Guidance on Safe Operation of Boilers

Ref: BG01

A joint document by the Safety Assessment Federation and Combustion Engineering Association produced in consultation with the Health & Safety Executive.

HSE

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CEA

Foreword by Health & Safety Executive

This document, Guidance for Safe Operation of Boilers (BG01) has been developed and written by Safety Assessment Federation (SAFed) and the Combustion Engineering Association (CEA) in consultation with other stakeholders within the boiler systems industry to help managers, designers and operators of new and existing boiler systems make health and safety improvements in the boiler systems industry.

Acknowledgements

SAFed and CEA acknowledges the support of the Health and Safety Executive in producing this guidance.

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.

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

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1 INTRODUCTION

Guidance for the Safe Operation of Boilers (Ref: BG01) is a guidance document intended to assist the managers, designers, operators, maintenance personnel and Competent Persons (CP) of new and existing boiler systems in addressing the following issues:

- The safe use and operation of the boiler installation.
- Determining the adequate supervision and maintenance (levels and competence) requirements that is consistent with the installed plant and its location.
- Reducing the likelihood of explosion, or other dangers, from events such as:
  - Loss of feed water or low water level.
  - Over-pressure.
  - Overheating 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.
- Using the proper treatment and monitoring of the feedwater and condensate to:
  - Minimise corrosion and scale and
  - avoid carry-over of water with the steam which in turn can cause water-hammer.
- Compliance with the various legal requirements, in particular that for periodic examination by a CP in accordance with a written scheme of examination (WSE).

2 SCOPE

This document applies to those industrial & commercial steam and hot water boiler plant operating at a working pressure of between 0.5 and 32 bar gauge and working temperature between 110°C to 400°C.

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

- Water tube boilers.
- Process Boilers with a capacity exceeding:
  - 30 tonnes steam per hour.
  - 25MW.
  - 32 bar gauge working pressure.
- Domestic, commercial boilers smaller than 70kW.
- Electric immersion, steam coil heated and electrode boilers.
- Manually operated boilers (i.e. those requiring constant human intervention).

This document also excludes from its scope any consequences arising from incorrect steam pressure delivery from the boiler.

3 LEGISLATION

Boiler systems are required to comply with different legislation, including a number of health and safety regulations, which aim 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 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 Regulations 1999 (PER).
- The Pressure Systems Safety Regulations 2000 (PSSR).
- The Provision and Use of Work Equipment Regulations 1998 (PUWER) and
- The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) (DSEAR may apply in some cases and will be briefly discussed with PER.)

With the exception of 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/

3.1 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 (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 should 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 chapter.

3.2 The Pressure Equipment Regulations 1999 (PER)

All new and substantially modified pressure equipment (including steam raising plant) come within scope of PER and they must comply with its requirements before they may be supplied for use. 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.

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 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 Department for Business, Innovation and Skills (BIS) has produced a very useful guide to PER. (www.bis.gov.uk/) There is an easy-to-use flow chart (Annex C) showing how equipment should be classified depending on, for example, what it is designed to contain and the operating pressure. This includes the conformity assessment procedure to be followed before placing the equipment on the market.

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 1996. 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 as set out in the Dangerous Substances & Explosive Atmospheres Regulations 2002 (DSEAR) assessment.

3.3 Pressure Systems Safety Regulations 2000 (PSSR)

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

- '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 responsibilities in relation to installed systems. Package boilers are considered to be installed systems for the purposes of the regulations.

The owner/user of the 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 CP 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 CP in accordance with the requirements of the scheme.

- All repairs & modifications must be carried out by people suitably competent in such work (Regulation 13, PSSR, ACOP Para 180). The details of such work must be retained. The effects of modifications and repairs should also be assessed to determine whether the WSE needs review.
- 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 (Regulation14, PSSR).

The results of all tests and examinations should be recorded (see Log Sheets, section 13.2) and retained for a suitable period. 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 and easily accessible (Regulation 14, PSSR). Examples of the type of records that should be kept and made available for scrutiny include:

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

3.4 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 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 & instructions, training and control systems. This is not an exhaustive list.

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 the 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 should aim to reduce the risks to a level as low as is reasonably practical (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.

- The location of the boiler with respect to:
  - 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, 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.

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

- Manning levels.
- 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 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 should also be recorded.

As an example, an owner moving from a manned boiler to an unmanned boiler should, as a first step, review the boiler design and the current/ recent 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 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 control the risk of a dangerous occurrence.
- Amendment of procedures where appropriate to ensure the plant continues to be operated safely.
- All personnel on-site & off-site and surrounding property remain safe.

4.2 Written scheme of examinations (WSE)

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 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 should 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 should be clearly identified. The boundaries of each WSE should be adjacent to each other, with no physical gaps.

4.3 Examinations in accordance with the WSE (thorough examinations)

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

The owner/user 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 owner/user. The report will also include, amongst other information, the following:

- Whether any repairs are required and the date by which they should be completed.
- The latest date by which the next examination should 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.

Note: 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/ examinations passes without these being completed.
- Make the required modifications to the WSE and have it recertified 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 owner/user 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 on the Owner/User 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 the equipment manufacturer.

5 PERSONNEL AND RESPONSIBILITIES

5.1 Employers

Under the Health & Safety at Work etc Act 1974 (HSWA), employers have general duties 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.

5.2. User/owners

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

5.3 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 unincoporate; and accordingly any reference in these Regulations to a CP performing a function includes a reference to his performing it through his employees."

From Paragraph 17 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.
- 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 by more than one organisation. The owner/user 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 advice 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 are not terms that have a legal definition.

5.4 Boiler operator

It is common practice for the user/owner to appoint a sufficiently competent and experienced person to be responsible for the daily safe operation of the boiler system. (The legal responsibility however cannot be transferred). The boiler operator should 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. The duties of the boiler operator include:

- Implementing the boiler manufacturer's recommendations with regard to starting up from cold, and for all the other aspects of the boilers 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.
- Checking burner and associated equipment.
- Responding to alarms and taking appropriate action.
- Carrying out the recommended water quality tests, routine water treatment, recording the results and making adjustments where necessary in accordance with established standards (BS EN 12953-10 or the manufacturer's instructions). This function is often contracted out to a water treatment specialist.

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

All such persons should possess sufficient training and information to take the appropriate action in the event of an alarm condition before calling for the assistance of a boiler operator. In some cases, this may involve the emergency shutdown of the system.*

5.6 Maintenance personnel

All maintenance personnel should possess sufficient training to be able to carry out the expected duties. Maintenance personnel should 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, fittings or control equipment.

* Persons should not enter the boiler house unless there is a system in place to ensure that access is safe, e.g. gas and fire detection.

6 TRAINING

Employers must ensure that all personnel possess sufficient knowledge of the boiler systems on which they work to perform their duties properly.

Any training should 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, (including that for boiler systems) 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 corresponding training requirements) should be reviewed when a system is modified, e.g. increased automation/remote supervision. The training should be delivered by personnel possessing the appropriate practical experience, assessment skills, and knowledge of the working environment.

The employer should ensure that all operatives and other relevant personnel are regularly assessed through work audits. Training should also be reassessed periodically.

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 through the Combustion Engineering Association. Training providers accredited under the Boiler Operation Accreditation Scheme (BOAS) are accredited to the industry standards.

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 in:

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

These qualifications form part of the Boiler Operation Accreditation Scheme (BOAS) mentioned above.

The level of training 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 fuel/s used.
- Feed water/boiler water analysis.
- Condensate drainage and water-hammer.
- 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 course.

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

- Basic heat & heat transfer concepts.
- Draught & combustion.
- Feed water & boiler water analysis.
- Control & instrumentation.
- Safety & legal requirements.
- Energy efficiency.
- Environment.
- Boilers & auxiliaries.
- Operation.
- Fuel concepts.

6.2 Training records

Employers should ensure that all relevant training and reassessment records are maintained and kept securely, including details of content and results of courses. Appropriate audit records should be maintained and kept securely. Such evidence of training may be required to be viewed by enforcing authorities.

7 DESIGN AND INSTALLATION

All new and substantially modified steam raising boilers must be designed to satisfy all relevant requirements of the Pressure Equipment Regulations (PER) 1999.

When repairs, modifications, including changes to control systems or commissioning of a new system are undertaken, these risk assessments must be re-assessed with a view to eliminating the risks or reducing them to the level ALARP.

7.1 Design considerations

Many trades and professions are involved in the design, construction, operation and maintenance of a boiler system, therefore 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 should 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 should address the following safety issues:

- Boiler house ventilation - ensure adequate air supply for combustion. Designs should comply with IGEM UP/10 and BS 6644 as appropriate.
- 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 should fail-safe, i.e. ensure boilers enter a safe mode under automatic control without requiring manual intervention. They should also have a control integrity depending on their mode of operation.
- Critical alarms relating to plant safety should default to lock-out and require manual reset as defined by BS EN 12953-9. (This is not necessary on Arrangement 1, first low water level, as this will normally reset automatically).
- Interruption of the electrical supply to water level and firing control equipment should cut off the boiler automatically. Restart should only be possible if the normal requirements for start up are met and the boiler system has been designed to do so.

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, four typical arrangements of boiler controls are detailed in Section 7.4. They are intended to be used in conjunction with the findings of the risk assessment.

7.2 Control systems

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

This equipment can have a monitoring role or a safety function where it acts in a predetermined manner to prevent a dangerous situation. For example, the first low-water-level alarm prevents boiler operation when the water level is low, but allows an automatic restart and resumption of operation once the water level has risen to a safe level. On the other hand, should the water level continue to fall, the second low-water-level alarm shuts the boiler down completely and does not allow an automatic restart. The boiler can only be started manually once the second low water level alarm is activated.

Control equipment includes the various level sensors, 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 manually controlled boiler system.

New safety-related systems should 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.

7.2.1 Level sensing devices

These can be mounted through the boiler shell or in external chambers providing that the system has proven reliability and is inherently fail-safe. Detailed information can be found in BS EN 12953 Part 6, which specifies the following:

- External chambers should have as a minimum 25mm diameter boiler shell connections at the steam and water level.
- Protection tubes (where fitted) should be designed:
  - With adequate venting to water and steam space.
  - To prevent steam bubbles causing undue disturbance to the water level.
  - To prevent sludge build-up.
  - With a minimum clearance of 14mm from the probe.
- The two low water level limiters should be mechanically and electrically independent, so as to avoid common cause failures.

  Note: Many existing boilers (not designed and constructed to BS EN12953) will have one low level limiter (lock-out) and a first low level cut-out and alarm (auto reset). Risk assessment may demonstrate that this is not satisfactory for unmanned (remotely operated) boiler systems.

7.2.2 Combustion control devices (oil & gas)

The system will incorporate the following (as applicable):

- Ignition flame, main flame detection and safety system.
- Forced draught and induced draught fan proving systems.
- Air and flue damper position proving systems.
- A high-integrity system incorporating self-checking systems monitoring flame detectors and the correct ratios of fuel and air. The system design should ensure that an unsafe fuel air ratio will cause lock-out. (Self-checking flame safeguards may not be needed if the burner progresses through a restart on a daily basis.)

7.2.3 Pressure and temperature devices

Heat input should be controlled automatically (refer to BS EN 12953 Part 6) as follows:

- Steam boilers to be controlled by pressure controls. i.e. pressure relief valve.
- Hot water boilers to be controlled by temperature controls.
- Limiting devices should be fitted to prevent excessive pressure or temperature. For new boilers they should be in accordance with BS EN 12953 Part 9.

7.3 Communications and alarms

Typical alarms are indicated in the four arrangements in Section 7.4. A lock-out condition requires that the boiler be attended and can only be re-set locally. 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.

New boiler systems should be designed such that boilers will always remain in a safe condition and will shut themselves down upon critical alarm, without manual intervention.

Risk assessment may indicate that there is benefit in also relaying alarms and providing an emergency shut-down facility at a remote location.

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 take appropriate action. The following should be considered:

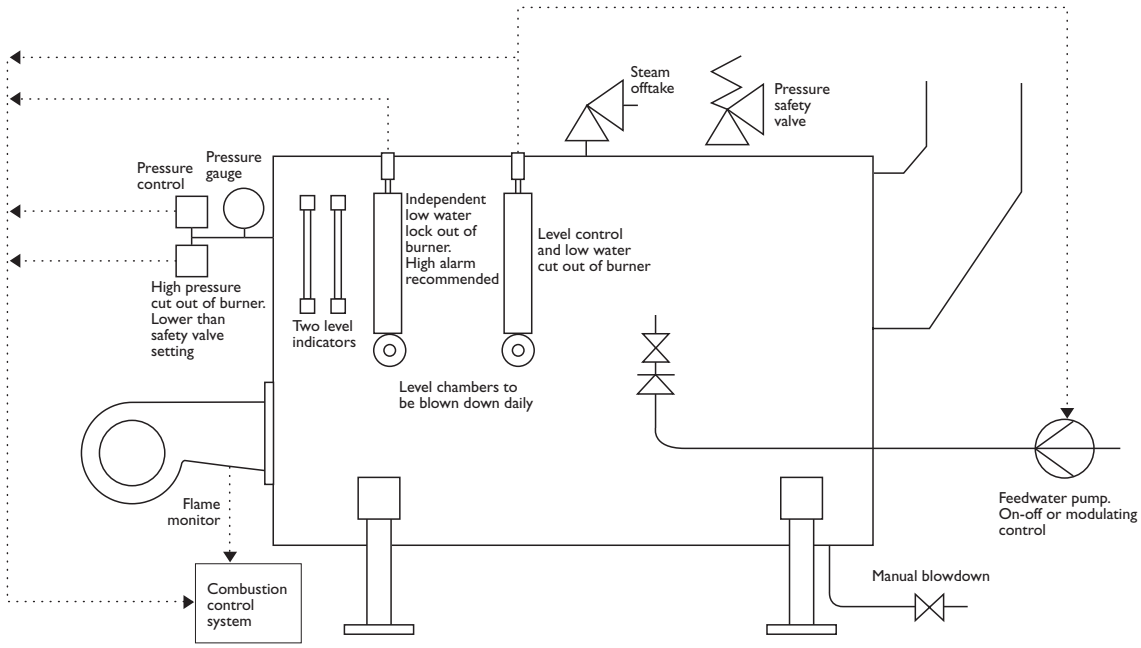
- The response time for personnel to investigate and rectify alarm conditions must be considered as part of the design of the control system.
- Alarms must be clearly audible and/or visible at a permanently manned location where persons who are competent to take the appropriate action can hear/see them.
- The integrity and testing of communication links between the boiler house and remote location/s must be considered as part of the design of the control system.

7.4 Typical control arrangements

The boiler control equipment layout will depend on the levels of attendance and manual testing. Four typical arrangements are shown below. They should be considered in conjunction with the findings of the risk assessment and information on the type and level of manning that is intended to be employed.

Typical Arrangement 1:

This shows the minimum equipment required for the lowest level of automation. This level does not meet the requirements of boiler standard BS EN 12953.

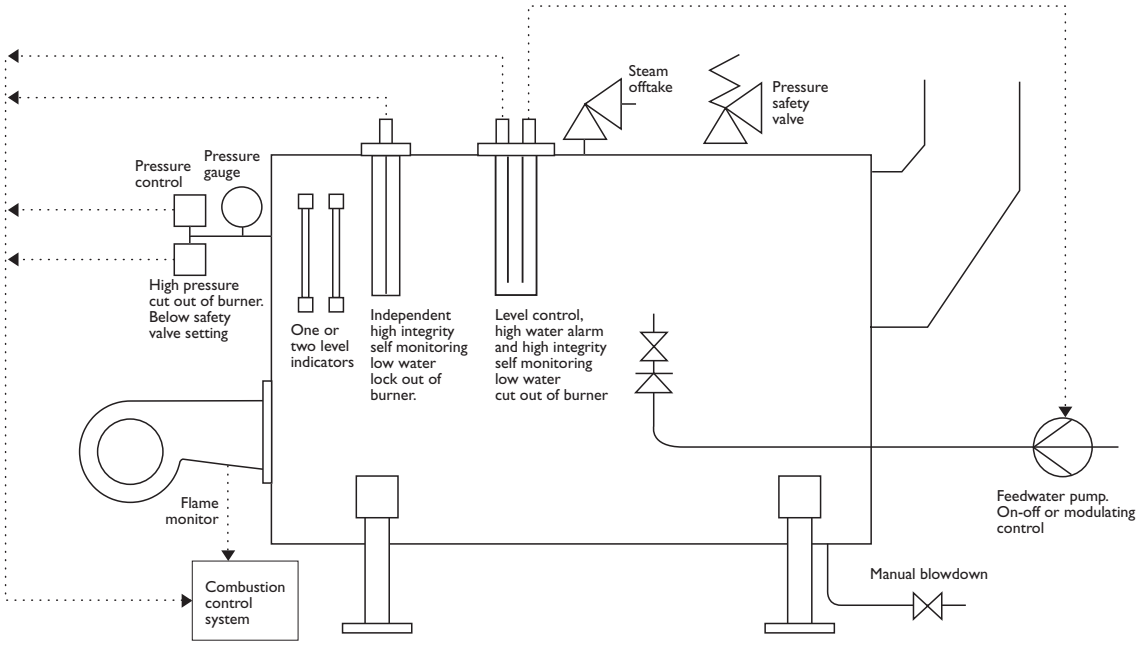


With typical Arrangement 1 the following factors need to be considered:

- Attendance: A boiler operator should be on-site at all times that the boiler is operating and be able to respond immediately to an audible and/or visual alarm condition.
- Equipment Integrity: All control equipment should be fail-safe.
- Boiler house fire protection: Fire detection, fire alarm and automatic shut-off of the fuel should be provided. For gas firing, gas detection and alarm should also be considered.
- Minimum frequency of routine testing:
  - Low water level devices in external chambers:
  - Daily checks: External chambers should be manually blown down at least daily and the low water cut-out and lock-out tested.
  - Weekly Checks: In addition, the low water level cut-out and lock-out should be tested by lowering the boiler water level by evaporation and controlled blow down. **Note:** Discharge temperature to drain should not exceed permissible limits.
  - Low water level devices in internal protection tubes in the boiler:
  - Daily Checks: The low water cut-out and lock-out should be tested at least daily by lowering the boiler water level or by an integrated test device. **Note:** At the beginning of each shift if a shift pattern is used.
  - Weekly Checks: In addition, the low water level cut-out and lock-out should be tested by lowering the boiler water level by evaporation and controlled blow down. **Note:** Discharge temperature to drain should not exceed permissible limits.
  - Level Indicators (gauge glasses):
  - Daily: Manually blown down.

Typical Arrangement 2:

This shows the minimum equipment required for a boiler with critical alarms monitored on-site by a remote panel located in a manned area such as a gatehouse. New installations should be manufactured to BS EN 12953, which requires additional limiters to be fitted.



With typical Arrangement 2 the following factors need to be considered:

- Attendance: A suitably trained and instructed person should be on-site at all times that the boiler is operating and should be capable of responding to an alarm condition. As a minimum, the person should ensure that the boiler is safe and notify the boiler operator of the alarm condition. The boiler operator should check the boiler at least every day.

- Equipment Integrity: Low water level devices of the high integrity self-monitoring type should be fitted. All control equipment should be fail-safe.

- Boiler house fire protection: Fire detection, fire alarm and automatic shut-off of the fuel should be provided. For gas firing, gas detection and alarm should also be considered.

- Minimum frequency of routine testing:

  - Low water level devices fitted directly to the boiler:
  - Weekly: The low water level cut-out and lock-out should be tested by lowering the boiler water level by evaporation and controlled blow down.
    Note: Discharge temperature to drain should not exceed permissible limits.

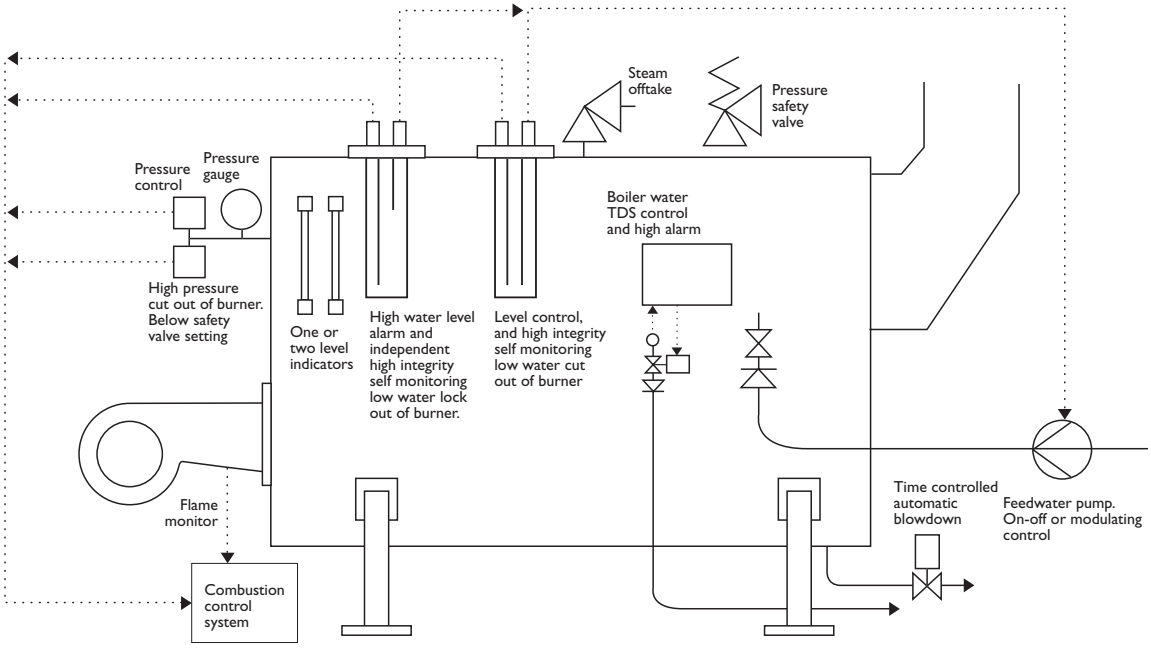
  - Low water level devices in external chambers fitted with automatic blow down facilities:
  - Daily: External chambers should be automatically blown down at intervals typically of at least every six hours.
  - Weekly: In addition, the low water level cut-out and lock-out should be tested by lowering the boiler water level by evaporation and controlled blow down.
    Note: Discharge temperature to drain should not exceed permissible limits.

  - Level Indicators (gauge glasses):
  - Weekly: manually blown down.

Typical Arrangement 3:

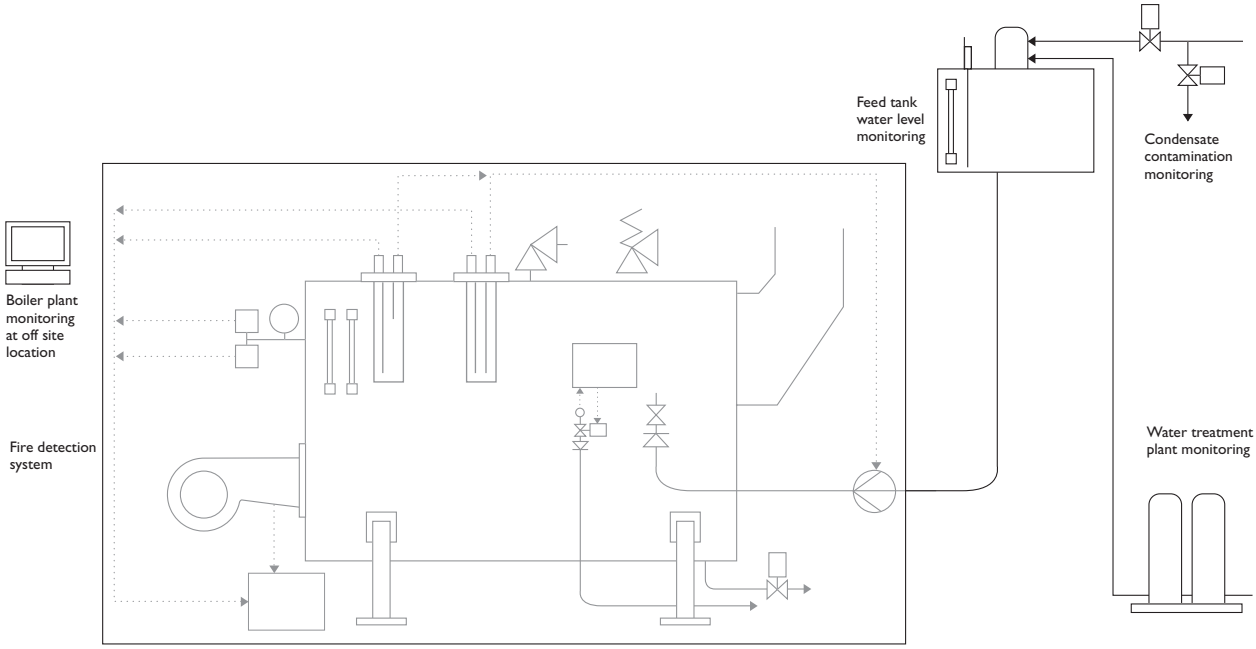
This shows the minimum equipment requirements for the highest level of automation, i.e. lowest degree of supervision, where no boiler operators are on-site and with status monitoring by a remote location/telemetry system.

Equipment for the boiler:



New installations should be manufactured to BS EN 12953, which requires additional limiters to be fitted.

Additional equipment in the boiler house:



Where this additional equipment is not provided - this must be supported by a risk assessment and other control measures as necessary.

- Attendance: The site should be visited and checked by a boiler operator at least every three days (unless risk assessment determines otherwise). Boiler status is monitored from either an on-site or off-site location.

- Equipment integrity: This arrangement is the highest level of automation requiring the greatest degree of confidence in the boiler controls and equipment. Low water level devices should be high-integrity. Self-monitoring combustion control system should be high-integrity. All control equipment should be fail-safe.

- Boiler house fire protection: Fire detection, fire alarm and automatic shut-off of the fuel should be considered. For gas firing, gas detection and alarm should also be provided.

- Minimum frequency of routine testing:

  - Low water level devices fitted directly to the boiler:
  - Weekly: The low water level cut-out and lock-out should be tested by lowering the boiler water level by evaporation and controlled blow down.

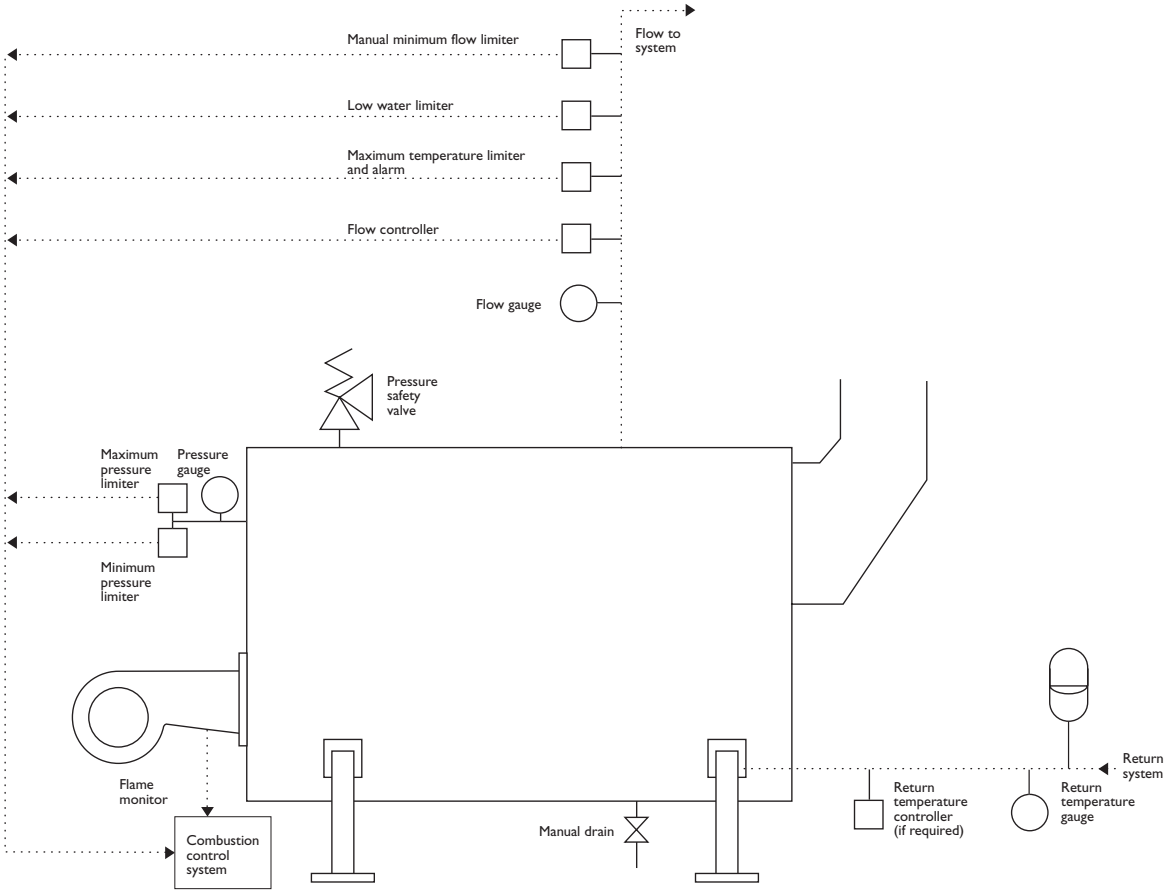
  - Low water level devices in external chambers fitted with automatic blow down facilities:
  - Daily: External chambers should be automatically blown down at intervals typically at least every six hours.
    Note: Discharge temperature to drain should not exceed permissible limits.

  - Weekly: In addition, the low water level cut-out and lock-out should be tested by lowering the boiler water level by evaporation and controlled blow down.
    Note: Discharge temperature to drain should not exceed permissible limits.

  - Level indicators (gauge glasses):
    At least every three days: manually blown down.

Typical Arrangement 4:

This is a typical arrangement for a hot water system with external pressure generation and expansion system.



Note: For detailed requirements to suit different boiler types (eg steam cushioned) refer to BS EN 12953 Part 6 and SAFed PSG3 – Guidelines for the Operation of Hot Water Boilers. Solid fuels may require additional emergency cooling systems.

With typical Arrangement 4 the following factors need to be considered:

- Attendance: The site should be visited and checked by the boiler operator at least every three days (unless risk assessment determines otherwise). Boiler status should be monitored from either an on-site or off-site location.

- Equipment Integrity: Unless otherwise determined by risk assessment:

  - All limiting devices must be fail-safe.
  - The low water limiter must be high-integrity, self-monitoring with manual test facility.

- Boiler house fire protection: Fire detection, fire alarm and automatic shut-off of the fuel should be considered. For gas firing, gas detection and alarm should also be provided.

- Minimum frequency of routine testing: This should be determined by a risk assessment conducted by the owner/user coupled with a consideration of the control and limiting device manufacturer's instructions. As a minimum, the correct operation of all limiting devices should be partially proven by simulation monthly and the correct operation of the entire system of all control, limiting and other safety devices should be proven during the statutory inspection of the boiler.

  For new equipment, the information on manning and level of remote monitoring should be provided to the system supplier. For complex electronic control systems, the SIL that has been assigned to each safety function will determine which monitoring devices and systems are used to contribute to that safety function and how they are applied, operated & tested.

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 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 particular site manning levels required to ensure that all risks remain as low as reasonably practicable.

8.1 Boiler instructions

Boiler instructions should as a minimum include the following:

- Instructions for the safe operation of steam boiler systems to comply with Regulation 11, PSSR plus BS EN 12953-13 and PER.
- The recommended daily checks required.
- How to warm through boiler systems starting from cold in a controlled manner. The water levels should be corrected to allow for expansion and the controls and limiters tested prior to the boiler entering service. For this reason, boiler systems should be allowed to start automatically from cold and unattended only if they are designed to do so and the risk assessment demonstrates that this is safe.
- Information on the safe systems of work (including appropriate standards of isolation that should be implemented for any works on the boiler systems).
- How to protect off-line boilers against corrosion, freezing and sudden thermal shocks.
- The requirement to notify any significant change in boiler operating conditions, e.g. reduction in operating pressure or increase in cyclic operation to the CP, so that the written scheme of examination can be reviewed.

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

8.2 Recording of controls, limiters and feed water quality tests

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

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

- Low water level which can expose the furnace or fire tubes and lead to metal overheating & catastrophic boiler failure.
- High water level which can lead to priming of the boiler or carry-over of water, causing water-hammer, damage to valves and pipework as well as sudden steam leaks.
- Scale, excessive sludge deposits and dissolved solids which can quickly build up in a boiler through inadequate blow down or water treatment regimes. These can cause boiler overheating or water carry-over, 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 taking into account the controls and attendance levels. A record of such tests should be maintained to keep an audit trail of the boiler operation. Examples of daily and weekly boiler log sheets are given in Section 13.2.

Routine tests may be carried out automatically or remotely if risk assessment demonstrates that this is acceptable and all the following conditions are also satisfied:

- High integrity, self-checking water level controls are fitted and:
- An alarm is generated, locally & remotely, and the boiler locks-out if the test fails.
- An automatic record is generated of the test result.
- The test is also witnessed on-site at least once per week by the boiler operator to verify that the automatic procedure functions correctly.

  Note: Where the boiler fails to re-start following testing of lock-outs, repeated attempts to re-start plant should not be made unless part of a controlled fault identification process.
- For any arrangement (i.e. including Arrangement 3), in the event of an unexpected alarm and lockout event (i.e. not during routine testing of boiler controls) rather than re-starting remotely the event should be investigated further and restart should be at a local level.

8.3 Water level controls and limiters

The testing regime for water level controls needs to be specific to the type of equipment employed. As a minimum it should verify the functionality of the water level controls and the associated alarms & limiters. This should form part of the operating instructions for the Boiler System. The following need to be considered when drawing up instructions:

- The manufacturer's recommended test methods should be carried out as a minimum.
- Any departure from the test frequencies outlined in the arrangements must be supported by the risk assessment.
- Only a trained boiler operator should carry out the tests.
- At no time during a test should the water be lowered to the extent that it disappears from the gauge glass.
- Test results should be logged (either electronically or manually) with boiler operator's name, date of test plus any corrective action taken.
- Corrective action following alarms should always be taken by the trained boiler operator.
- After tests have been completed, ensure that the water level is restored and that all valves are in the correct operating position. The boiler should not be left until it is operating correctly.

Further details of tests can be found in BS EN 12953 Part 6 Annex C.

8.4 Burners and combustion tests (oil & gas)

Gas and oil fired burner installations should comply with the relevant standards (see section 12, References). Maintenance and testing by a qualified person in accordance with manufacturer's instructions is essential to ensure safe and efficient operation.

Combustion tests should 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 a CO, CO_2 or O_2 may be appropriate. All tests should be recorded on the log sheet and allowable

limit data should be readily available. Suitably qualified persons should investigate any problems and take corrective action. All manufacturers' tests should be carried out at recommended frequencies with special attention to:

- Test photocell operation & record the results. Prove lock-out and manually reset. In a process where the burner is firing continuously, a self-checking photocell should be used.
- Test correct operation of forced ventilation and/or ensure 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.
- Fuel leak and shut-off checks:
  - Gas - if a significant gas leak is suspected, the gas supply should 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 and supply lines for leakage. Record and immediately report any leaks to the maintenance personnel.

8.5 Solid fuel (coal and biomass)

Whilst this guidance is primarily written for oil & gas, much of its contents are relevant for solid fuels. In this case, references to burners and fuel systems can be taken to mean the solid fuel system (grate or equivalent), and the associated fuel handling equipment.

Particular consideration should be given to:

- The residual heat left in a boiler after a shut-down condition. The plant should be designed so as to be able to accept this heat.
- The margin between normal working pressure and the safety valve pressure.
- The sinking-time of the boiler, i.e. the time during which the water level will sink from the lowest permissible water level to the highest point of the heated surface. This may involve consideration of an automatically closing valve on the steam outlet so as to prevent steam export.

8.6 Feedwater checks

A feedwater specialist should undertake regular checks on the feedwater treatment plant and test the feedwater quality. In addition, a suitably competent boiler operator should make the following feedwater checks when in attendance or at scheduled intervals:

- That the feed tank level is adequate and there are no contaminants.
- That the chemical dose metering device is functioning and there are adequate chemical stocks in the tanks.
- That in-house routine sample results are within their given parameters provided by the water treatment specialist and take remedial action when necessary.
- The temperature is above the required level for the treatment doses specified for oxygen scavenging.

Special circumstances

In some installations, there may be environmental or operational implications to testing of boiler controls, e.g. waste heat boilers connected to incinerators or gas turbines. Testing regimes should be established to ensure that the controls and trips can be proven without tripping the plant except under controlled conditions.

9 MAINTENANCE, REPAIR AND MODIFICATION

9.1 Maintenance

- Boiler systems should be properly maintained and in good repair, so as to prevent danger, and should take account of manufacturers' instructions in accordance with PSSR Regulation 12 and PUWER Regulation 5.
- All maintenance requirements and activities should be fully documented, including the frequency that maintenance should take place.
- If scale is found in boilers, the water treatment system should be checked for correct operation and appropriate corrective action taken.

9.2 Modification & repairs

The effects of any modifications, repairs or adjustments should be assessed by the CP to determine whether a review of the WSE will be required. The WSE itself is reviewed by the CP at each examination.

Modifications and repairs to pressure systems must comply with PSSR Regulation 13.

For significant repairs, the following points should be addressed:

- Reason for repair/modification – rectify the cause, not the symptoms.
- Design of the repair should make reference to the original design code and other suitable guidance and achieve an equivalent standard.
- Materials should be suitable and closely match the properties of the original equipment.
- Workmanship should 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 should 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/s before instigating.
- Steam and 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 & repairs, where they affect integrity and/or safety of the system, its controls & software, should be properly considered and the CP should be kept fully informed of proposals.

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 (owner) 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:

- Boiler operators should ensure that they hand over the boiler to maintenance personnel in a safe condition.
- On completion of maintenance, the checking of all controls and alarms should be verified by the boiler operator in the presence of the maintenance personnel before the boiler is placed on line.
- If the maintenance is carried out at the same time as the boiler examination, the controls and alarms will also be verified by the CP.

10 PERIODIC EXAMINATION OF BOILERS

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.
- Written and certified by the in-house CP (so long as they are sufficiently independent from the operating function).
- 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 should be performed as soon as reasonably practicable after the out of service examination. In any event, pre-checks on the functionality controls and protective devices should have already been performed by the owner/user as soon as the boiler was returned to operation.

The user/owner should 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 must be implemented.

SAFed Guidance PSG06: Examination of Pressure Systems in Accordance with Written Scheme of Examination, 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 long 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, auto TDS control, combustion control etc, some of which may be eligible for assistance under the Government's enhanced capital allowances programme: http://www.eca.gov.uk/
- Plant scheduling and boiler optimisation to maximise plant efficiency.
- The ability to carry out measurement is recommended to demonstrate efficient operation and emissions.
- It should be noted that reducing steam pressure may not necessarily improve efficiency.

Further guidance can be found in: Good Practice Guide 369: Energy Efficient Operation of Boilers, available from the Carbon Trust: http://www.carbontrust.co.uk/default.ct

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 a Pollution Prevention and Control (PPC) permit issued by the Environment Agency. This will detail the boiler and its ancillary plant's effect on the environment & 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 Environment Agency 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 should be removed by a licensed waste carrier. Water discharged to drains must comply with water utility restrictions.

Useful websites include:

- Clean Air Act: www.opsi.gov.uk/acts/acts1993/Ukpga_19930011_en_1.htm
- Environment Agency Netregs covering all aspects of environmental legislation: www.netregs.gov.uk/netregs/?version=1&lang=_e
- Environment Agency sector guidance for combustion operations: www.environment-agency.gov.uk/ static/ documents/ Business/ ippc_combustion_1765656.pdf

12 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.
- 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
- The Electricity at Work Regulations (EAW) 1989 are supported by Memoranda 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 No. 3242

3 Provision and Use of Work Equipment Regulations (PUWER) 1998*
SI 1998 No. 2306

4 Electricity At Work Regulations 1989
SI 1989 No. 635

5 Confined Spaces Regulations 1997*
SI 1997 No. 1713

6 Control of Substances Hazardous to Health Regulations (COSHH) 2002*
SI 2002 No. 2667

7 Dangerous Substances and Explosive Atmosphere Regulations (DSEAR)**
SI 2002 No. 2776

8 Control of Noise at Work Regulations 2005
SI 2005 No. 1643

9 Construction Design and Management Regulations (CDM) 2007*
SI 2007 No. 320

10 Supply of Machinery (Safety) Regulations (SMSR) 2008
SI 2008 No. 1597

11 Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 1996 (amended in 2001)
SI 1996 No. 192 & 2001 No. 3766

12 Pressure Equipment Regulations (PER) 1999
SI 1999 No. 2001

13 Pressure System Safety Regulations (PSSR) 2000*
SI 2000 No. 128

14 The Gas Safety (Installation and Use) Regulations (GSIUR) 1998*
SI 1998 No. 2451

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

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

17 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)

18 BS 7671 Requirements for electrical installations. IEE Wiring Regulations

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

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

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

22 BS EN 12953 Shell Boilers

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

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

25 Permit-to-work systems HSE INDG98 ISBN 0 7176 1331 3
www.hse.gov.uk/comah/sragtech/techmeaspermit.htm

26 Permit to work web link
www.hse.gov.uk/comah/sragtech/techmeaspermit.htm

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

28 Institution of Gas Engineers and Managers (IGEM) UP/12

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

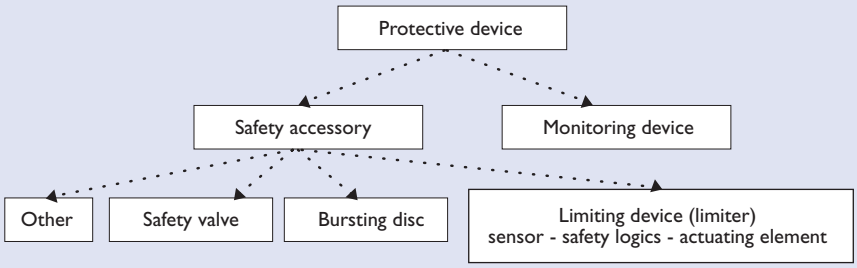
30 Business Innovation and Skills Pressure Equipment Guidance Notes on the UK Regulations http://www.bis.gov.uk/files/file11284.pdf

13. ANNEXES

13.1. Definitions

Boiler system	Boilers, ancillaries and all related items including pipework. Additionally may include: fuel supply, water treatment, feedtank, flue, ventilation, blow down equipment, vents, monitoring and control equipment etc.
Boiler system operator	Someone who has attended a recognised training course 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 PSSR.
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 the discharge constraints.
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.
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)



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	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 in 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.
Remote locations	Locations remote from boiler house but on the same site. This would include a permanently manned location such as a gatehouse, switchboard or security post.
Self-monitoring	Regular and automatic determination that all chosen components of a safety system are capable of functioning as required.
SOL	Safe operating limit.
Water-hammer	Dynamic shock loading resulting from the accumulation of condensate in steam pipework.
WSE	Written Scheme of Examination.

LOG OF TESTING OF SELF-MONITORING BOILER CONTROLS

BOILER NO: _____

DAILY TEST

	MON	TUES	WED	THURS	FRI	SAT	SUN
Date							
Water gauge test Satisfactory	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
Water level left hand gauge	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐
Water level right hand gauge	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐
Water level control Feed pump start/stop or modulation	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
Time test carried out							
Pressure gauge reading							
Feed water and condensate check	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐
Water test TDS							
pH							
Water treatment	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐
Blow down quantity							
Signature of operator							

WEEKLY TEST

Date	
Flame failure, lock-out test satisfactory (if applicable)	YES ☐ NO ☐
Failure to ignite, lock-out test satisfactory (if applicable)	YES ☐ NO ☐
Test by lowering water level 1st low water alarm Burner lock-out and alarm sounded	YES ☐ NO ☐
Test by lowering water level 2nd low water alarm Burner lock-out and alarm sounded	YES ☐ NO ☐

Name of boiler operator: _____

Log examined by: _____

Name of responsible person: _____

Signature of responsible person: _____

LOG OF TESTING OF BOILER CONTROLS

BOILER NO: _____

DAILY TEST

	MON	TUES	WED	THURS	FRI	SAT	SUN
Date							
Water gauge test Satisfactory	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
Water level left hand gauge	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐
Water level right hand gauge	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐
Water level control feed pump start/stop or modulation	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
Time test carried out							
Pressure gauge reading							
Feed water and condensate check	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐
Water test TDS							
pH							
Water treatment	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐	YES ☐
Blow down quantity							
Signature of operator							

WEEKLY TEST

Date	
Flame failure, lock-out test satisfactory (if applicable)	YES ☐ NO ☐
Test by lowering water level 1st low water alarm Burner lock-out and alarm sounded	YES ☐ NO ☐
Test by lowering water level 2nd low water alarm Burner lock-out and alarm sounded	YES ☐ NO ☐

Name of boiler operator: _____

Log examined by: _____

Name of responsible person: _____

Signature of responsible person: _____

BURNER LOG

BOILER NO:

Date	Time	Test No	Load	Photo-cell test	Fuel	CO mg/m³ or ppm	CO_2%	O_2%	Temp Deg. C	General flame appearance	Notes	Signature

NOTES

NOTES

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

Combustion Engineering Association
1a Clarke Street
Ely Bridge
Cardiff
CF5 5AL
www.cea.org.uk

Health & Safety Executive
(1G) Redgrave Court
Merton Road
Bootle
Merseyside
L20 7HS
www.hse.gov.uk

Guidance on Safe Operation of Boilers

This document will be formally reviewed every five years, although amendments and revisions may be made more frequently as required (jointly by HSE/SAFed/CEA).

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

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