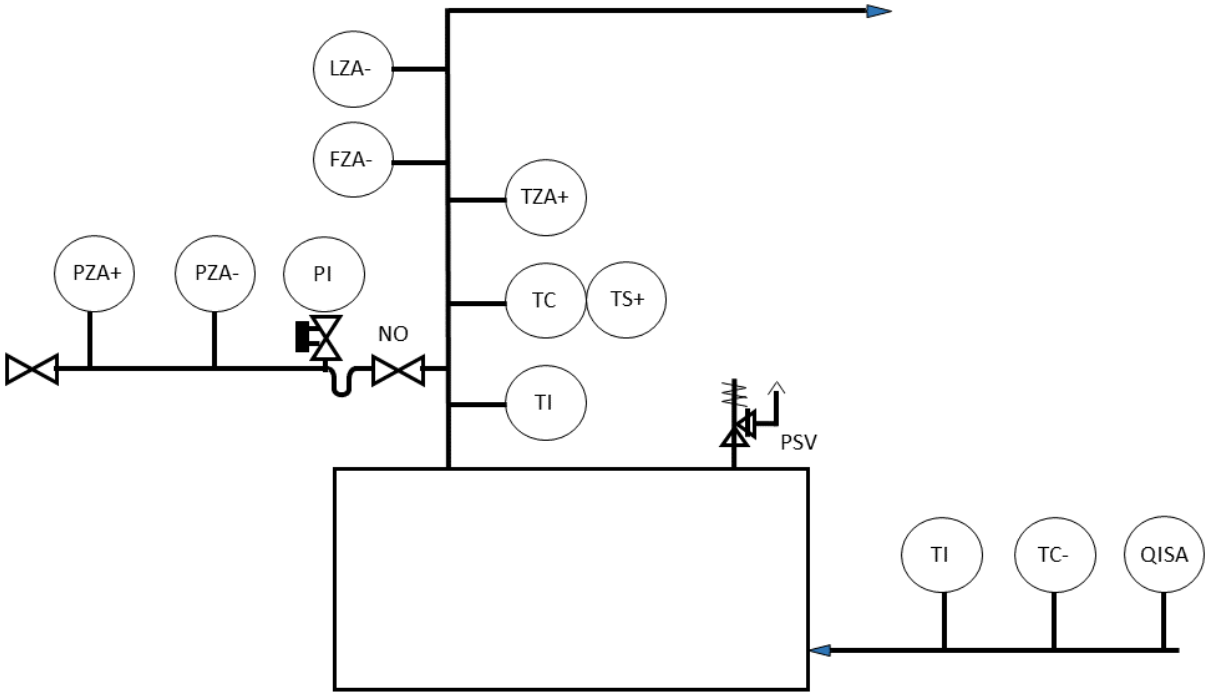
TI Temperature indicator

TC- Minimum temperature controller

QISA Water quality indicator/controller (alarm)

NOTE: In a system with more than one boiler in parallel, each boiler should be equipped with its own security line.

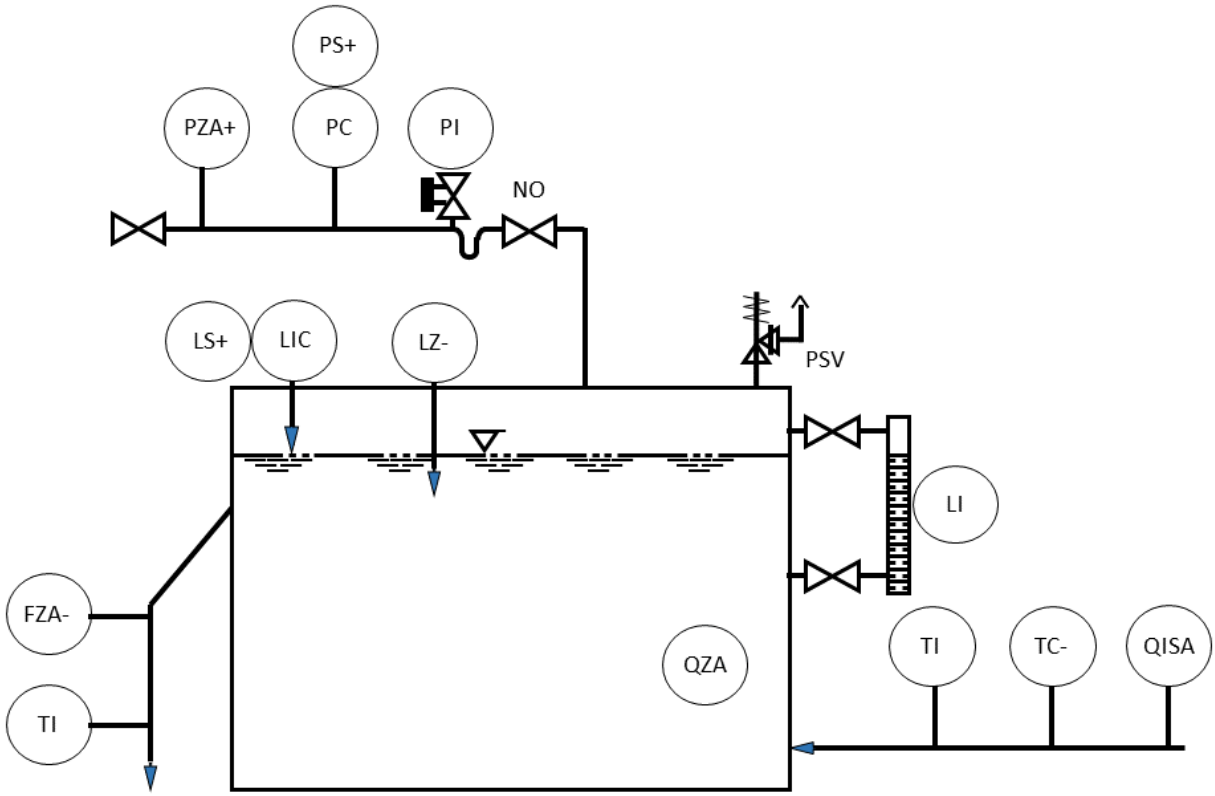
Appendix 3.2 Hot water system with external pressure generating and expansion system



Key:

PSV	Pressure safety valve. If required a flash vessel should be installed.
LZA-	Minimum water level limiter (- alarm)
FZA-	Minimum flow limiter (- alarm)
NO	Stop valve locked in open position
PZA+	Maximum pressure limiter (+ alarm)
PZA-	Minimum pressure limiter (- alarm)
PI	Pressure indicator (with master gauge connection valve)
TZA+	Maximum temperature limiter (+ alarm). For solid fuels it may be necessary that an additional emergency cooling system be started
TC	Temperature controller
TS+	High temperature controller (integrated function in the temperature controller)
TI	Temperature indicator
TC-	Minimum temperature controller
QISA	Water quality indicator/controller (alarm)

Appendix 3.3 Hot water system with internal pressure generating and expansion system – Steam cushion in the boiler



Key:

PSV Pressure safety valve. If required a flash vessel should be installed.

NO Stop valve locked in open position

PZA+ Maximum pressure limiter (+ alarm) For solid fuels it may be necessary that an additional emergency cooling system be started

PC Pressure controller

PS+ High pressure controller (integrated function in the pressure controller).

PI Pressure indicator (with master gauge connection valve)

LZ- Minimum water level limiter (- alarm)

LIC Water level controller. Water level indicator may be integrated in the level controller

LS+ High level controller (integrated function in the level controller)

LI Water level indicator

FZA- Minimum flow limiter (- alarm). If required depending on the boiler construction

QZA Conductivity limiter (alarm). If required

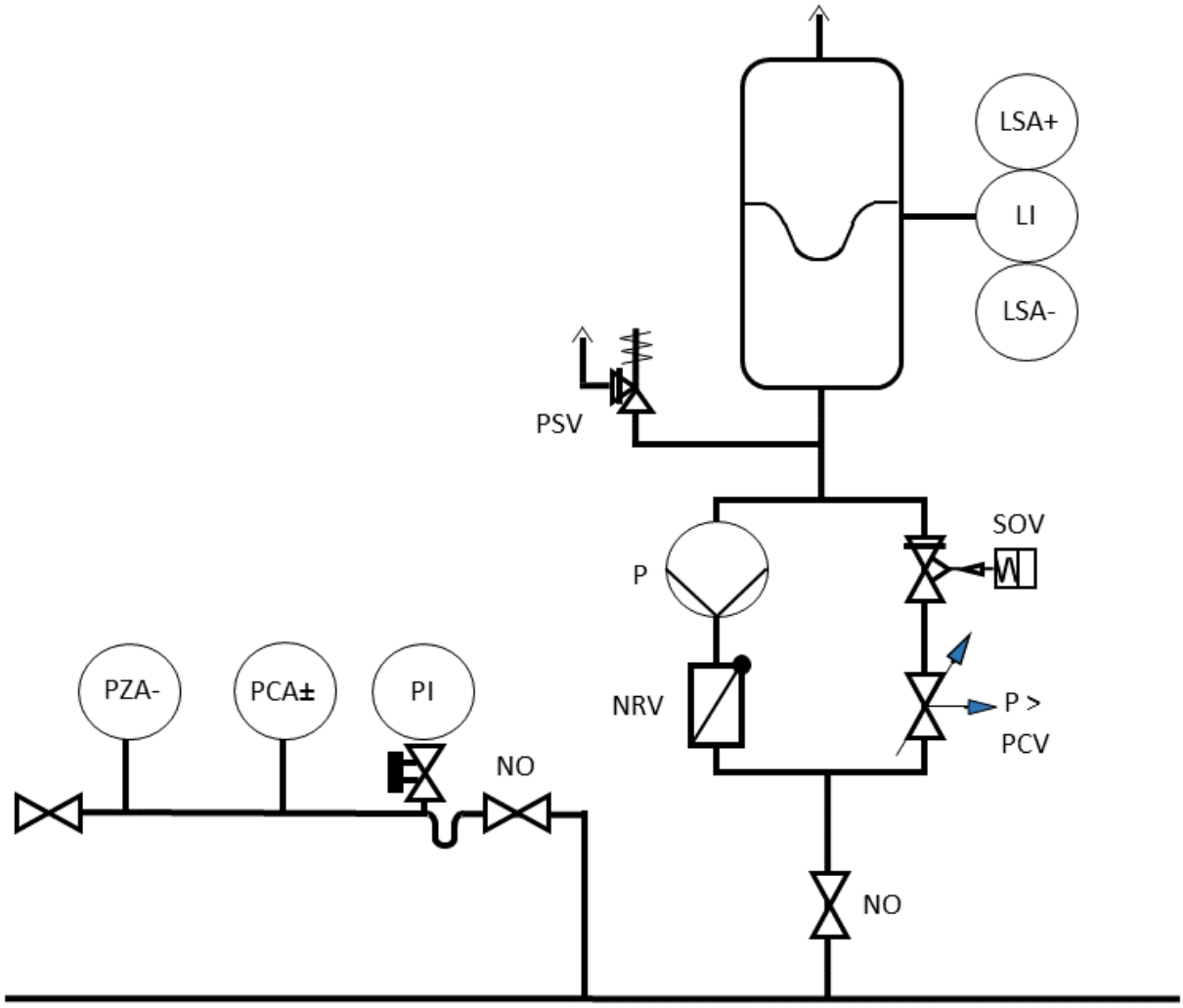
TI Temperature indicator

TC- Minimum temperature controller. If required

QISA Water quality indicator/controller (alarm). If required

NOTE: Pressure controlling and limiting is preferred for boilers with internal pressure generating and expansion system to achieve a quicker and more precise control of the heat supply. If the manufacturer wants to control the heat supply by the outgoing flow temperature the boiler should be fitted with a TC Temperature controller TZA+ maximum temperature limiter (+alarm) and PZA- minimum pressure limiter (- alarm)

Appendix 3.4 Pressure pump-controlled system with pressureless membrane type expansion vessel



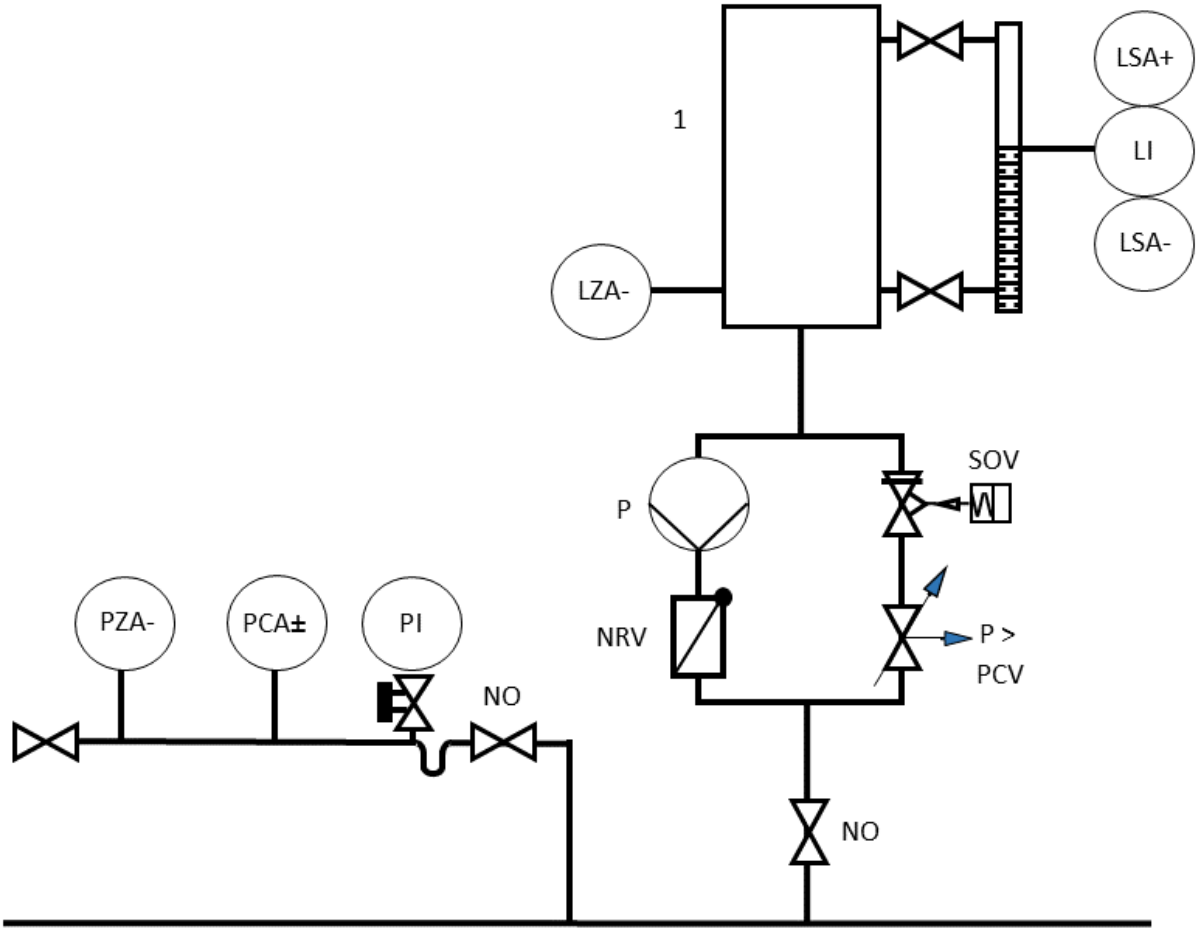
Key:

NO	Stop valve locked in open position
P	Pressure pump
NRV	Non return valve
PCV	Pressure control valve
SOV	Shut-off valve (self-closing on power loss)
PSV	Pressure safety valve (designed for thermal expansion and only necessary if PS of the expansion vessel is lower than PSV of the system)
LI	Water level indicator (may be achieved by means of a vessel weight transducer)
LSA+	High water level controller (may be integrated in the LI equipment, + alarm)
LSA-	Low water level controller (may be integrated in the LI equipment, - alarm)
PI	Pressure indicator (with master gauge connection valve)
PCA±	Pressure controller
PZA-	Minimum pressure limiter (- alarm) (closes SOV)

NOTE 1: PI may be integrated in a PCA± equipment

NOTE 2: If necessary a cooling vessel should be installed between the system and the pressurising equipment.

Appendix 3.5 Pressure pump-controlled system with open expansion tank

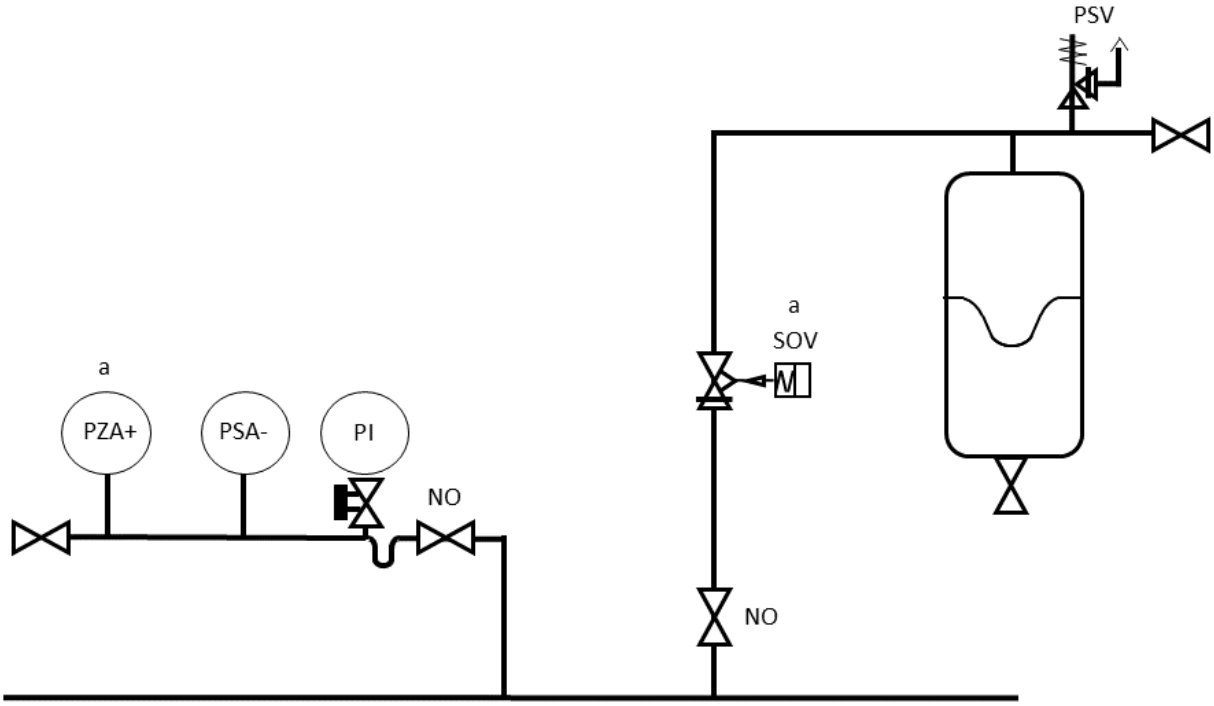


Key:

NO	Stop valve locked in open position
P	Pressure pump
NRV	Non return valve
PCV	Pressure control valve
SOV	Shut-off valve (self-closing on power loss)
LI	Water level indicator (may be achieved by means of a vessel weight transducer)
LSA+	High water level controller (may be integrated in the LI equipment, + alarm)
LSA-	Low water level controller (may be integrated in the LI equipment, - alarm)
LZA-	Minimum water level limiter (stops the pressure pump, - alarm)
PI	Pressure indicator (with master gauge connection valve)
PCA±	Pressure controller (controls the pump P and the PCV if it is not self actuating, ± alarm)
PZA-	Minimum pressure limiter (- alarm) (closes SOV)
1	Open expansion tank

NOTE: If necessary a cooling vessel should be installed between the system and the pressurising equipment.

Appendix 3.6 Membrane type expansion vessel with pre-pressurised gas cushion

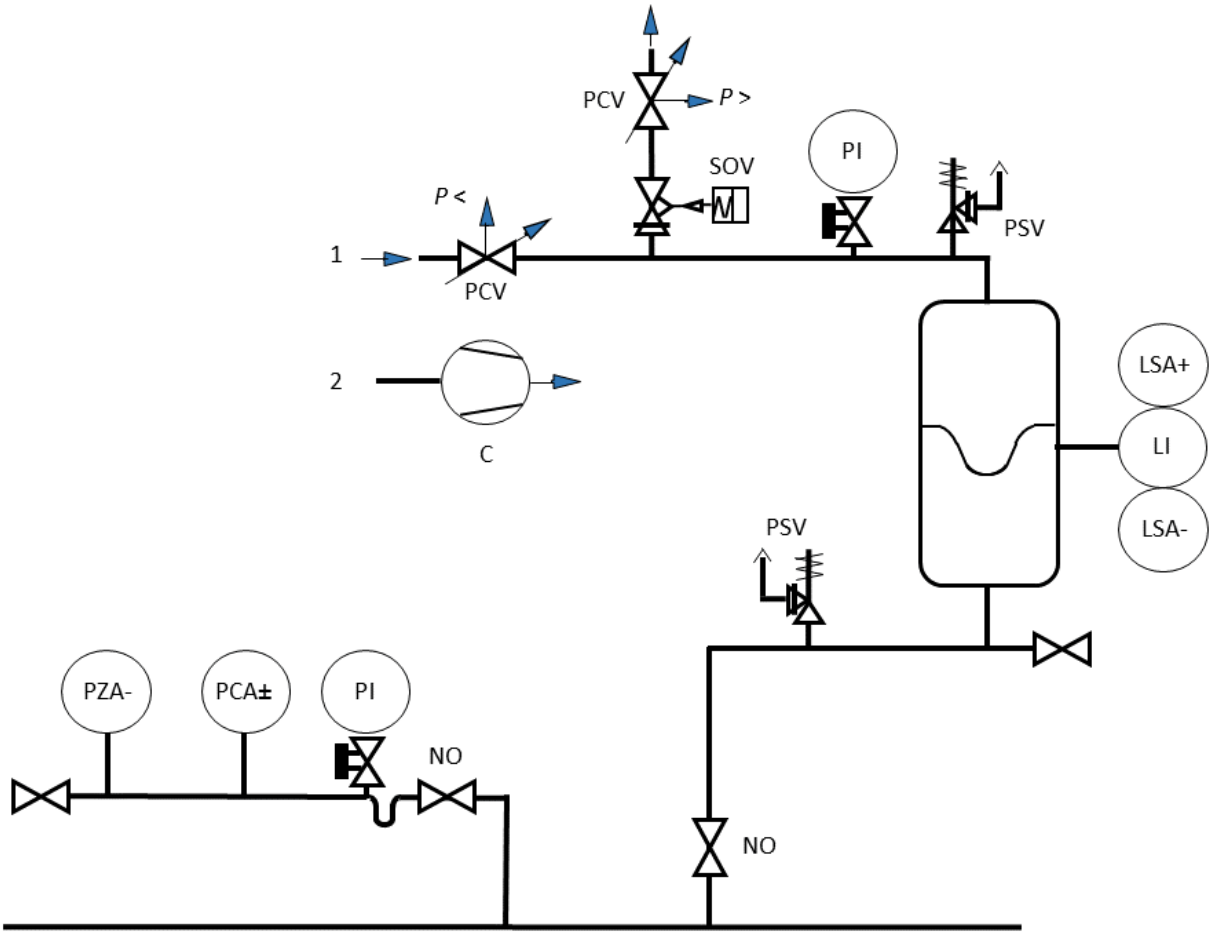


Key:

NO	Stop valve locked in open position
PSV	Pressure safety valve (designed for thermal expansion and only necessary if PS or the expansion vessel is lower than the PSV of the system)
PI	Pressure indicator (with master gauge connection valve)
PSA-	Low pressure controller (- alarm)
SOV	Shut-off valve (self-closing on power loss)
PZA+	Maximum pressure limiter (closes SOV at pressure higher than PSV of the vessel)
a)	Equipment only necessary if PS of the expansion vessel is lower than the PSV of the system

NOTE: If necessary a cooling vessel should be installed between the system and the expansion vessel

Appendix 3.7 Membrane type expansion vessel with controlled gas cushion



Key:

NO	Stop valve locked in open position
SOV	Shut-off valve (self-closing on power loss)
PCV	Pressure control valve
C	Compressor (option)
PSV	Pressure safety valve (designed for thermal expansion and/or maximum gas pressure)
LI	Water level indicator (may be achieved by means of a vessel weight transducer)
LSA+	High water level controller (may be integrated in the LI equipment, + alarm)
LSA-	Low water level controller (may be integrated in the LI equipment, - alarm)
PI	Pressure indicator (with master gauge connection valve)
PCA±	Pressure controller (controls the C and the PCV if they are not self actuating, ± alarm)
PZA-	Minimum pressure limiter (- alarm) (closes SOV)
1	Gas
2	Option

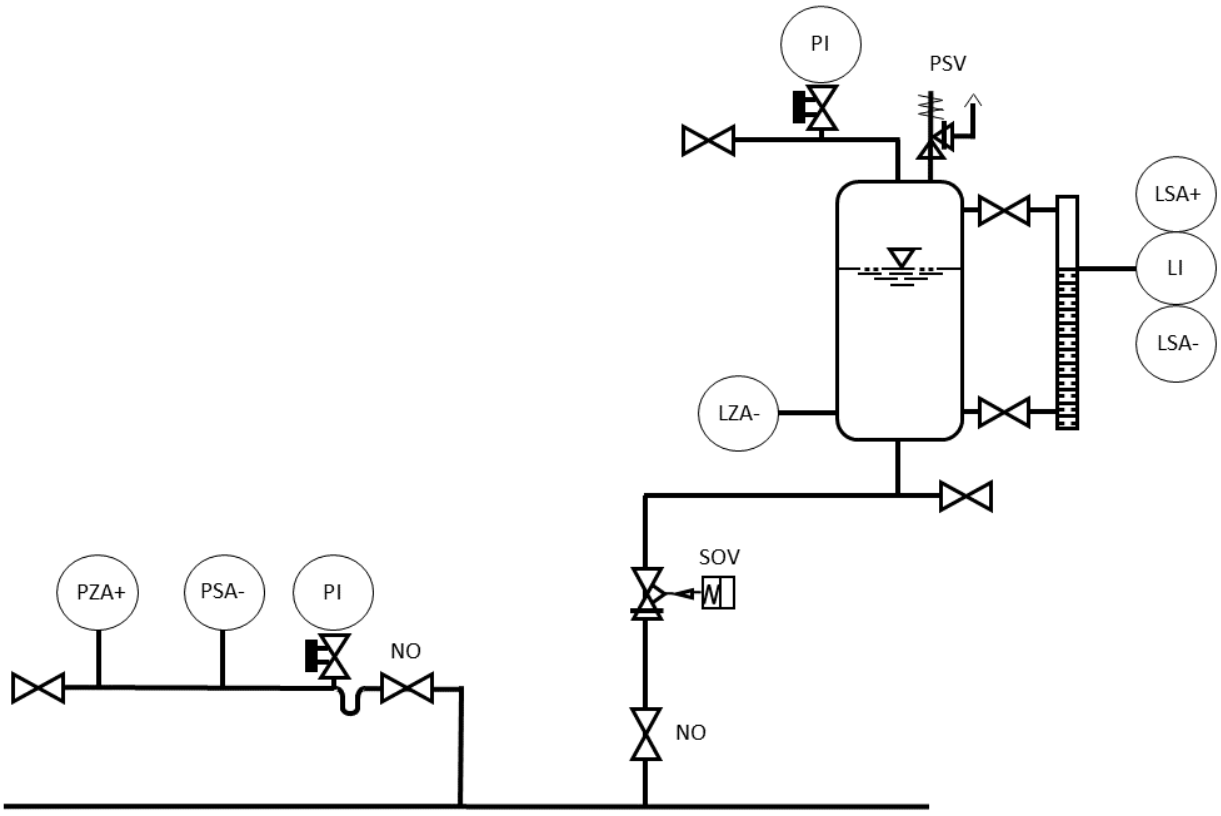
NOTE 1: PSV on the water side is only necessary if PS of expansion vessel is lower than PSV of the boiler and should be sized for of the allowable heat output of the boiler system.

NOTE 2: PI may be integrated in a PCA± equipment.

NOTE 3: PCA± transmitter may be situated on the gas side if it is relevant to the function of the system.

NOTE 4: If necessary a cooling vessel should be installed between the system and the expansion vessel.

Appendix 3.8 Closed expansion vessel with pre-pressurised gas cushion

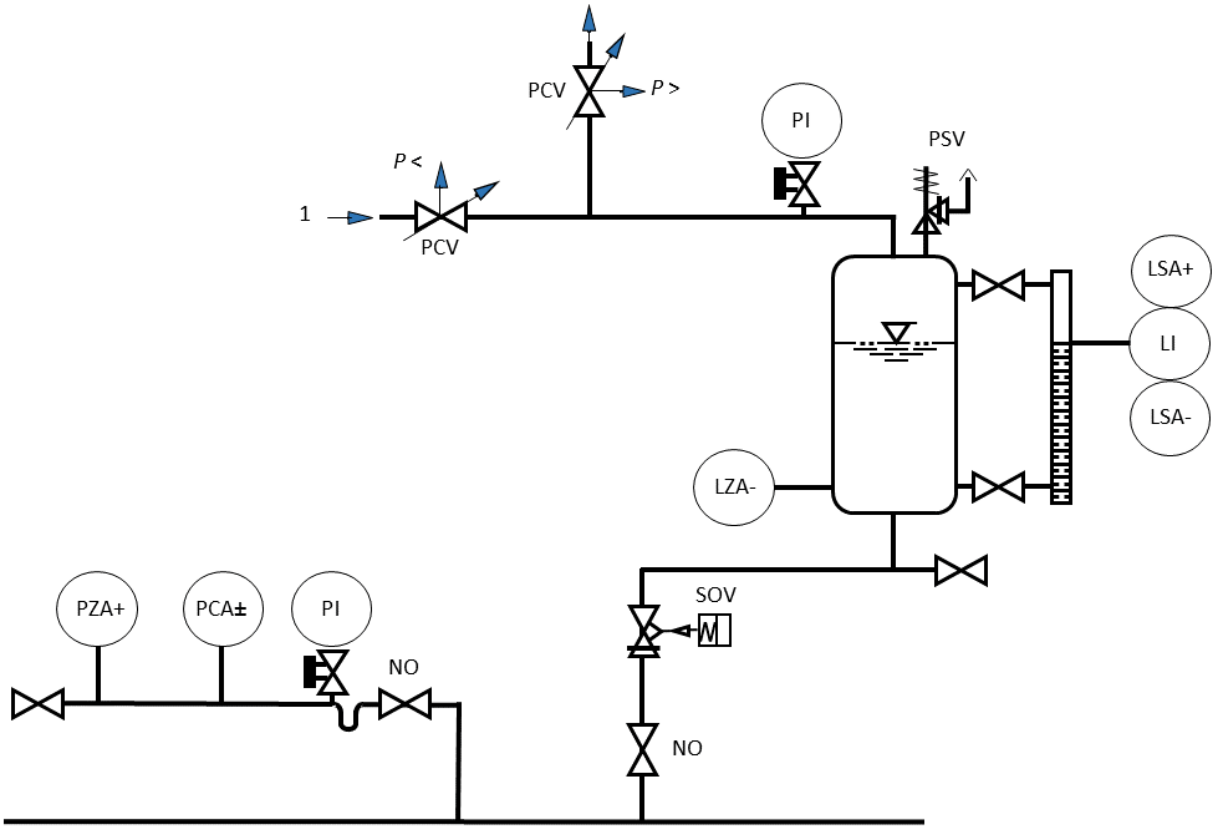


Key:

NO	Stop valve locked in open position
SOV	Shut-off valve (self-closing on power loss)
PSV	Pressure safety valve (designed for thermal expansion)
LI	Water level indicator (may be achieved by means of a vessel weight transducer)
LSA+	High water level controller (may be integrated in the LI equipment, + alarm)
LSA-	Low water level controller (may be integrated in the LI equipment, - alarm)
LZA-	Minimum water level limiter (closes SOV, - alarm)
PI	Pressure indicator (with master gauge connection valve)
PSA-	Low pressure controller (- alarm, may be integrated in PZA-)
PZA+	High pressure limiter (closes SOV at pressure higher than allowed for expansion system)

NOTE: If necessary a cooling vessel should be installed between the system and the expansion vessel.

Appendix 3.9 Closed expansion vessel with gas or steam cushion



Key:

NO	Stop valve locked in open position
SOV	Shut-off valve (self-closing on power loss)
PCV	Pressure control valve
PSV	Pressure safety valve (designed for thermal expansion and/or maximum gas pressure)
LI	Water level indicator
LSA+	High water level controller (may be integrated in the LI equipment, + alarm)
LSA-	Low water level controller (may be integrated in the LI equipment, - alarm)
LZA-	Minimum water level limiter (closes SOV, - alarm)
PI	Pressure indicator (with master gauge connection valve)
PCA±	Pressure controller (controls the PCV if it is not self actuating, ± alarm)
PZA+	High pressure limiter (closes SOV at pressure higher than allowed for expansion system)
1	Gas

NOTE 1: PCA± transmitter may be situated on the gas side if it is relevant to the function of the system.

NOTE 2: If necessary a cooling vessel should be installed between the system and the expansion vessel

APPENDIX 4 – TYPICAL LOG SHEET EXAMPLES

The boiler logs possess two functions:

- They should be formulated as the logical outcome of a risk assessment and as such the checks contained within constitute a risk assessment checklist.

- They are also a record of the activities that occur within a boiler house and as such all visits, work, actions and interventions which may affect the operation of the boiler should be recorded in as much detail as necessary for safe and efficient operation.

The examples that follow are suggestions for the types of records that need to be kept for typical boiler houses – **every boiler house is different and will need its own log sheet.**

The suggested list of items to be logged comes from BS EN 12953 part 6.

Recommended checks and tests schedule for hot water boilers.

Log book front sheet

Boilerhouse log book for the boilers at _____

Date started: _____

Date closed: _____

Site name and address: _____

_____

System volume _____ litres

Open vented / sealed unvented system

Important notes

- All tests and records shall be completed and recorded by a competent boiler operator.
- Every visit to the boiler house and the name of every visitor shall be recorded.
- Visits by third parties who work on the boilers or associated plant shall be recorded in this log book and include a brief note of the work undertaken and the reference numbers of their job sheets.
- Keep all checks and records for a minimum of 5 years.
- On re-starting a boiler following maintenance or a breakdown, a full set of tests must be carried out and recorded prior to putting the boiler back on line.
- This log book shall be kept in a safe, secure location and shall be retained for a minimum of 5 years (INDG436).
- All inspection reports stay with the boiler for life.

EXAMPLE ONLY

EVERY BOILER HOUSE WILL REQUIRE ITS OWN BESPOKE CHECKLIST

BOILER HOUSE ACTIVITY LOG

DATE	NAME	REASON FOR VISIT	ACTIONS TAKEN
xx/yy/zz	*A N Engineer*	*Routine visit to check boilers*	*Readings recorded – all OK*

ROUTINE CHECKS AND TESTS every 72 hours

Print Name:		Date:	Time:

Boiler	ONE	TWO	THREE	
Status	Online / Offline / Off	Online / Offline / Off	Online / Offline / Off	
Boiler pressure reading (gauge)				bar g
Boiler temperature flow & return	/	/	/	°C
Burner firing rate				%
Exhaust temperature				°C
Flame inspection (describe below if abnormal)	Normal / Abnormal	Normal / Abnormal	Normal / Abnormal	

If a part of the furnace is glowing orange / yellow, shut down, isolate and report

Gas meter reading				m^3
Oil meter reading				m^3
Water meter reading				m^3

Propane ignition cylinders	Bottle 1	Bottle 2
	Online / standby / empty	Online / standby / empty
Oil tank level	Tank 1	Tank 2
	litres	litres

Security of system (leaks and flow) – inspection only, for integrity and correct set points

Safety valves		Low water protection	
Water level indicator		Pressure limiter	
Drains and vents		Pressure controller	
Water quality protection		Temperature limiter	
Flow limiter		Temperature controller	

Comments / faults / incidents

Signature:

ROUTINE CHECKS AND TESTS monthly/ 3 monthly/ 6 monthly

Note – all tests and checks shall be carried out by competent operatives in accordance with manufacturer's instructions – use standard method statements for every test.

Print Name:		Date:	Time:

Monthly checks and tests for the month of _____ 20___

		Actions
Circulation limiter	Pass / Fail	
Flame failure device	Pass / Fail	
Pressure parts – integrity	Pass / Fail	
Water quality protection sampling	Pass / Fail	

Note: Water treatment Readings, Actual Parameters and Targets to be determined by risk assessment in accordance with BG04

Water Quality readings	Typical Target Parameters - BG04 Table 3	Reading	Actions
pH	6.5-9.5 Steel ; 6.5-8.5 Aluminium		
Inhibitor	Varies According to Inhibitor		
TDS	3500 ppm Max		
Suspended Solids	200 ppm Max.		
Total Microbiological Activity	<1000 cfu/ml		
Dissolved Iron	<1ppm		

3 monthly tests for the month of Jan/Apr/Jul/Oct* 20___ * delete as appropriate

		Actions
Low water protection device	Pass / Fail	
Pressure limiting device	Pass / Fail	
Temperature limiting device	Pass / Fail	

Water supply data	target	reading	Actions
pH			
conductivity			

6 monthly tests for the month of Apr/Oct* 20___ * delete as appropriate

		Actions
Safety valve tests	Pass / Fail	
Vent valve tests	Pass / Fail	
Water quality protection device tests	Pass / Fail	
Protective systems – electrical and mechanical integrity tests	Pass / Fail	
Pressure controller test	Pass / Fail	
Temperature controller test	Pass / Fail	

Comments / faults / incidents

Signature:

Recommended checks and tests schedule for hot water boilers.

(C) Observation of abnormal functioning, noises, smells or other noticeable factors.

(T) Checking and/or testing the functional behaviour of equipment parts, including observation.

Checks and tests every …	**3 days**	**1 month**	**3 months**	**6 months**	**12 months**	**Remarks**
Safeguards against excessive pressure (safety valves)	C			T		See NOTES 1 and 2 below
Water level indication	C					Compared with limiters and controls
Drain and blow-down devices	C					
Vent valves	C			T		As per manufacturer's instruction manual
Low water protection	C		T			May be tested by simulation
Pressure and temperature indication	C					Compared with limiters and controls
Pressure limitation	C		T			May be tested by simulation
Temperature limitation	C		T			May be tested by simulation
Circulation limitation	C	T				
Devices for water quality protection where fitted	C	T (1)		T (2)		(1) Comparison of the measured values with the reliable samples (2) Performed by a suitably qualified and competent person
Protective systems	C			T (3)		(3) Electrical and mechanical testing performed by a suitably qualified and competent person
Pressure parts (pipes, inspection openings, flanges, gaskets, joints…)		C				
Pressure controller and temperature controller	C			T		
Water supply	C		T			
Water quality		T				See BG04
Heat supply	C				T (5)	(5) by a suitably qualified and competent person as per manufacturer's instruction manual but not less than once a year

NOTE 1 - Additional function tests and observation can be required either by National Rules, third parties or the manufacturer.

NOTE 2 - Deviations of periods or tests are possible with agreement of third parties if safety level will not be reduced.

NOTE 3 - Consideration should be given to functional testing of additional devices outside the boiler.

From BS EN 12953 – 6:2011

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Amendments:

July 2019 Edition 1 version 2 – minor corrections to text.

April 2020 Edition 1 version 3 – minor corrections to text, addition to 7.2.5 Chimneys & Flues.

Safety Assessment Federation
Unit 4, First Floor
70 South Lambeth Road
Vauxhall
London
SW8 1RL
www.SAFed.co.uk

The Combustion Engineering Association
NETPark
Thomas Wright Way
Sedgefield
Co. Durham
TS21 3FD
www.cea.org.uk

Guidance for the Safe Operation of Industrial Shell Hot Water Boilers (Ref: BG02)

This document will be formally reviewed periodically although amendments and revisions may be made more frequently as required.

Users of this document should ensure they are working to the latest edition.