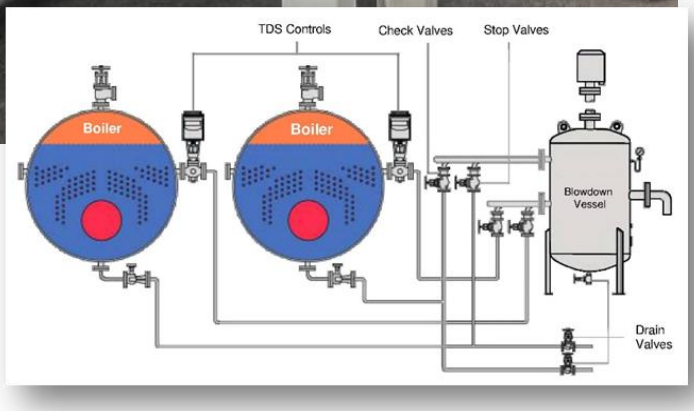
Blowdown Systems
Guidance for Industrial Steam Boilers

Ref: BG03



CEA
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1 INTRODUCTION TO THE SECOND EDITION

Blowdown Systems, Guidance for Industrial Steam Boilers (Ref: BG03) is a guidance document intended to provide advice to designers, specifiers, manufacturers, installers and those responsible for the management and operation of steam plant as well as Competent Persons. It is applicable to both new and existing installations of steam boilers and addresses the following issues:

- The safe discharge of blowdown from boilers;
- The safe use and operation of blowdown vessels;
- The safe use and operation of blowdown pits;
- Proper maintenance and inspection of blowdown vessels and pits including requirements for regular inspection by a Competent Person in accordance with the Written Scheme of Examination (WSE).

Advice was previously provided by Health and Safety Executive Guidance Note **PM60 Steam boiler blowdown systems 2nd edition 1998** which has been withdrawn. This second edition of BG03 incorporates additional information regarding the sizing of typical blowdown vessel inlets and outlets (Section 6.2), and some amendments to the text to correct out-of-date references and other minor adjustments.

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.

1.1 About this guide

This comprehensive guide deals with all aspects of steam boiler blowdown for industrial steam boilers and why it is necessary to carry out the function of **"blowing down"** the boiler. We trust that by studying the contents and following this advice your boiler plant will operate safely and more efficiently, and provide you with a trouble-free system. If in any doubt contact the supplier, the system designer, or your boiler water treatment specialist for advice.

It is aimed at the Owner, Operator, Engineer and Manager of the boiler plant to help them understand all aspects that affect the boilers and why blowing down is necessary, both from a practical operational performance view and for the legal requirements.

It covers who is responsible for the safe and efficient operation of steam boiler plant, and who is responsible for managing the safe operation of this type of equipment. Ultimately the responsibility lies with the most senior person on site; however, they can delegate the responsibility for daily operations, but only to a suitably trained and competent person on site.

With other HSE guidance being withdrawn, and having taken all factors into consideration, The Combustion Engineering Association (CEA) agreed to write this guide with the help of its members.

Within this guide there are a significant number of legal requirements, regulations and standards highlighted; these regulations and standards are periodically reviewed and they can and do change, but they are as accurate as possible at the time of publication.

CEA cannot accept any liability for the information provided herein; however, be assured that we have consulted widely with our member companies during the compilation of this guide.

1.2 Acknowledgements

Thanks go the following CEA member organisations for their time and contributions:

- Coal Hill Associates
- Industrial Boilerhouse Safety
- Energy and Environmental Solutions
- Cochran Ltd
- Spirax Sarco
- ISIS Fluid Controls
- SAACKE Combustion Services
- BOSCH Commercial and Industrial Heating
- Flowserve Gestra
- M&M Training

In memory of Kim Stopher, past Chairman of the CEA and contributor to this and many other CEA Guides.

2 SCOPE

This guidance applies to blowdown arrangements for steam boilers including water tube boilers with a single main blowdown line.

The following **are specifically excluded** from the scope of this document:

- Water tube boilers with multiple blowdown circuits;
- Blowdown tanks of non-circular cross-section;
- Design and construction information for blowdown pits. Experience has shown that the state of repair and rate of deterioration are difficult to monitor, and serious undetected leaks have been known to undermine foundations. It is recommended that no new blowdown pits be constructed and a blowdown vessel shall be the preferred option.

2.1 Typical schematic arrangements

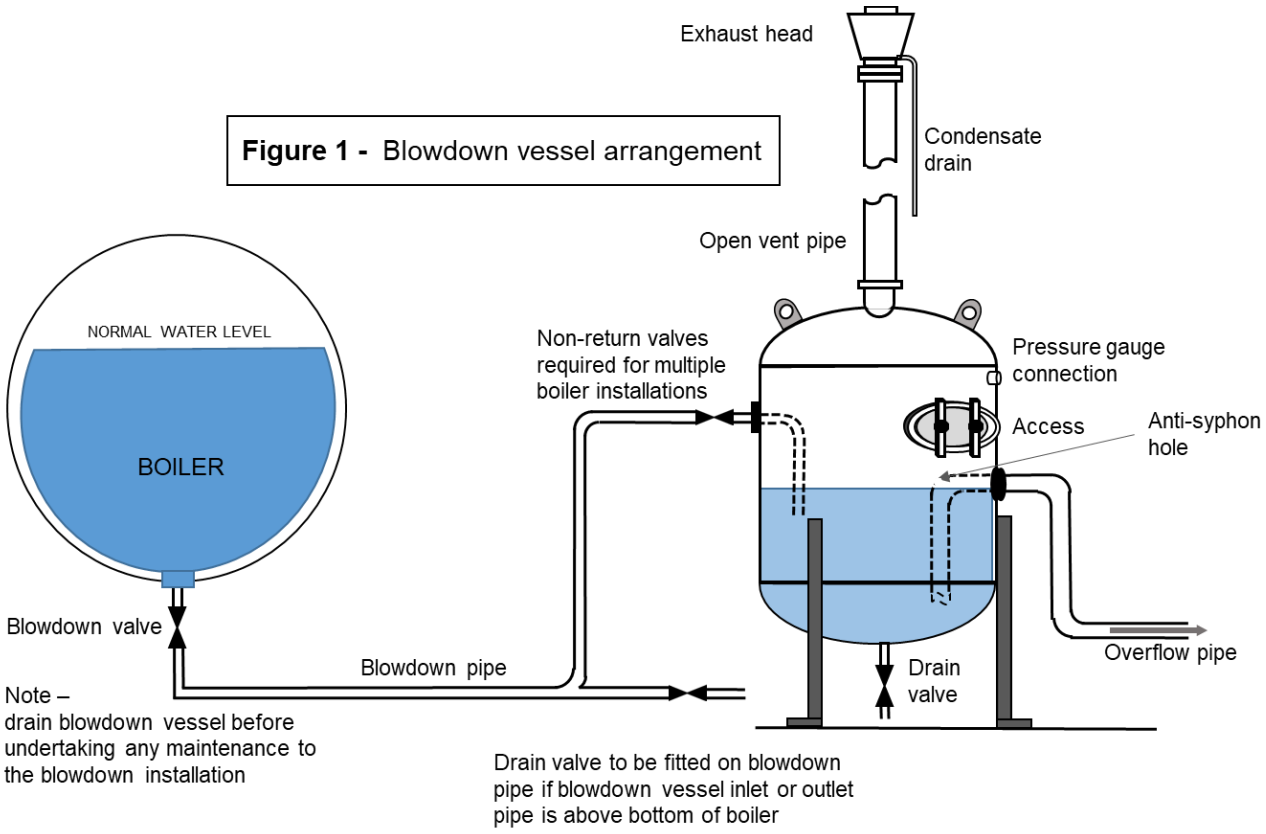
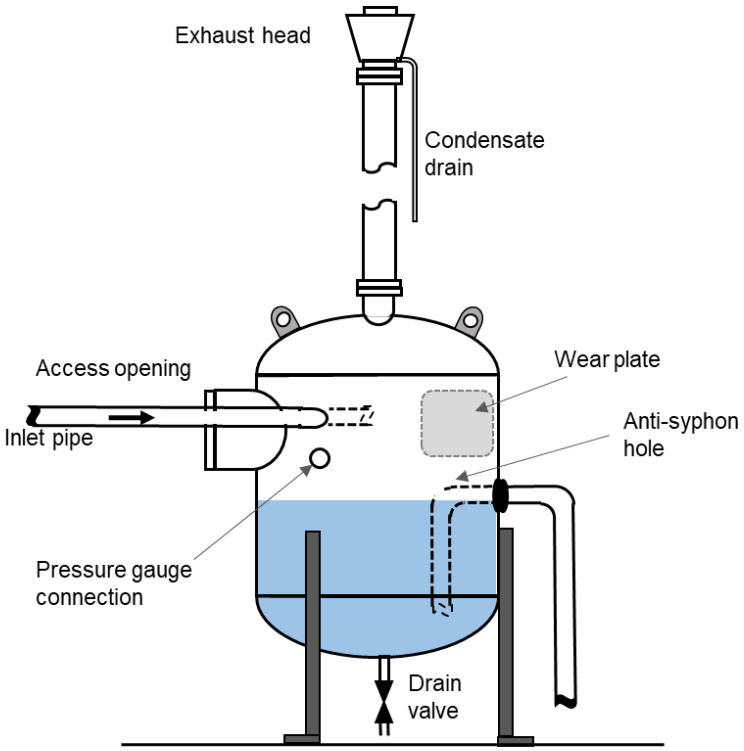


Figure 1 - Blowdown vessel arrangement



NOTE – Care should be taken to ensure that where patents exist these should not be infringed

Figure 2 - Alternative blowdown vessel arrangement

3 REASONS FOR BLOWDOWN

Blowdown is essential to control steam boiler water contamination. As a boiler generates steam, any impurities that are in the boiler feedwater which do not boil off with the steam will concentrate in the boiler water. As these dissolved and suspended solids become more concentrated, steam bubbles fail to burst as they reach the water surface. They accumulate as a layer of foam in the void above the boiler water and ultimately get carried over into the steam system. Not only does this make the steam leaving the boiler excessively wet, but it contains contaminants that could clog and damage control valves, heat exchangers and other equipment.

Suspended solids form into sludge that can coat boiler heating surfaces and control devices causing overheating and damage including potentially catastrophic failure of the boiler.

It is therefore extremely important to restrict and control the level of both suspended and dissolved solids within a boiler. This is achieved by either **continuous blowdown** or **intermittent blowdown** or a combination of both, and can be either automatic or manual.

The maximum permitted level of solids in a boiler varies according to the type of boiler. More information can be found in the CEA's guide:

> **BG04 Boiler Water Treatment; Guidance for Shell Boilers, Coil Boilers, Steam Generators and Hot Water Boilers**.

3.1 Continuous blowdown

Continuous blowdown is required where dissolved and suspended solids levels cannot be adequately controlled by bottom blowdown alone. The continuous blowdown process is usually automatic and is always in addition to intermittent (bottom) blowdown. It must also be noted that continuous manual blowdown is not a recommended option.

Continuous blowdown systems (TDS systems) shall be installed with a non-return valve to protect the control valve from backflow. Total Dissolved Solids (TDS) control valves rely on narrow control paths and as such are susceptible to blockage from solids if backflow from the intermittent blowdown occurs. The water level in a blowdown vessel will rise during blowdown, so it is possible to have reverse flow in the continuous blowdown line from the intermittent blowdown even where the connections are nominally above the water line.

Whenever a continuous blowdown system is installed, consideration should be given to the inclusion of heat recovery equipment. Heat recovery systems usually consist of a flash vessel to recover flash steam back to the feed tank and a heat exchanger to extract further heat from the residual condensate (usually to heat make-up water to the feed tank).

This residual water is contaminated by a high concentration of dissolved solids and should not be recovered for use in the boiler unless suitably and adequately treated. Where the temperature is sufficiently low, the waste water can be discharged directly to drain without the need for passing through the blowdown vessel.

In the case of a single boiler installation it is acceptable to connect the TDS blowdown line from the boiler to a point downstream of the bottom or main blowdown line through a non-return valve.

Where multiple boilers are connected to the same blowdown vessel, the TDS blowdown line shall not be connected to the bottom blowdown line or bottom blowdown manifold.

Continuous blowdown is also variously referred to as surface blowdown, continuous TDS blowdown, TDS control blowdown, side blowdown, desalting, or TDS control.

3.2 Intermittent (bottom) blowdown

Intermittent, or bottom blowdown is essential for boilers operating with internal feed water treatment; it is the only effective method of removing sludge, and should only be applied in short sharp bursts. Longer bursts aid in the reduction of dissolved and suspended solids but have limited additional benefit for the removal of sludge and are likely to interfere with the effective management of the boiler water level.

3.3 Other types of blowdown

Other blowdowns from a boiler, e.g. the blowdown lines from external boiler water level control chambers or water gauges, should not be piped into the main boiler blowdown line or manifold. Such discharges shall be led to a separate inlet on the blowdown vessel. Where such blowdown can be carried out in sequence (e.g. manual blowdown of gauge glasses and water level control chambers), it is not necessary to keep the lines separate from each other.

Waste condensate (i.e. that which cannot or should not be returned to the feed tank) shall be discharged to drain through a blowdown vessel with a dedicated and appropriately sized connection where it cannot be demonstrated that the condensate would otherwise have cooled to a safe level for direct discharge to drain.

Gauge glass lines should not connect into the same blowdown line as the TDS or bottom blowdown.

If the boilers have external level chambers, these can be connected to the same discharge line as the gauge glasses as it is expected an operator will blow each down in sequence.

4 HAZARDS

The blowdown vessel can quickly become very hot as a result of blowdown; the sudden or rapid discharge of pressurised hot water is hazardous. It is important, therefore, that measures are taken which prevent accidental contact but do not interfere with the natural cooling of the contents of the vessel.

Because a blowdown vessel is intended to dissipate heat, it is not normal practice to apply thermal insulation. It should therefore be provided with guard rails or other personnel protection as determined through risk assessment.

Because of the considerable amount of energy released, structures such as drainage ducts, culverts and sewers are likely to be damaged, and unsecured manhole lids and slabs covering blowdown pits are liable to be lifted. There is also a significant risk of injury to people working in the vicinity of any inadequately protected discharge. Unsuitable blowdown vessels are potentially dangerous and can fail catastrophically under pressure.

Figure 3. (Left) The insulated blowdown vessel shown here, is not the recommended option. The purpose of a blowdown vessel is to cool the discharge water from the boiler before it enters the drains. The Water Industry Act 1991 states that a maximum 43°C can be discharged to drain.
However, if the plant has been designed and/or built with the vessel inside the building and there is a need to insulate the vessel to prevent danger to personnel or the immediate environment, then a self-acting cooling kit with fail safe must be installed; it is also recommended to include temperature measurement on the discharge. See Page 21 for further information on self-acting cooling systems.

Figure 4 (above) A well-designed system should look like the example above.

5 LEGISLATION

The following is a non-exhaustive summary of key regulations applying to boiler blowdown systems. A range of supporting material can be found on the HSE website including Approved Code of Practice documents, Health and Safety Guidance, and Legal Reference documents.

Note: Be aware that Approved Codes of Practice (ACOP) and other guidance documents are often withdrawn by HSE and not replaced; for this reason, CEA have created BG03 and other guidance documents. As an example, 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.

A revised and enhanced online version of 'Managing for Health and Safety' (also known as HSG65) is now available. The guidance is divided into four sections:

- Core elements of managing for health and safety
- Are you doing what you need to?
- Delivering effective arrangements
- Resources

The first two sections of Managing for Health and Safety are targeted at leaders, owners, trustees and line-managers, whilst the third part will be particularly useful to those who need to put in place or oversee their organisations arrangements for health and safety. It will also be of value to workers and their representatives.

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

MHSWR apply to every employer and self-employed person who carries out any work activity whether or not they own or control a pressure system.

Note: All future references to employers in this guidance should be read to include self-employed persons.

The MHSWR 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 should identify sensible measures to control identified risks that may otherwise result in injury or danger.

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

Should you be unfortunate enough to have an accident or incident with equipment on your plant and especially if somebody is injured, HSE will often use the MHSWR to prosecute both **you and your company** when apportioning blame. This is irrespective of the accident falling under other regulations such as PER, PSSR etc.

5.2 The Pressure Equipment (Safety) Regulations 2016 (PER)

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 steam raising plant) 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).
- Pressure equipment and assemblies placed on the market before 29 November 1999.
- 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 Conformity Assessment marking (unless required by another Regulation).

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 ESR 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 ESR.

Right – Blowdown vessel in production
Image courtesy of Spirax Sarco Ltd

5.3 The Pressure Systems Safety Regulations 2000 (PSSR)

PSSR set out the main legislative requirements to ensure the continued safety of pressure systems (which includes steam boilers and blowdown vessels) in use. PSSR applies to two clearly defined categories of people **(duty holders)**. These are:

'Owner' – This means 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.

'User' – This means 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 more responsibilities in relation to installed systems.

The owner/user of a blowdown system 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 and manufacturer where appropriate.
- The system 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 Competent Person in accordance with the requirements of the scheme.
- All repairs and modifications must be carried out by people suitably competent in such work (Regulation 13). You must discuss and agree any changes with the "Competent Person" and include any changes within your written scheme of examination (WSE).
- The statutory technical documentation and other records must be kept and, where required, be made available for examination.
- Records must be transferred when the ownership of a system changes (Regulation 14).

Duty holders must keep all reports produced under the WSE for the entire life of the vessel; these records should go with the vessel if it is sold on to another party.

The results of all tests and examinations must be recorded and retained for a suitable period (Regulation 14). A period of at least two years is recommended for records of routine tests. These may be kept on-site or at a designated central location but wherever they are kept, they should be secure, safe and easily accessible.

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

- Written Scheme of Examination (WSE).
- Record of periodic tests (e.g. Non-Destructive Testing (NDT), Hydraulic test).
- Certificates of thorough examination.
- Records of servicing and modifications.
- Examination reports.
- Risk assessments.
- Manufacturer's records and instructions.
- Maintenance records.
- Training records.
- Audit reports.
- Test logs.
- Water treatment records.

5.4 The 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 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 logbook, when provided, must be kept up to date.

Other parts of PUWER of relevance to boiler systems cover such topics as equipment suitability, maintenance, inspection, information and instructions, training and control systems.

5.5 The Water Industry Act 1991

Section 111 prohibits waste steam or any liquid at a temperature higher than 43°C being discharged into public sewers as well as the discharge of any material likely to interfere with the free flow of fluids.

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

Although installing or replacing a blowdown vessel may 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 blowdown vessel is part of a major installation the regulations will apply in full and should 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.

6 DESIGN CONSIDERATIONS

6.1 Vessel

Boiler blowdown vessels shall be constructed as pressure vessels to a suitable standard such as: **PD 5500 Specification for unfired fusion welded pressure vessels**, **BS EN 13445 Unfired pressure vessels, ASME VIII** or an equivalent standard.

All vessels must have a permanently attached nameplate containing the following information:

- The manufacturer's name.
- A serial number unique to that vessel.
- The date the vessel was manufactured.
- The standard to which the vessel was designed and constructed.
- The maximum allowable pressure of the vessel.
- Where the minimum allowable pressure is other than atmospheric, the minimum allowable pressure.
- The design temperature.
- Where a vessel has a design pressure in excess of 0.5 bar, the vessel must meet the requirements of The Pressure Equipment (Safety) Regulations and bear a Conformity Assessment mark.

A boiler blowdown vessel shall not only be designed to withstand internal pressure, but shall also have sufficient structural strength to sustain the shock loading associated with intermittent blowdown under the worst possible in-service conditions, and be able to withstand any external loading from pipes and attachments.

It is good practice to design a blowdown vessel for at least 25% of the maximum allowable pressure of the boiler to which it is connected. The design temperature of the blowdown vessel shall be the temperature of saturated steam at a pressure equal to the design pressure.

On a multi-boiler installation with boilers of varying working pressures, the boiler with the highest maximum allowable pressure shall be used to determine the design criteria.

Adequate internal and external access must be provided for cleaning and inspection of the vessel.

The **size of a blowdown vessel** depends on a number of factors such as:

- The boiler pressure,
- The size of the blowdown pipe system and its equivalent length, giving the maximum flowrate to the blowdown vessel,
- The quantity of water blowdown at any time,
- The time between successive blowdowns,
- Whether the blowdown enters the vessel above or below the standing water level.

The water held within the vessel performs two functions:

- It acts as a seal to prevent flash steam discharging through the water outlet to drain, and
- It cools the incoming blowdown, so that the resulting water going to drain is at an acceptably low temperature.

The degree of cooling depends on:

- The water capacity in the vessel,
- The surface area of the vessel, and
- The quantity and frequency of blowdown.

The **standing water capacity** of the vessel shall be at least twice the capacity of water which is discharged therein when the largest connected boiler is blown down. Approximately half of the vessel's volume shall be occupied by standing water and the remainder as airspace.

One recommended procedure for testing the low water cut-out and lock-out functions on an automatically controlled steam boiler is to evaporate the boiler water down to the first low water alarm level. The boiler is then blown down to the second low water level, at which point an alarm sounds and the boiler goes to lock-out, i.e. it requires manual intervention before restart is possible (often called the Evaporation Test).

If the amount of water blown out of the boiler between the first and second low water levels is greater than that discharged during routine blowing down of the boiler, the former quantity shall be taken into account when calculating the size of the blowdown vessel.

Where boilers are attached to a vessel without the use of a manifold, or where multiple manifolds are used (e.g. to attach 4 boilers to a vessel with two blowdown inlets) it is possible that several boilers can blowdown at the same time. In such a case the volume of standing water shall be twice the maximum possible simultaneous discharge into the vessel.

Where key operated bottom blowdown valves are in use, only one blowdown key should be available in the boiler house to ensure that only one boiler is blown down at any given time.

Where automatic bottom blowdown is in use on a multiple boiler installation, the designer shall ensure the control philosophy takes into account the design of the blowdown vessel and the number of boilers that can discharge into that vessel at any given time such that it does not exceed the vessel's design criteria.

6.2 Pipework

Blowdown piping is subject to rapid pressurisation, high velocity flow, erosion, thermal shock and vibration, all of which can be severe. Pipework must be suitably supported. Pipe bends shall be of large radius and their length kept as short as possible. Pipework from each boiler up to and including the last isolation valve prior to the blowdown vessel shall have a design pressure and temperature not less than those of the design pressure of the associated boiler.

The BS EN 13480 series contains guidance on the design, manufacture, installation and testing of metallic industrial piping although other standards may also be suitable if they provide an equivalent level of safety;

- **BS EN 13480-1** specifies the general requirements for industrial piping systems and supports, including safety systems, made of metallic materials with a view to ensure safe operation.
- **BS EN 13480-2** specifies the requirements for materials.
- **BS EN 13480-3** specifies the design and calculation of industrial metallic piping systems, including supports.
- **BS EN 13480-4** specifies the requirements for fabrication and installation.
- **BS EN 13480-5** specifies the requirements for inspection and testing.
- **BS EN 13480-6** specifies additional requirements for buried pipework.

Guidance on conformity assessment procedures can be found in:

PD TR 13480-7:2017 Metallic industrial piping. Guidance on the use of conformity assessment procedures.

Guidance on suitable fittings is contained in:

BS 759-1:1984 Valves, gauges and other safety fittings for application to boilers and to piping installations for and in connection with boilers. Part 1: Specifications for valves, mounting and fitting.

Table 1 below gives typical sizes of vent pipe and outlet pipe appropriate to a boiler operating at 14 bar g, with 18m equivalent length of blowdown pipework, a vent height of 6m and a pressure build-up within the vessel not exceeding 0.35 bar g. For lower boiler pressures, smaller vent sizes may be used but any variation from these figures should be agreed with the manufacturer and/or a person who is competent to advise on these matters. The figures assume that only one boiler is attached, or that multiple boilers are attached via a single main blowdown manifold.

Boiler blowdown pipe size	Blowdown vessel vent size	Blowdown vessel outlet size
20 mm ¾"	80 mm 3"	50 mm 2"
25 mm 1"	100 mm 4"	65 mm 2½"
32 mm 1¼"	125 mm 5"	80 mm 3"
40 mm 1½"	150 mm 6"	100 mm 4"
50 mm 2"	200 mm 8"	125 mm 5"
65 mm 2½"	250 mm 10"	200 mm 8"

Table 1. Typical blowdown vessel vent & outlet pipe sizes for vessels having one connection for main blowdown.

Notes: A pipework system consists of straight pipe and fittings, such as bends, elbows, tees and valves. All of these components can cause resistance to flow. To find the total resistance through a pipework system, it is usual to express the frictional resistance of fittings and valves as being the equivalent of the pressure drop through a number of linear metres of straight pipe. This length added to the actual length of the existing pipe is known as 'equivalent length'.

In the case of vessels having the possibility of several boilers discharging at once, the vent and outlet sizes shall be modified accordingly. The cross-sectional area (CSA) of the vent should normally be at least 14 times that of the combined inlets (e.g. for a vessel having two 50 mm Ø inlets, the vent should be at least 300 mm Ø) and the overflow shall be at least 6 times the combined CSA of the inlets (e.g. for three 25 mm Ø inlets, the overflow should be at least 100 mm Ø).

It is essential to bear in mind that the dimensions shown in Table 1 are 'typical': they are not mandatory and/or minimum. The actual sizes will depend upon the manufacturer's design, and in particular the boiler operating pressure, and the size and the equivalent pipe length between the boiler and the vessel inlet.

Water being discharged by blowdown will produce flash steam as it approaches atmospheric pressure, which must form without significant pressurisation of the vessel. Depending upon design this is often limited to a maximum of 0.3 bar g. The proportion of flash steam will increase as boiler pressure increases, so it may in some cases be necessary to have a larger flash steam vent than the typical size shown in BG03; conversely, at low operating pressures, a smaller vent will pose no problem.

Whilst the size of the main blowdown valve will initially dictate the flowrate, the equivalent pipe length (taking into account actual length, plus the flow restriction of bends and valves) will determine the flow resistance, and therefore the actual flowrate into the blowdown vessel. Internal design of the vessel may optimise separation of flash steam from water entering the vessel. It is consequently inappropriate for any guidance document to advocate specific connection and pipe sizes. Hence the dimensions in Table 1 are shown as typical examples, and not intended to be specific.

Owners of vessels installed in accordance with PM60 should only need to consider BG03 section 6 unless there have been, or they intend to make, changes to the original installation.

6.2.1 Vessel Inlets

An inlet at least equal in cross-sectional area to the area of the blowdown pipe or manifold is strongly recommended. It can either discharge into standing water or be located between the water level in the vessel and the top of the vessel.

In the latter case, the shell shall be protected against erosion. This may be achieved by careful inlet design or by fitting suitable wear plates, deflection plates or baffles in the vessel (see Figure 2).

6.2.2 The vent pipe

The vent and outlet pipe sizes largely determine the pressure rise within the blowdown vessel, and the vent pipe in particular shall be generously sized. The vent shall be designed to handle the flash steam released during blowdown and its size depends on:

- The boiler pressure.
- The size of the blowdown pipe system.
- The vent pipe layout and length.
- Where the blowdown enters the vessel, i.e. above or below standing water level.
- Any arrangements for condensing the flash steam.

The venting arrangements of the blowdown vessel shall be designed so that:

- The internal pressure does not exceed 0.35 bar g (5 psi g);
- Flash steam is vented safely and there is no significant carry-over of water at the exit of the vent pipe; an exhaust head should be fitted to remove entrained condensate droplets providing that this does not impose a discernible obstruction to flow. Condensate so separated shall be piped safely to a suitable drainage point.
- The vent pipe is connected to the highest point of the vessel and is not less than the size given in Table 1, unless agreed with the manufacturer and/or person who is competent to advise on these matters.
- It is as straight as possible with no valve or other obstruction to prevent free-flow.
- Where possible, it terminates in a suitable exhaust head with an adequate condensate drain.
- It discharges into the atmosphere where it is not liable to cause personal injury or material damage.
- In the event that safe discharge or the configuration of the building does not facilitate the vent pipe to be a straight run, it may be necessary to increase the size/diameter of the vent pipe to compensate for the resistance of the bends.

6.2.3 The water outlet

The cross-sectional area of the outlet should be at least 6 times the area of the inlet pipe. Where there is a risk of several boilers discharging at once, the vent and outlet sizes shall be modified accordingly.

The cross-sectional area (CSA) of the outlet shall be at least 6 times the combined CSA of the inlets (e.g. for two 25 mm Ø inlets, the overflow should be at least 100 mm Ø).

The attached outlet pipework should be properly designed for the required flowrate and no valves or other obstructions shall be fitted. The outlet pipe should be connected to the blowdown vessel so that the vessel will remain approximately half full of water after each blowdown to allow room for the expansion of flash steam.

The outlet connection may require a water seal to prevent steam discharge. This may be achieved by extending the vertical leg of the water seal to within 150 mm of the bottom of the vessel. The top of the water seal shall incorporate a suitable opening to serve as a siphon breaker.

6.2.4 Fittings

The following fittings shall be provided on the blowdown vessel:

- Drainage - the vessel shall be fitted with a suitable drain valve.
- Pressure gauge - means shall be provided for attaching a test pressure gauge.
- Water-level gauge - this is not considered necessary but, if fitted, must be adequate for the design conditions.
- Outlet temperature gauge - which may be combined with an alarm arrangement for unattended sites.
- Access for inspection and to aid cleaning.

6.2.5 Multi-boiler installations

In the case of water tube boilers, discharging multiple boilers to the same blowdown vessel is not permitted.

For other types of boiler:

When used in conjunction with a multiple steam boiler installation, the blowdown vessel shall be sized to suit the boiler with the largest blowdown volume.

For safety reasons, it is essential that only one boiler can be blown down intermittently at any time unless the vessel and piping system is expressly designed to accommodate this.

With manually operated intermittent blowdown valves:

- Only one blowdown key shall be available; and
- The system shall be designed and constructed so that the valve key cannot be removed until the valve is fully closed.

Automated intermittent blowdown systems can be installed without the one key arrangement but the controls shall prevent no more than one boiler on a common manifold being blown down at any one time.

In the case of vessels with boilers attached by independent connections, multiple boilers can blow down simultaneously provided;

- The vessel capacity is sufficient for the worst-case scenario of all boilers, or combination of boilers (in the case of vessels with several attached manifolds) discharging simultaneously;
- The vent and overflow capacity are sufficient for the maximum possible discharge; and
- Any cooling system is appropriately sized considering the possibility of multiple simultaneous blowdowns.

Where blowdown lines connect to an inlet manifold to the vessel each of them shall be fitted with either a screw-down non-return valve (SDNR) or, alternatively, a non-return valve and an isolation valve. The manifold should be at least equal in cross-sectional area to the largest boiler blowdown valve in the installation. See section 9 for more information regarding positive isolation of the blowdown vessel.

Recommended arrangements of multiple steam boiler and blowdown vessel installations are shown in Figures 5, 6 and 7.

Figure 5 An example of a multiple steam boiler and blowdown vessel installation. Separate lines from external water level controls and gauge glasses are not shown.

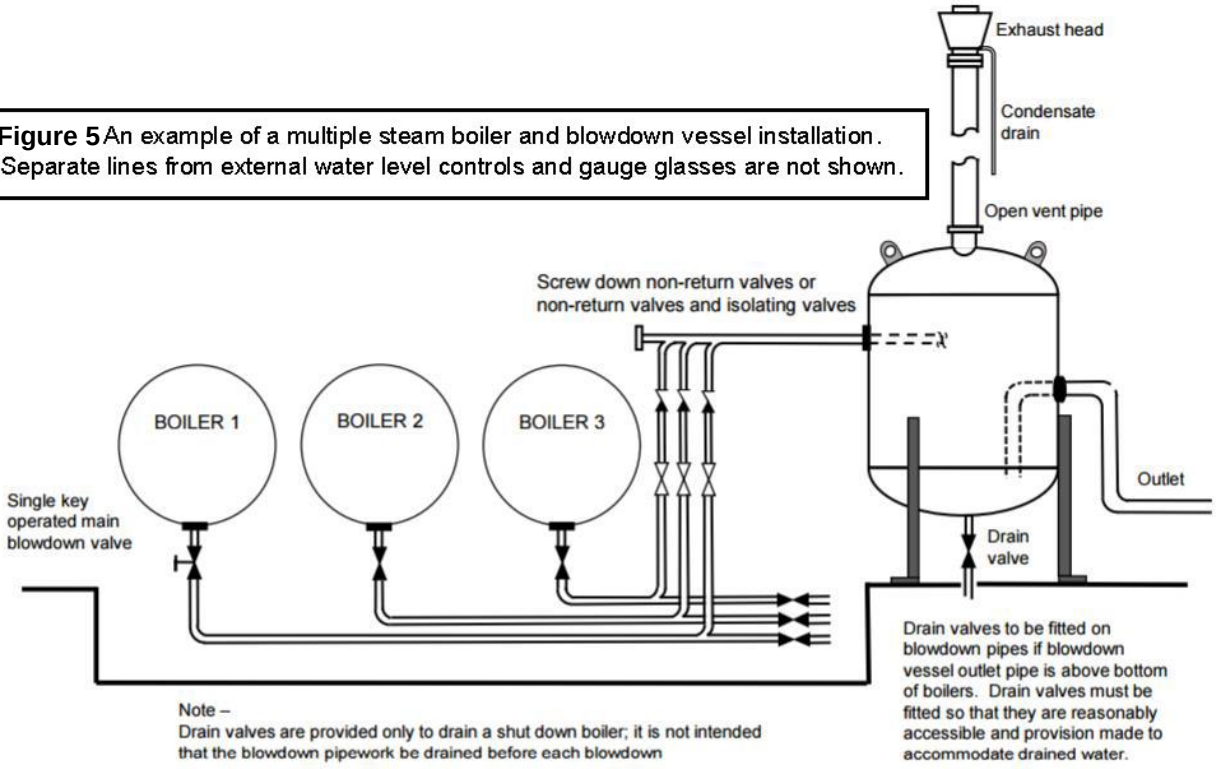


Figure 6 shows the same installation with the addition of a continuous blowdown system. Both the intermittent and continuous blowdown systems are kept completely separate up to the blowdown vessel. In a single boiler installation, the continuous blowdown may discharge into the main blowdown line downstream of the main blowdown valve.

Note: In all instances, drain valves shall be lockable and rated to withstand full boiler pressure.

Figure 6 An example of a multiple steam boiler and blowdown vessel installation with continuous blowdown. Separate lines from external water level controls and gauge glasses are not shown.

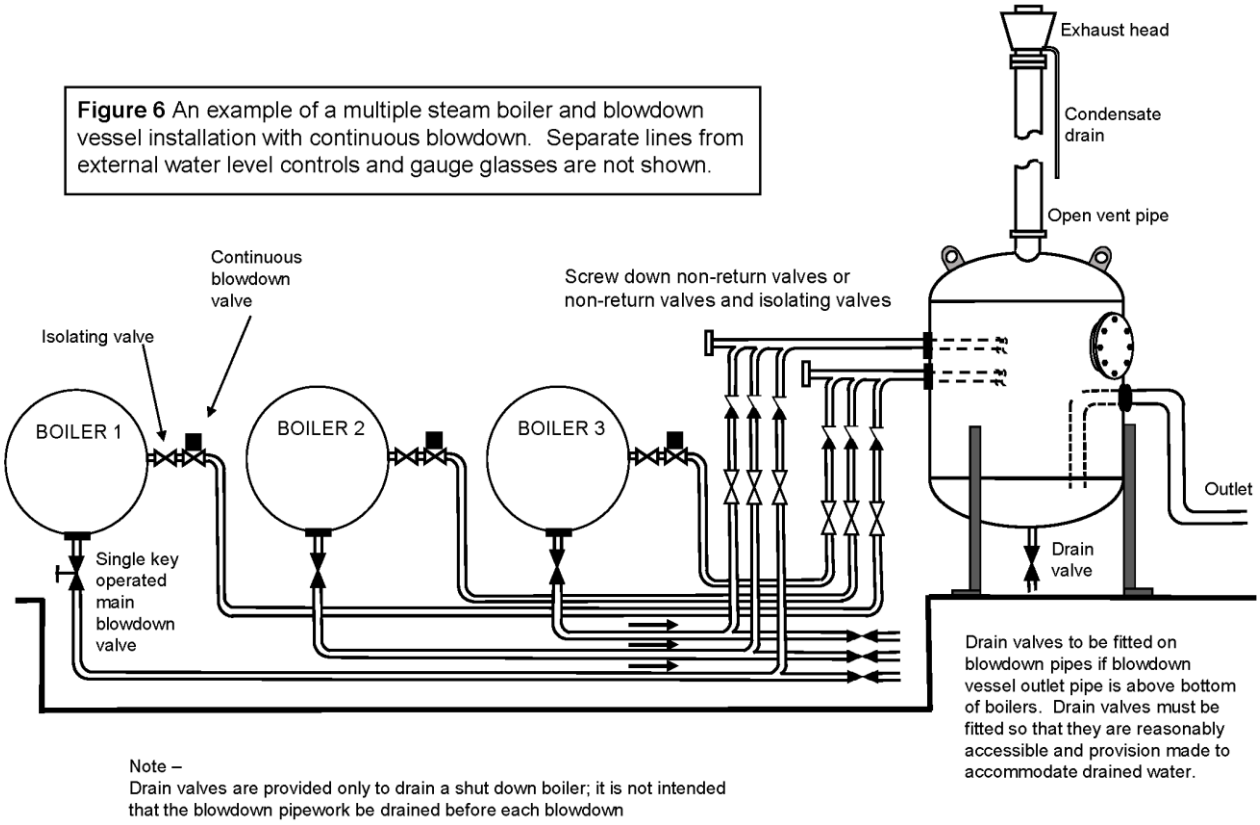
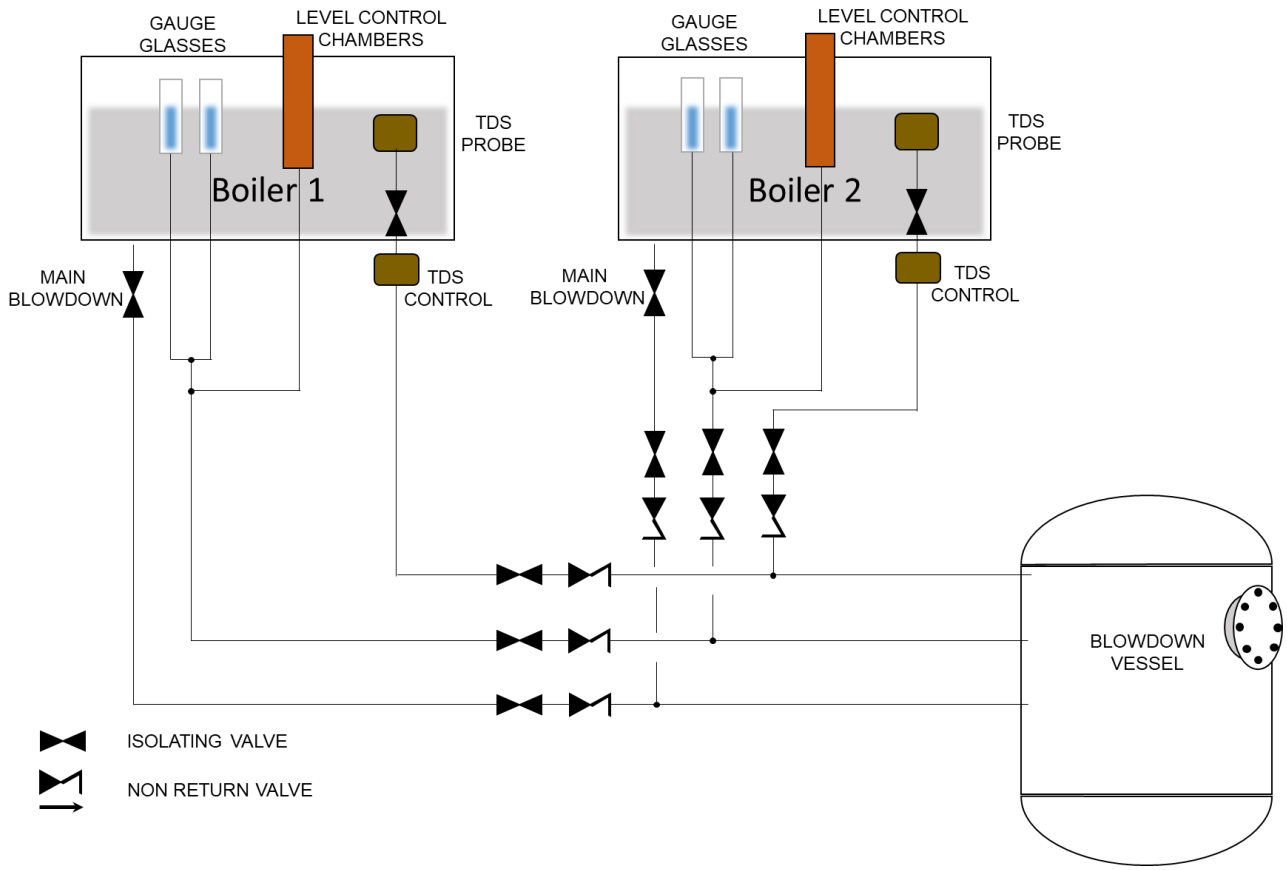


Figure 7 Recommended arrangement for multiple boilers with control chambers.



6.2.6 Blowdown vessel cooling

In certain cases, such as;

1. Multiple boiler installations where the total volume of blowdown from all the boilers exceeds the cooling capacity of the standing water in the vessel; or
2. Continuous blowdown systems; or
3. If a blowdown vessel is liable to contain hot water of such a temperature that blowdown causes the outlet temperature to exceed the permissible limit.

It will be necessary to cool the water leaving the blowdown vessel before it goes into the public drainage system. This can be achieved simply by the use of an aftercooler, or by installing a temperature control valve with cooling water injection directly into the standing water, or by using more than one blowdown vessel in series for the purpose of staged reduction of the temperature and pressure of the discharge. When considering the use of blowdown vessels in sequence, careful attention should be given to the design, construction, and installation to ensure that the system is fit for its intended purpose.

Where a cooling water injection system is employed, it is normal practice that the cooling water be taken from the town mains. Softened water is not normally required as long as boiler water is properly treated and blowdown regimes are well managed.

Any temperature controller forming part of a blowdown system shall be of such design that the set temperature cannot be easily altered. Suitable preventative means include (but are not limited to) adjustment mechanisms that require a special key or tool, or removing or restricting the adjustment device after setting.

Self-acting cooling systems (that use the expansion of a liquid within a capillary as the operating mechanism for example, rather than electricity or pneumatic power) are generally sufficient for most applications. However, self-acting cooling systems usually fail in the closed position, so such systems are not normally suitable for use on vessels dependant entirely on the injection of cooling water to ensure a safe discharge temperature. Exceptions may be made where suitable additional protective measures are employed or where a high degree of system integrity can be demonstrated.

Where quarter-turn isolation valves are used on cooling water lines, the valves shall be arranged such that the handles do not fall to the closed position under vibration and obstruct flow.

Figure 8 and Figure 9 both show a lagged blowdown vessel in an area where people operate and is therefore done for safety reasons.

Fig 8 (left) has an automatic cooling kit fitted for cooling the blowdown.

Fig 9 (right) shows a temperature gauge to indicate discharge temperature.

(Figure 8)

(Figure 9)

7 GENERAL PRECAUTIONS

Blowdown can be a noisy operation. If this noise presents a hazard to personnel, then measures must be taken to reduce the level of noise exposure (see HSE publication INDG362). For example, at the design stage, careful consideration should be given to the siting of the blowdown vessel and the lowering of steam/water velocities. Silencers should be avoided wherever possible. When fitted, the requirements of clause 6.2.2 shall be observed.

The vessel and pipework shall be installed where:

- The water will not freeze in cold weather; or
- They can be protected to prevent freezing; or
- They can be drained of all water in cold weather, in which case the vessel shall be filled to its normal level before blowing down. **Do not** blow down into an empty vessel.

The disposal of discharge must conform to any relevant local authority regulations and the water temperature must not exceed 43°C at the point it enters the public sewer (see 5.5 The Water Industry Act 1991).

8 SAFE USE OF BRICK/CONCRETE PITS

The use of brick or concrete blowdown pits is actively discouraged; steam is aggressive and new pits should not be built. Issues include leaks that remain undetected (potentially undermining the foundations of the pit or any adjacent buildings as well as polluting the land), access and falls from height (possible confined spaces), blockages from leaves and rubbish, and the need to shut down, clean and inspect which may be inconvenient for site operations.

A planned preventative maintenance programme shall be drawn up to ensure that existing brick/concrete pits are properly maintained. They must be drained, thoroughly cleaned out and examined at regular intervals. It is recommended that the examination should be carried out at a maximum frequency of once in every 14 months, or at such intervals as stipulated by a Competent Person.

Particular attention shall be paid to the adequate venting of the pit so that it cannot be pressurised above 0.1 bar.

Access to the pit must be properly safeguarded and the covers adequately secured.

Rubbish shall not be swept into the pit.

The vent pipe of the brick/concrete pit shall be located at its highest point and be protected against blockage. It must discharge into the atmosphere to a safe place where it is not liable to cause personal injury or material damage. Consideration should be given to changing over to a suitable steel blowdown vessel where:

- An existing pit is not of sufficient capacity; or
- It is not provided with an adequate vent pipe; or
- It requires major repairs.

9 EXAMINATION AND MAINTENANCE

At every thorough examination of the associated steam boilers, or at such intervals as determined by a Competent Person, the blowdown vessel should be positively isolated from the boiler(s) for examination purposes e.g. by valve removal or with double isolation and blank flange, spade or line blind. The electrical supply to any automated blowdown valve(s) should be locked off and, where fitted, any compressed-air system should be isolated and de-pressurised. The vessel should then be drained, cleaned internally and thoroughly examined.

If the quality of the boiler feed water is poor, the blowdown vessel may require draining and/or cleaning more often.

The positive isolation procedure is to ensure safety during examination of the blowdown vessel. Where it is necessary for people to enter a boiler in a multi-boiler installation, the fitting of a suitable blank flange in the blowdown line of the out-of-service boiler will provide a high level of protection.

Where an anti-siphon hole is located in the top of the outlet pipe inside the vessel, it shall be kept clear of any blockage.

It should be noted that during the preparation of a boiler for statutory examination, it is necessary to completely drain the associated boiler. Where the blowdown vessel is located on a similar floor level as the boiler, it will not be possible to empty the boiler through the blowdown vessel. Care must be taken to ensure that final emptying of the boiler is only made to drain when the water temperature is below the permissible limit of 43^{o}C.

10 REFERENCES AND FURTHER READING

The following is a list of applicable documents current at the time of preparation of this publication. This is an indicative, not comprehensive list.

- Free copies of all legislation are available from www.legislation.gov.uk.
- Legislation marked with an asterisk is supported by Approved Codes of Practice and Guidance (ACOP) published by HSE.
- Legislation marked with a double asterisk is supported by more than a single ACOP.

1. Health and Safety at Work etc. Act 1974

2. Management of Health and Safety at Work Regulations (MHSWR)
   SI 1999 No. 3242

3. Provision and Use of Work Equipment Regulations (PUWER) *
   SI 1998 No. 2306 (SI 1999 No. 305 in Northern Ireland)

4. Electricity at Work Regulations
   SI 1989 No. 635 (SI 1991 No. 13 in Northern Ireland)

5. Confined Spaces Regulations *
   SI 1997 No. 1713 (SI 1999 No. 13 in Northern Ireland)

6. Control of Substances Hazardous to Health Regulations (COSHH)*
   SI 2002 No. 2667 (SI 2003 No. 34 in Northern Ireland)

7. Control of Noise at Work Regulations
   SI 2005 No. 1643 (SI 2006 No. 1 in Northern Ireland)

8. Construction (Design and Management) Regulations (CDM)*
   SI 2015 No. 51 (SI 2016 No. 146 in Northern Ireland)

9. Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations
   SI 2016 No. 1107 (SI 2017 No. 90 in Northern Ireland)

10. Pressure Equipment (Safety) Regulations (PER)
    SI 2016 No. 1105

11. Pressure System Safety Regulations (PSSR)*
    SI 2000 No. 128 (SI 2004 No. 222 in Northern Ireland)

12. BS 759-1 Valves, gauges and other safety fittings for application to boilers and to piping installations for and in connection with boilers. Specification for valves, mounting and fitting

13. BS 5925 Code of practice for ventilation principles and designing for natural ventilation

14. BS 7671 Requirements for electrical installations. IEE Wiring Regulations

15. BS EN 12952 Water-tube boilers and auxiliary installations

16. BS EN 12953 Shell Boilers

17. BS EN 13445 Unfired pressure vessels

18. BS EN 13480 Metallic industrial piping

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

20. PD5500 Unfired fusion welded pressure vessels

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

22. Business Energy & Industrial Strategy Pressure Equipment (Safety) Regulations 2016 Guidance

23. L5 Control of substances hazardous to health The Control of Substances Hazardous to Health Regulations 2002. Approved Code of Practice and guidance. HSE Books

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

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

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

27. L122 Safety of pressure systems. Pressure Systems Safety Regulations 2000. Approved Code of Practice. HSE Books

28. L138 Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved Code of Practice and guidance. HSE Books

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

11 GUIDANCE NOTES ON RELATED TOPICS

- **BG01 Guidance on Safe Operation of Steam Boilers**
  Jointly published by The Safety Federation and the CEA
- **BG02 Guidance on Safe Operation of Hot Water Boilers**
  Jointly published by The Safety Federation and the CEA
- **BG04 Boiler Water Treatment; Guidance for Shell Boilers, Coil Boilers, Steam Generators and Hot Water Boilers**
  Jointly published by ICOM Energy Association and CEA
- **BG05 Guidance on Design and Operation of Biomass Boilers**
  Published by the CEA
- **BG06 De-aeration of Boiler Feed Water; Guidance for Industrial Installations**
  Published by the CEA
- **BG07 Thermal Fluid Systems; a Practical Guide for Users**
  Published by the CEA
- **BG08 Temporary Steam and Hot Water Boiler Plant - Guidance for Safe Installation and Use**
  Published by the CEA
- **BG11 Guidance on the Safe Operation of Water Tube Boilers**
  Published by the CEA
- **GS4 Safety in pressure testing**
  HSE Books
- **HSG250 Guidance on permit-to-work systems**
  HSE Books
- **INDG178 Written schemes of examination: Pressure Systems Safety Regulations 2000**
  HSE Books
- **INDG258 Safe work in confined spaces**
  HSE Books
- **INDG362 Noise at work A brief guide to controlling the risks**
  HSE Books
- **INDG436 Safe management of industrial steam and hot water boilers**
  HSE Books
- **PEC 11 Guidance for the competent person when considering the suitability of blowdown receivers associated with steam generating plant.**
  The Safety Assessment Federation

Document Control – Amendments

Edition 1 Third Impression – August 2019

New figure 5 (removal figure 3), amended text in Section 3

Edition 2 First Impression – August 2020

Updated guidance to include water-tube boilers

Consolidated references to multi-boiler installation into section 6.2.5

Updated references to the BEIS (formerly DTI) pressure equipment guidance document including removing the out of date web link

Changed references to CE Marking to a more general “Conformity Assessment mark” in the absence of clear guidance for post-Brexit vessel markings

General alterations to improve readability

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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 of this document and the related legislation and guidance.

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