Pressure

Systems

GUIDELINES

Guidelines for Users and Competent Persons

Introduction to Blowdown Systems

Document Reference: PSG 22 — Issue 1 — 23 April 2021

1 Introduction.

The Health and Safety Executive guidance note PM60 (Steam Boiler Blowdown Systems) was first published in 1987 in response to a number of incidents caused by inadequately designed and manufactured blowdown systems. Although the document is now withdrawn the guidance has been extensively applied by the vast majority of blowdown system suppliers in the UK since its inception and has also been regarded by inspection bodies as the benchmark for acceptance. This has ensured that blowdown systems (and blowdown receivers in particular) have maintained a very good safety record for many years.

With PM60 being withdrawn this document has been produced to provide information on various aspects of steam boiler blowdown systems, their component parts, design, installation, operation, maintenance and examination.

This guidance also deals with standards and safety precautions applied to blowdown systems and verification by the Competent Person as to the system being fit for purpose.

2. Scope

This guidance applies to blowdown arrangements for Steam boilers with maximum evaporative capacity of 30 tonnes/hr and design pressure not exceeding 32 bar but specifically excludes non-circular cross section tanks, design of blowdown pits and water tube boilers with multiple blowdown circuits. Both single boiler systems and multi boiler systems are covered.

3. Blowdown operation.

Blowdown is required to control the condition of the boiling water, any feed water impurities which do not boil off with the steam will concentrate in the water and form dissolved and suspended solids. As these solids become more concentrated, they accumulate as foam above the boiler water and get carried over into the steam system.

In addition to making the steam leaving the boiler excessively wet it also contains contaminants which can form into sludge coating the heated surfaces of the boiler,(causing overheating), and causing damage to control valves, heat exchangers and other equipment in the system.

Restriction and control of both the suspended and dissolved solids can be achieved by either continuous or intermittent blowdown or a combination of both.

Figures 1 and 2 Typical blowdown arrangements

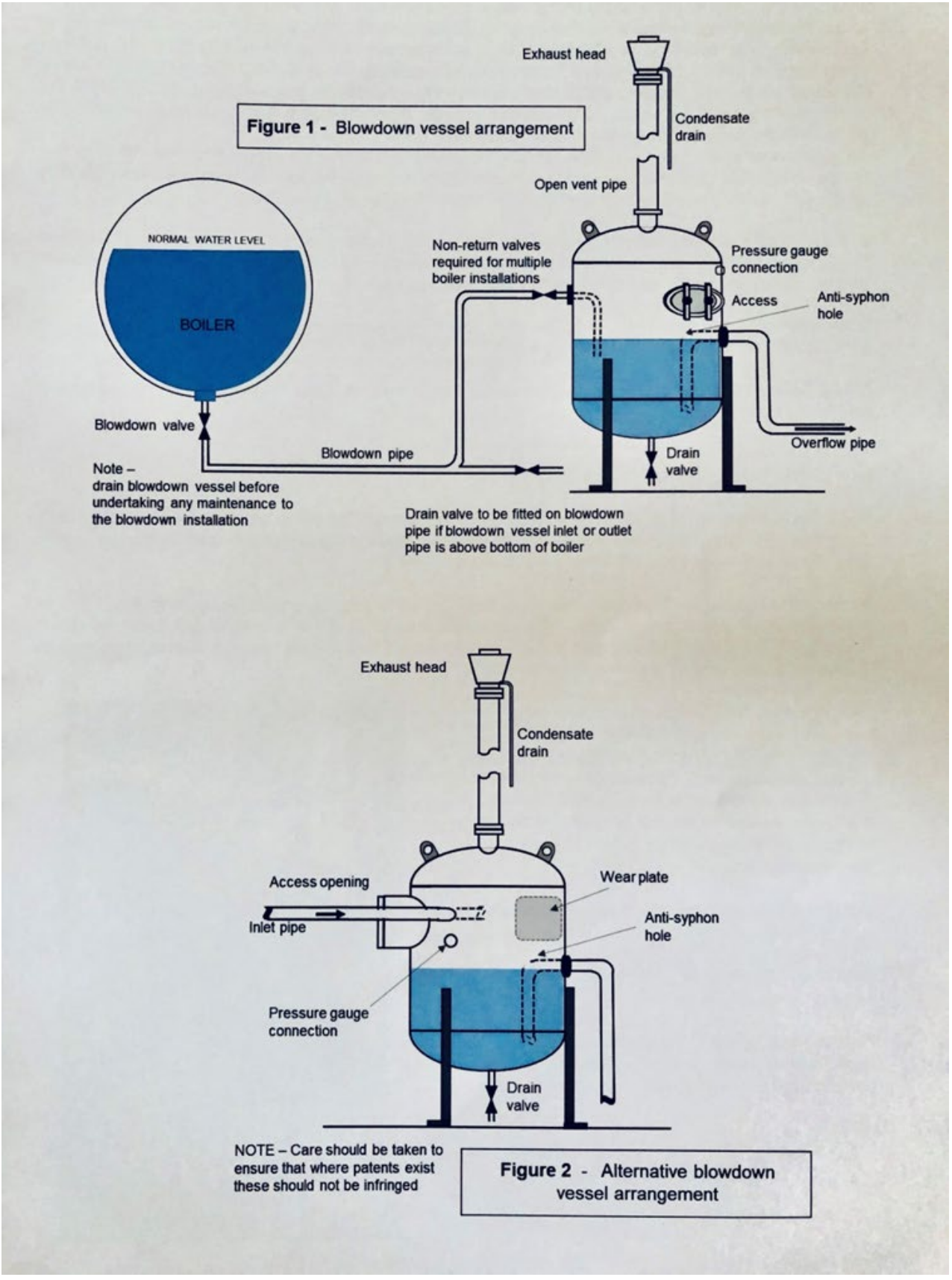

Figure 1 - Blowdown vessel arrangement

Figure 2 - Alternative blowdown vessel arrangement

3.1 Intermittent (bottom) blowdown.

Intermittent or bottom blowdown is essential for boilers operating with internal feed water treatment as it is the only effective method of removing sludge and should only be applied in short bursts

Figure 3 Typical Intermittent bottom blowdown arrangement

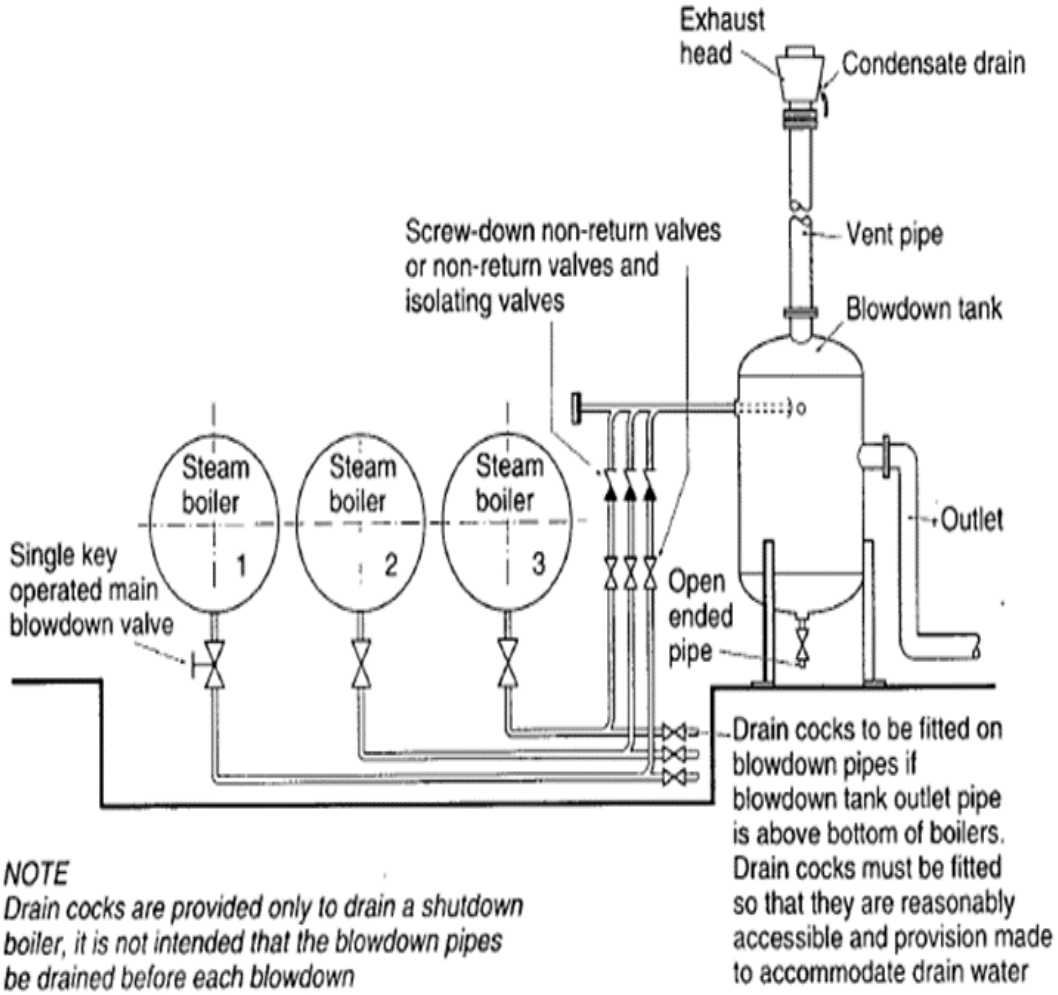

Figure 3 An example of a multiple steam boiler and blowdown tank installation (separate lines from external water level controls and gauge glasses are not shown)

3.2 Continuous blowdown.

Continuous blowdown is required where dissolved and suspended solid levels cannot be adequately controlled by intermittent bottom blowdown; this process is usually automatic and carried out in conjunction with bottom blowdown and is also referred to as TDS blowdown.

Figure 4 Typical continuous blowdown arrangement

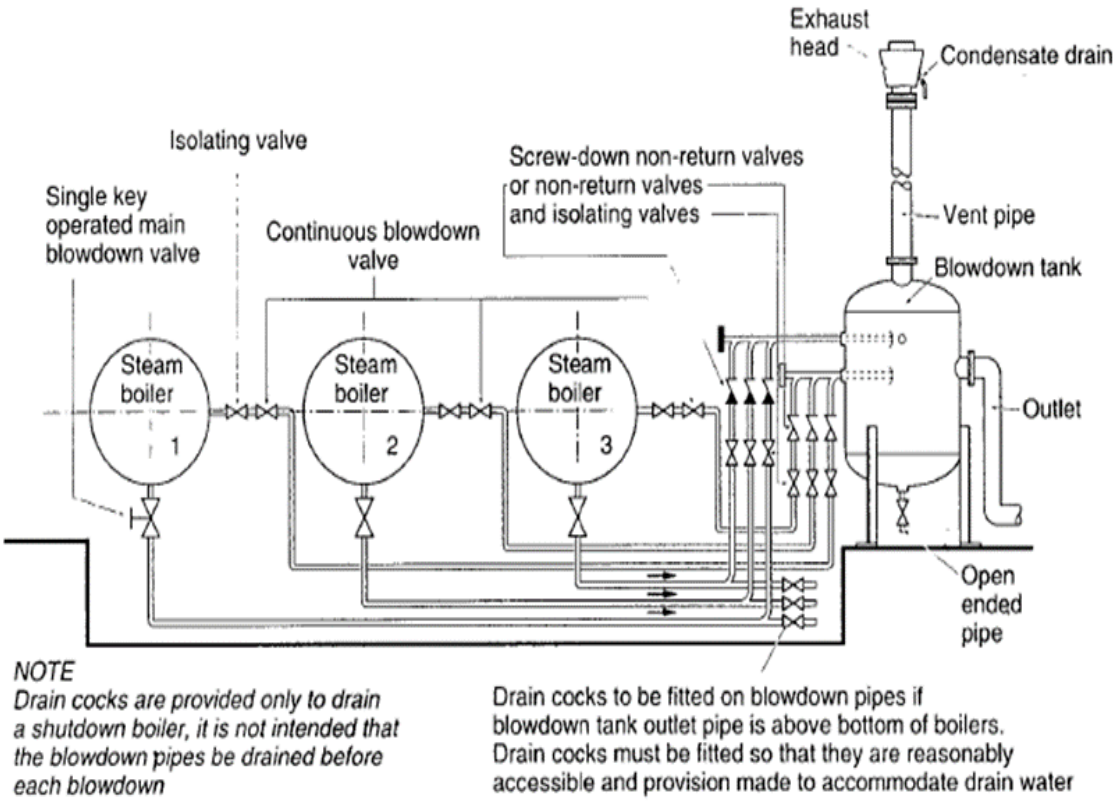

Figure 4 An example of a multiple steam boiler and blowdown tank installation with continuous blowdown (separate lines from external water level controls and gauge glasses are not shown)

Other blowdowns from a boiler e.g. the blowdown lines from external boiler water level control chambers or water gauge glasses should not be piped into the main boiler blowdown line or manifold, such discharges should be led separately to the blowdown vessel.

4. Design

The prime design concern is the accumulation pressure arising in the receiver during blowdown and whether the pressure actually achieved is within the rating of the receiver. This is dependent on a number of factors, including the boiler pressure, blowdown line diameter, receiver vent diameter, receiver capacity and whether more than one boiler is blown down simultaneously. Where documentation is available that confirms the blowdown receiver has been built as a pressure vessel in accordance with the requirements of PM60 or Annex D of EN-12953-6: 2010 or to a suitable standard such as PD5500 “Specification for unfired fusion welded pressure vessels”, BSEN 13445 “Unfired pressure vessels”, ASME VIII or an equivalent standard then it can be regarded as fit for purpose.

A blowdown receiver can also satisfy the requirements of EN-12953-6: 2010 Annex D if it is built as an atmospheric vessel. In this case the documentation needs to confirm that it has had a specific assessment for suitability for the particular boiler blowdown system connected to it to demonstrate there will be no significant pressure accumulation during blowdown.

In the absence of adequate documentation, the only practicable way of determining suitability is through pressure measurement during blowdown, using a pressure gauge or pressure recorder during operation to monitor the amount of pressure accumulation.

Other concerns that could affect the receiver integrity are sufficient robustness to withstand the shock loading during blowdown and sufficient provision for corrosion and erosion. Engineer Surveyors will need to make case by case judgments on the adequacy of blowdown receivers based on the documentation provided and the results of their initial examination. PM60 still represents what is generally recognised as good practice and should be used for reference purposes. For example, PM60 recommends drain lines from level gauges, control chambers etc should be piped up to a separate manifold into the blowdown receiver. Some blowdown receivers supplied from other European states do not satisfy this requirement but it also needs to be recognised that alternative designs may be equally suitable for particular applications.

In the case of atmospheric (or near atmospheric) vessels which fall outside the scope of the PED there is still a legal requirement under Regulation 5 of PSSR for the supplier to provide sufficient written information relating to safe operating limits, operation and maintenance. The vessel should also have a nameplate or other means of permanent marking and be compatible with the system it serves. If there is any doubt as to the fitness for purpose of a blowdown system, then a design assessment should be requested. It should be noted that calculations to evaluate pressure accumulation during blowdown can be complex and an empirical approach may be the better option.

The design of the blowdown receiver has not always aligned with the guidance given in PM60 and whilst this does not automatically make them unsuitable, it does mean that the Competent Person will need to ensure there is sufficient documentation/information available to verify the blowdown receiver is suitable for the particular application.

One of the recommendations of PM60 was that blowdown receivers should be built as a pressure vessel with a design pressure rating of at least 25% of the maximum working pressure of the boiler(s) they serve. This general rule ensures the blowdown receiver has adequate strength with additional provision for shock loading, corrosion and erosion that might occur during normal service.

Blowdown receivers may or may not come within the requirements of the Pressure Equipment Directive (PED). This is dependent on whether the pressure they foreseeably achieve during operation, especially during momentary surges in blowdown, exceeds 0.5 bar, but as they contain steam the Pressure Systems Safety Regulations will apply regardless. There are naturally commercial pressures with suppliers to manufacture blowdown receivers with design pressures not exceeding 0.5 bar so that they fall outside of the PED. However the technical justification for this is often questionable and it therefore presents a problem when these items are examined in accordance with a WSE.

Although blowdown receivers are open vented, they are considered as pressure vessels for the purpose of examination. This is because of the potential for pressure accumulation during the boiler blowdown sequence. It was a requirement of PM 60 that blowdown receivers should be examined at the same time as the boiler examination and for this reason they are generally included in the written scheme of examination for the steam plant.

It is often very difficult to obtain information from manufacturers that demonstrate the pressure in the blowdown receiver will remain within its rated limits when installed on a particular boiler system.

There are no British or European standards specifically dealing with blowdown receivers, although an informative annex (Annex D) in European shell boiler standard BS EN 12953-6: 2011 gives general guidance on the subject. This guidance allows the tanks to be designed by special analysis or by general rule using the pressure and vent size guidelines that were previously contained in PM60.

It is recommended that boiler blowdown vessels be constructed as pressure vessels to a suitable standard such as PD5500 “Specification for unfired fusion welded pressure vessels”, BSEN 13445 “Unfired pressure vessels”, ASME VIII or an equivalent standard and should have a permanently attached nameplate containing manufacturing standard requirement details, including, but not restricted to: Maximum allowable pressure/temperature, manufacturing standard, serial number and date of manufacture.

Additionally, where a vessel has a design pressure in excess of 0.5 bar g, the vessel must bear the Conformity mark in order to satisfy the requirements of The Pressure Equipment (Safety) Regulations 2016.

The size of the blowdown vessel depends on a number of factors, boiler pressure, quantity and frequency of blowdown. Generally, the standing water capacity of the vessel should be at least twice the capacity of water discharged at any one time, half the vessel shall be occupied by water, the rest airspace. If the water blown down between testing 1st and 2nd low level alarms is greater than that generally discharged then this quantity should be taken into account when calculating vessel capacity.

The water contained in the blowdown vessel serves two purposes, to prevent flash steam discharge through the outlet to drain and it cools the incoming blowdown

4.1 Pipework: Inlets, outlets, and vents

Blowdown pipework is subjected to rapid pressurisation, high velocity, erosion, thermal shock and vibration and should be suitably designed; the BSEN 13480 series contains guidance on design, manufacture installation and testing of metallic industrial pipework.

The vent and outlet should be generously sized as they will determine the pressure rise within the vessel, Table 1 provides typical sizing related to vessel inlet

Inlet: The vessel inlet should be at least equal in cross sectional area to the area of the blowdown pipe or manifold, it can either discharge into standing water or be located between water level and top of vessel, in this case the shell should be protected from erosion, by inlet design or fitting of wear plates

Outlet: The vessel outlet diameter should be approximately 2 1/2 times the diameter of the inlet pipe, where there is a risk of more than one boiler discharging at one time combined cross sectional area should be taken into account.

Vent: The vessel venting arrangements shall be designed in such a way as to prevent the internal pressure exceeding 0.35 bar g; sizing largely determines the pressure rise within the blowdown vessel and the diameter of the vent should be approximately 4 times the inlet diameter.

Vents should be taken from the highest point on the vessel, be straight, terminating in suitable exhaust head with condensate drain. The vent should discharge into atmosphere where it is not liable to cause injury to persons or material damage

There should be no valve or obstruction to prevent free flow

The correct design, installation and operation of the venting arrangement is critical in ensuring the safe discharge of flash steam and the prevention of water carry over

When sizing the vent consideration should be given to the boiler pressure, size of blowdown system, inlet connection/connections (whether directly into or above water level) and any condensing **arrangements**

PSSR Regulation 15 “Precautions to prevent pressurisation of certain vessels” states the need for a permanent outlet attached to a vessel where the pressure does not (generally) exceed atmospheric pressure to be kept open and free from obstruction

Table 1. Typical blowdown vessel outlet and vent sizes for vessels having one blowdown connection

INLET SIZE	OUTLET SIZE	VENT SIZE
25 mm	65 mm	100mm
40mm	100 mm	150mm
65 mm	200mm	250mm

4.2 Fittings

The blowdown vessel should be fitted with a suitable drain valve, provision for fitting test pressure gauge and an outlet temperature gauge, which may be connected to alarm arrangement

Water gauge is not considered necessary, but if fitted should be of adequate design

5. Multi boiler installations.

When used in conjunction with a multiple steam boiler installation the blowdown vessel outlet and venting arrangements should be sized to suit the boiler with the largest blowdown capacity.

It is essential that only one boiler can be blown down at any time, (unless the blowdown system is designed in a such manner as to accommodate simultaneous blowdown) manual blowdown valves should only have one key available, automatic controls should prevent no more than one boiler in common manifold from being blown down.

Where simultaneous blowdown is likely to occur it should be ensured that the blowdown vessel is of sufficient capacity and the outlet, vent and any cooling arrangements are suitably sized.

Suitable valve arrangements including non- return valves should form part of the blowdown arrangement in order to isolate parts of the system when required

6. Hazards and precautions

As a result of blowdown, the vessel can become hot, as the vessel is intended to dissipate heat it is not normal to apply thermal insulation. Guard rails or other personnel protection should be provided, as determined through risk assessment, any precautionary actions should not interfere with the cooling process within the vessel

Fig 3.Typical Blowdown Compound

If the blowdown vessel is liable to contain hot water above the permissible level it will be necessary to cool the water before it leaves the vessel. This can be achieved by installing an aftercooler or by a temperature control system with cooling water injection; this system should be of such a design that the set temperature cannot be easily altered. The use of multiple blowdown tanks in sequence within the system is permissible, although consideration of system design should be made in order to ascertain fitness for purpose.

The disposal of discharge must conform with local authority regulations and the water temperature must not exceed 43 deg.c (see 5.5 The Water Industry Act 1991)

The vessel shall be suitably sited to prevent the water freezing in cold weather or suitably protected to prevent freezing.

Should the vessel be sited outside it should be designed with suitable temperature parameters.

Blowdown operation can produce high levels of noise, if the noise levels prove hazardous to personnel measures must be put in place in order to reduce such levels.

HSE publication INDG362 provides guidance on this subject.

7. Blowdown pits

Use of brick or concrete pits is actively discouraged, new pits should not be built and planned preventative maintenance programme should be drawn up to ensure existing pits are properly maintained.

Consideration should be given to the installation of a suitably designed blowdown vessel as described in Section 4.

8. Maintenance and Examination

Blowdown vessels are generally included within the steam system Written Scheme of Examination and are generally examined either every 14 months, at the time of the Thorough Examination, or at intervals determined by the Competent Person.

Prior to any examination or maintenance activity requiring internal access the blowdown vessel a suitable risk assessment shall be made, and the vessel shall be positively isolated.

Particular consideration should be given in the case of multi- boiler systems, the design of the system and the isolation afforded should ensure the safety of personnel working on the system. This can be achieved, for example, by double isolation, by valve removal, blanking off from the boilers or the use of spectacle blinds or a combination of all

Where internal access to a boiler within a multi boiler system is required, the fitting of a blank flange in the blowdown system to the out of service boiler will provide protection to the hazards of unintentional blowdown.

Automatic blowdown valves should be locked off from the electrical supply and, where fitted, any compressed air controls should be isolated

9.0 REFERENCES

The following are applicable at the time of preparation of this Guidance:

a) SAFed /CEA document BG01, ‘Guidance on Safe Operation of Boilers’

b) The Pressure Systems Safety Regulations 2000 (SI 2000 No 128)

c) Pressure Systems Safety Regulations (Northern Ireland) 2004

d) Health and Safety at Work etc. Act 1974

e) HSE Guidance INDG 362 Noise at Work

f) HSE Approved Code of Practice. Safety of Pressure Systems. No. L122.

g) SAFed Guidance PSG1. Pressure Systems. Guidelines on Periodicity of Examinations

h) BS 2486: 1997 Recommendations for treatment of water for land boilers

