

BOILER GUIDELINES FOR THE OPERATION OF STEAM BOILERS

1. INTRODUCTION

This guidance is not intended as a specification for boiler controls in new installations. These should be manufactured in accordance with the Pressure Directive and should comply with the requirements of relevant Harmonised Equipment Standards supporting the directive, with levels of supervision and training to be appropriate to specific site requirements.

During the production of these guidelines, account has been taken of the trends in boilerhouse practice to towards unmanned operation of boilers for extended periods.

Guidance is given on manning requirements for boilers equipped with various levels and types of controls but the user must ensure that a safe system of work is in place which will prevent danger to plant, boiler attendant, surrounding property and personnel.

Extensive development work is taking place in the field of functional safety of boiler controls. International standards such as IEC 61508, **Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems**, and prEN 50156, **Electrical equipment for furnaces and ancillary equipment**, are in draft stages.

These are intended to provide a framework for the design of safety related systems. As the standards are published and equipment and methodologies for implementation become available it may be necessary to review existing control systems to ensure satisfactory levels of integrity.

These guidelines are primarily aimed at preventing danger arising from the operation of steam boilers including Hot Water Boilers with an internal steam cushion. It is intended that separate guidance will be issued at a later date to cover Water Tube Boilers and fully flooded Hot Water Boilers. Attention is drawn to the need to ensure that:

- The danger of explosion does not arise from a loss of feed water.
- The danger of fire or explosion does not arise from the use of fuels, or from the design, installation and operation of burners and associated equipment.
- Feedwater and condensate return are properly treated and monitored to maintain the correct internal boiler conditions in order to minimise corrosion and scale.
- The correct supervision and maintenance (levels and competence) are provided for the installed plant.
- During operation, boilers are prevented from undergoing excessive pressure/thermal cycles and load swings and that carry over of water with the steam does not occur.

Both the Management of Health & Safety at Work Regulations 1992 and The Provision and Use of Work Equipment Regulations 1998 require users to carry out suitable and adequate risk assessments of boiler plant. Following this, users must then take any steps necessary to eliminate risks identified or, where elimination is not possible, to reduce them to a minimum level.

The types of controls and site manning levels must be a result of such risk assessments.

An essential requirement for safe operation of steam boilers is the training of **responsible persons** and **boiler attendants**. All attendants must be given suitable training and updating to ensure that they are fully conversant with the boiler controls and protective devices. All training should be documented and designed to ensure that attendants understand the test procedures and the dangers that may arise from incorrect operation or defective controls.

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Legislation and current standards demand that ***untrained personnel must not operate steam boilers.***

The user/owner of a steam boiler is responsible for the safe operation and maintenance of the system as part of their duties under The Health and Safety at work etc. Act 1974 and the Pressure Safety Systems Regulations 2000.

This includes the provision of adequate levels of supervision by suitably trained boiler attendants consistent with the type and extent of controls fitted and the possible need for emergency actions.

The competent person carrying out the necessary examinations of the boiler and other pressure equipment can give advice and assistance to the user/owner in deciding the level of supervision required but the examinations will be subject to the system being properly used with normal maintenance carried out.

2. DEFINITIONS

Owner/User

Person or organization responsible for the safe operation of the boilerhouse and/or associated plant

Boiler Attendant

Person who is responsible for the day to day operations and tests of limiters and other controls of the boiler plant

Maintenance Personnel

Persons who are responsible for undertaking maintenance on the plant

Competent Personnel

The individual or organization who certifies the written scheme of examination and carries out the required examinations in accordance with The Pressure Systems Safety Regulations 2000.

Responsible Persons

The representative of the owner/user responsible for the management of the boiler plant.

Remote Location(s) -

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.

Off-Site Location -

An off-site location with direct links to the boiler controls and alarms.

Cold Boiler -

A boiler at atmospheric pressure and close to ambient temperature.

Control-

A device used for holding variables (e.g. water level and pressure) within specific parameters. If more than one controller is provided for a single variable, both controllers may be of a single type.

Cut-out –

A cut-out is a transducer 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.

Limiter –

A limiter is a transducer which, on reaching a fixed value (e.g. pressure, temperature, flow, water level) is used to lock-out the energy supply requiring manual reset before restart.

High Integrity -

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.

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Fail-Safe -

A limiter or control device is fail-safe if it possesses the capability of remaining in a safe condition or transferring immediately to another safe condition in the event of certain faults occurring.

Self-Monitoring -

The regular and automatic self determination by the device that all chosen components of a safety system are capable of functioning as required.

Redundancy -

The provision of more than one device or system so that in the event of a fault, the necessary facilities will still be provided.

Diversity -

The provision of more than one different means of performing the required function, for example other physical principles or other ways of solving the same problem.

Lock-out -

The isolation of energy supply which requires manual intervention to reinstate within the boilerhouse.

3. PERSONNEL

Employers and employees have general duties to provide safe places of work under (the Health and Safety at Work etc Act 1974.

Competent Person

A person who has sufficient theoretical knowledge and experience of the plant to be examined that allows him to make judgments on its condition and certify it as safe for further use.

Competent persons may cover the pressure system, gas/fuel, electricity etc. and:

- Certify written schemes of examination. (The competent person may also draw up the written scheme).
- Review written schemes of examination
- Examine and report in accordance with the written scheme of examination.
- Comment on training and competence of boiler attendants.

Boiler Attendant

A person who operates the boiler and/or carries out the required tests. The boiler attendant must:

- Be competent and adequately trained for all the duties to be performed at each specific site and recognise when the limits of their own expertise are reached and when to call for assistance.
- Be present when the boiler is started up from cold and remain with the boiler until it is at working pressure/temperature. Observe boiler manufacturer's recommendations with regard to warming through from cold boiler conditions. Carry out functional tests of all limiters and controls before the boiler is left unattended.
- Carry out all functional tests of limiters and controls at the frequencies required by this guidance.
- Check burner and associated equipment
- Maintain records of all tests of all limiters and controls

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- Respond to alarms and take appropriate action
- Carry out the recommended water quality tests, routine water treatment and record the results in a competent manner, and make adjustments in accordance with BS 2486:1997 or equivalent.

PERSONNEL MONITORING BOILER ALARMS FROM REMOTE LOCATIONS

Should be trained to take the appropriate action as considered necessary from the risk assessment in the event of a specified alarm condition before calling for the assistance of a trained boiler attendant.

MAINTENANCE PERSONNEL

Manufacturers of boilers, fittings and control equipment usually provide maintenance services and may provide training courses for maintenance personnel. Personnel carrying out maintenance on all controls and limiters should be capable of carrying out the work and be suitably trained. Safety of all personnel and the safe use of equipment is vital

- All maintenance should be carried out in accordance with specified maintenance procedures. The use of a method statement and permits to work are recommended.
- Plant should be maintained in a safe condition.

Owner/User

Should have a **safe system of work** in place including:

- Carrying out a risk assessment in accordance with appropriate regulations.
- Ensuring the controls and limiters do not lead to conditions that give rise to danger.
- Consulting a competent person before carrying out modifications or repairs that effect the operation of controls or protective devices.
- Maintaining records of design, construction repair and modification.
- Provision of adequate training and instructions to employees commensurate with the risk assessment.
Ensuring suitable maintenance, water treatment and relevant tests are carried out and check that records are maintained.
- Appointing a responsible person.

Responsible Person

Should undertake the following:

- Manage the boiler plant in a safe manner
- Vent and ensure that all tests are carried out satisfactorily
- Inspect and countersign records of boiler tests on at least a weekly basis

FEED WATER SPECIALIST

Persons who provide consultancy services on feed water quality and water treatment.

4. TRAINING

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All personnel involved in the operation of a boilerhouse should receive appropriate documented training to ensure they have sufficient knowledge to undertake their duties in a safe manner. The level of training will be dependent upon the duties an individual will perform either as a part of normal duties or under exceptional circumstances.

Training should be viewed as an on-going process and, following successful initial training, periodic updating should be undertaken. Generally personnel should receive re-training every 2 years and after any significant modifications to the boiler or steam system. Relevant training records should be maintained and should include details of content and results of courses.

Generic training courses can be used to provide the required knowledge but all training courses should involve site specific elements. As a minimum, a course should cover the following topics:

- Boiler operation
- Boiler start-up and shut-down
- Actions to be taken in an emergency
- Boiler and burner controls taking account of the fuel(s) used
- Boiler and burner failure modes
- Feed water analysis
- Consequences of inappropriate actions
- Responsibilities of all parties involved
- Legal aspects
- Drainage - water hammer
- Site specific training
- Documented written examination on completion of course

The effectiveness of training should be assessed by regular work audits of all personnel. The audits should be completed by persons who are competent in the operation of boiler plant and records should be maintained.

Proof of training may be required to be viewed by Enforcing Authorities.

5. RISK ASSESSMENT AND BOILER CONTROLS

Types of Control and Manning Level

Risk Assessment should be carried out for each boiler and site to determine appropriate types of controls and site manning levels so that the risks of an explosion or other serious incident are minimized. The choice of types of controls may also be affected by the standards of maintenance and testing regimes as well as the competency of attendants.

For guidance, 4 suggested arrangements are detailed within this section. These take account of both the standard of the equipment fitted to the boiler and the level of Supervision.

Arrangement 3- is the highest level of automation requiring the greatest degree of confidence in the boiler controls and equipment. This level permits the lowest degree of supervision and facilitates a completely unmanned site with status monitoring by a remote telemetry system where appropriate.

Arrangement 2- permits an unmanned boilerhouse with critical alarms monitored on site by a remote panel located in a manned area such as a gatehouse. The person monitoring the alarms should be trained to ensure that the plant is in a safe condition before notifying a boiler attendant.

Arrangement 1- is the lowest level of automation. This level requires a boiler attendant to be on site at all times that the boiler is operating

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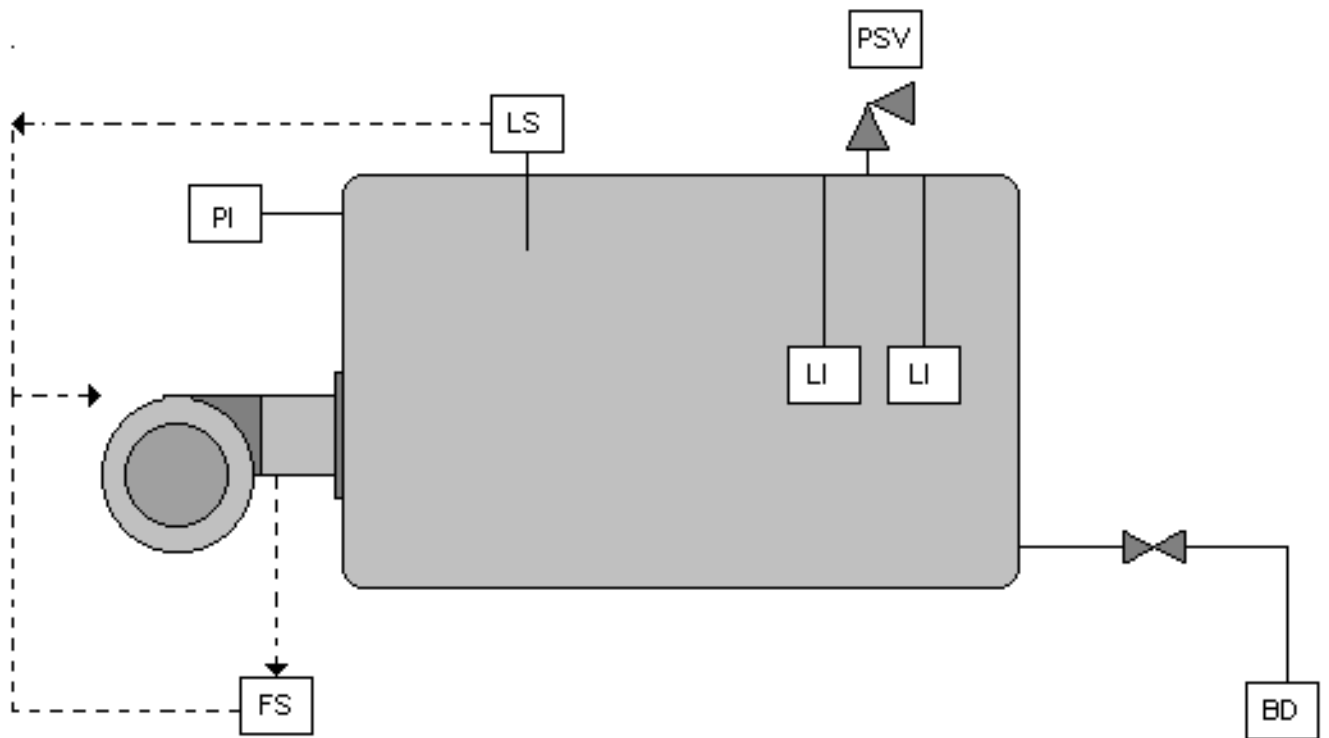
to respond immediately to alarm conditions.

Arrangement 0, - manual operation, is included for the few boilers without automation of firing and water level controls.

Typical applications of these arrangements are given on the following pages:

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MANUAL OPERATION – ARRANGEMENT 0

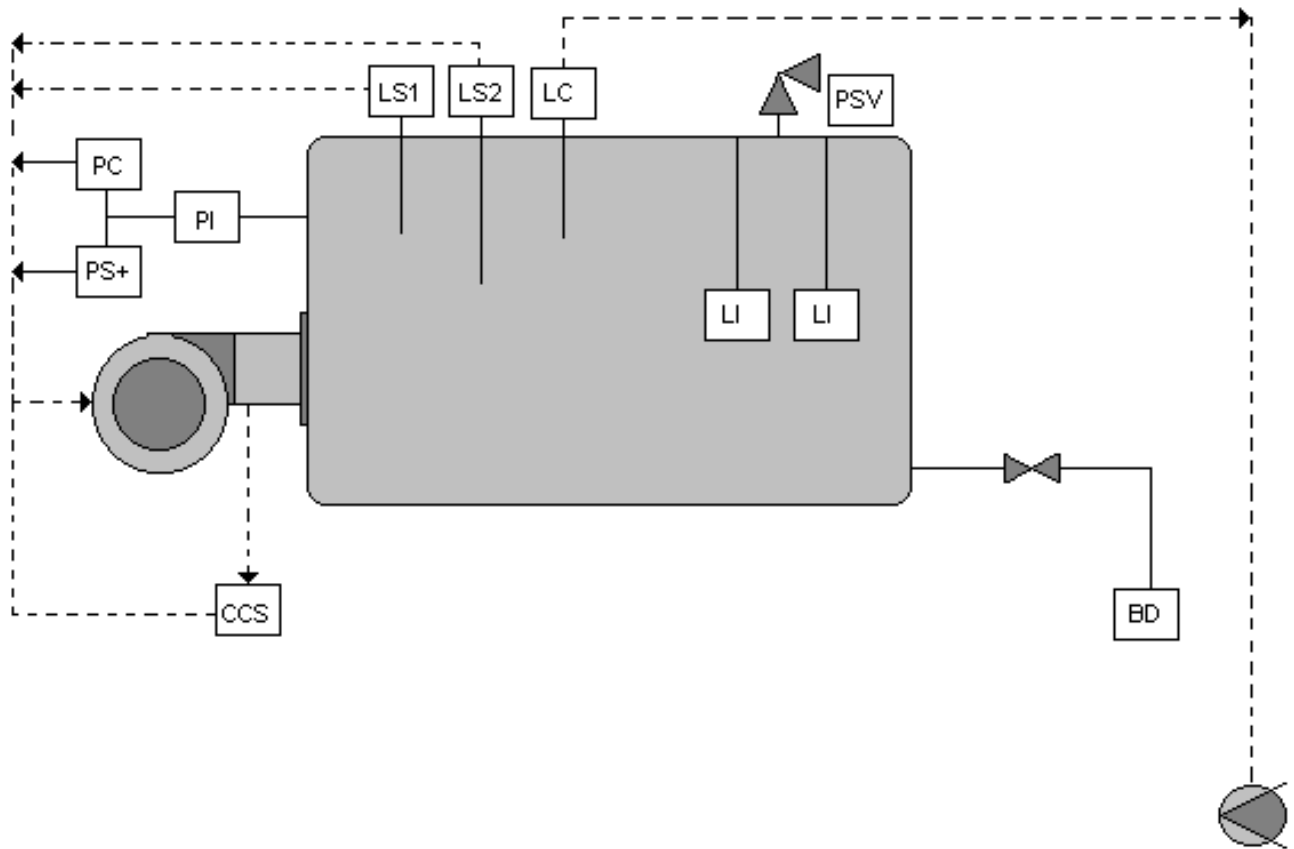


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COMPONENT	ITEM	DEVICE OR LIMITER	INTEGRITY
Water Level	LS	Low water level alarm or limiter	Standard
	LI	Level indicator gauge glass	
Firing/combustion	FS	Flame failure lock-out device where fitted	Standard
Pressure	PI	Pressure indicator	
	PSV	Pressure safety valve	
Water Treatment	BD	Manual blowdown system	
Supervision		Continuous supervision by a boiler attendant who is within sight of the pressure gauge and water level gauge at all times	
Testing	The low water level device or limiter should be manually tested at a minimum frequency of once per working day or in the case of shift work at the start of each shift		

ARRANGEMENT 1

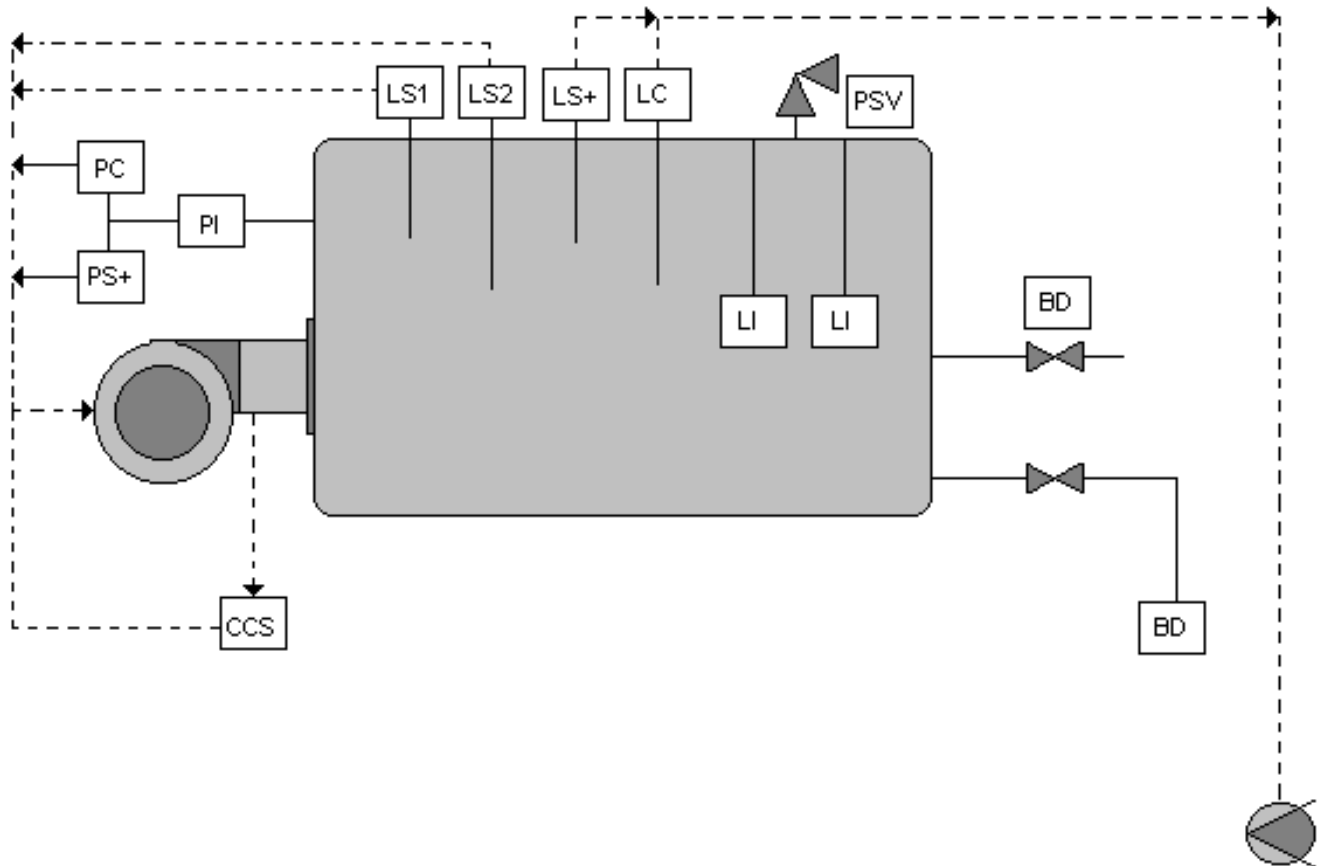
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COMPONENT	ITEM	DEVICE OR LIMITER	INTEGRITY
Water level	LC	Automatic water level control either by stop/start of the feed pump, or by modulating level control	Standard
	LS	Low water level device to cut out burner	Standard
	LS	Independent low water level limiter and burner lock-out	Standard
	LI	Level indicator	
Firing/combustion	CCS	Combustion control system	Standard
Pressure	PI	Pressure indicator	
	PC	Pressure control either by burner stop/start. High fire/low fire/stop, or modulating control	Standard
	PS+	High-pressure cut-out set below safety valve setting	Standard
	PSV	Pressure Safety Valve	
Water treatment	BD	Manual blowdown systems	Standard
Supervision		Boiler Attendant on site at all times that the boiler is operational and who can respond to alarms immediately	Standard
Testing		The low water level cut-outs and limiters (whether externally or directly mounted) should be manually tested at a minimum frequency of once per working day or in the case of shift working at the start of each shift. A test by lowering the water level should be performed at least once per week. This test should be done by evaporation.	

ARRANGEMENT 2

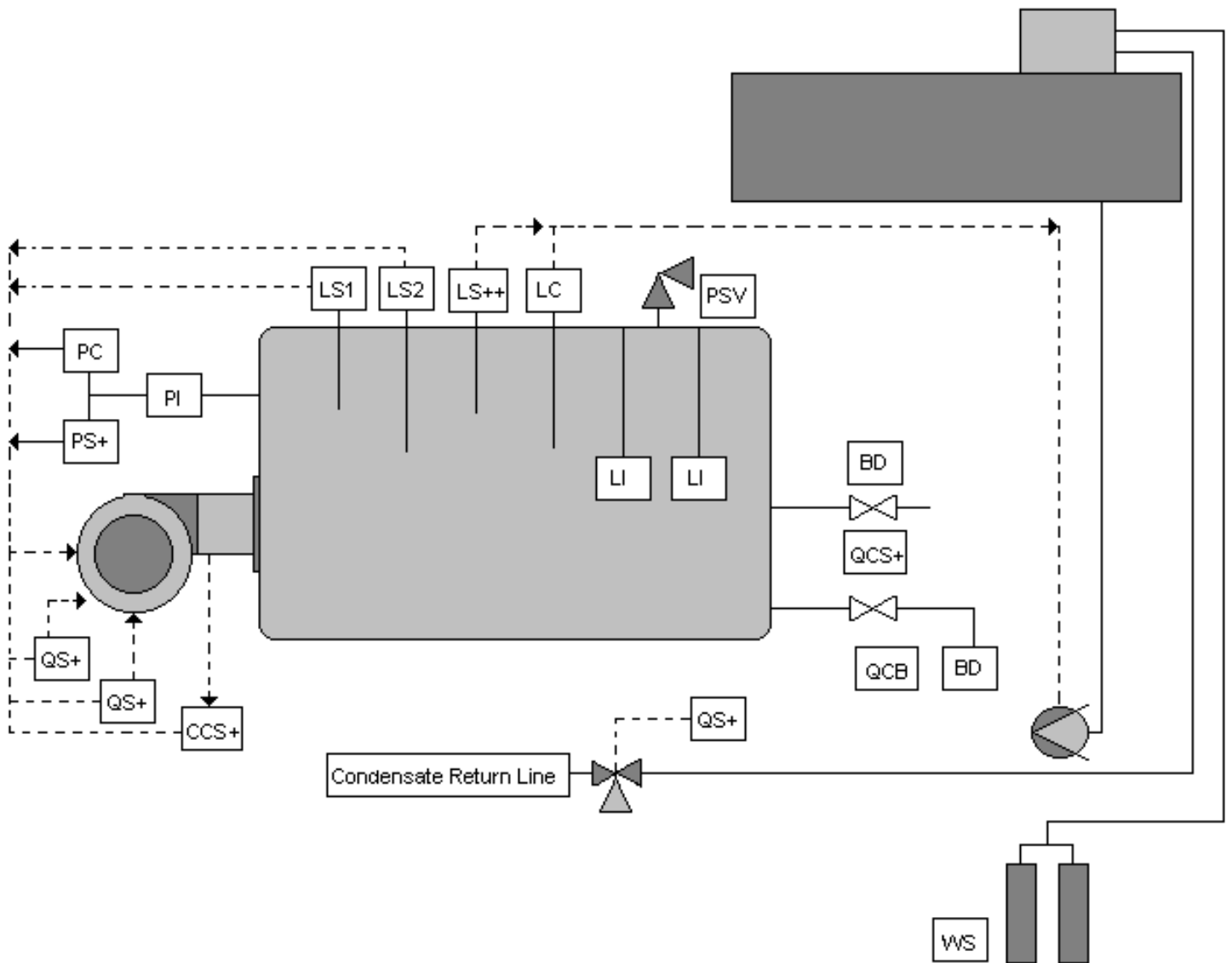
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COMPONENT	ITEM	DEVICE OR LIMITER	INTEGRITY
Water level	LC	Automatic water level control either by stop/start of the feed pump, or by modulating level control	Standard
	LS	Low water level device to cut out burner	Standard
	LS	Independent low water level limiter and burner lock-out	Standard
	LS	High-level water control device or alarm	
	LI	Level indicator	
Firing/combustion	CCS	Combustion control system	Standard
Pressure	PI	Pressure indicator	
	PC	Pressure control either by burner stop/start. High fire/low fire/stop, or modulating control	Standard
	PS+	High-pressure cut-out set below safety valve setting	Standard
	PSV	Pressure Safety Valve	
Water treatment	BD	Manual blowdown systems	Standard
Supervision	Check at maximum intervals of 24hours by a boiler attendant. Person on site at all times that the boiler is in operation who is capable of responding to alarms and as a minimum can ensure that the boiler is in a safe condition and notify a boiler attendant of the alarm condition.		
Testing	External water level controls and limiters shall be tested once per day or in the case of shift working at the start of each shift. A test by lowering the water level should be performed at least once per week. This test should be done by evaporation. Internal controls should be tested weekly.		

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ARRANGEMENT 3



Key overleaf...

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COMPONENT	ITEM	DEVICE OR LIMITER	INTEGRITY
Water level	LC	Automatic water level control either by stop/start of the feed pump, or by modulating level control	Standard
	LS	Self monitoring low water level device to cut out burner	High
	LS	Independent self-monitoring low level water limiter and burner lock-out	High
	LS++	High water level alarm with feed water isolation	Standard
	LI	Level indicator	
Firing/combustion	CCS+	Combustion control system	High
	XZS	On oil fired installations consideration should be given to fitting dual skinned flexible fuel lines for use > 20BarG. On gas fired installations consideration should be given to fitting a gas detector system which is alarmed and will shut down the gas supply.	
	FDS	Consideration should be given to fitting a fire detection system	
Pressure	PC	Pressure control either by burner stop/start. High fire/low fire/stop, or modulating control	Standard
	PS+	High-pressure cut-out set below safety valve setting	Standard
	PI	Pressure indicator	
	PSV	Pressure Safety Valve	
Water treatment	WS	Automatic water treatment	Standard
	BD	Manual blowdown systems	
	QS+	Automatic continuous monitoring of feed water for intrusion of grease, oil or other contaminants where there is such a risk	Standard
	QCS+	Constant monitoring of TDS with automatic top blowdown system. Alarm to shut down system at predetermined level	Standard
	QCB	Automatic time-controlled bottom blowdown system.	Standard
Electrical	EE	Electrical equipment	High
Supervision	<p>Check at maximum intervals of 24 hours by a boiler attendant. This may be extended where justified by further risk assessment. Alarms relating to limiter devices to be continuously monitored by a person who is capable of responding to the alarm, and as a minimum, can ensure that the boiler is in a safe condition.</p> <p>Monitoring may be from a remote panel and shutdown may be achieved by the use of remote switching hard wired to the main boiler control panel.</p> <p>Offsite monitoring of the status of boilers and alarms can be achieved using suitable communication systems. A boiler attendant must check the boiler before a lockout condition is locally reset.</p>		
Testing	<p>The water level controls, cut-outs and limiters should be tested following start up of the boiler from cold and thereafter at weekly intervals by lowering the water level.</p> <p>The weekly test period may be extended following satisfactory risk assessment.</p>		

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6. COMPONENTS

This section details the components for each of the arrangements in section 5. When assessing the suitability of propriety items it is important that relevant standards and regulations are taken into account.

6.1 Pressure Devices

Pressure Indicator (P1) - Each boiler shall be fitted with a suitable steam pressure gauge. The range of the gauge should exceed the maximum working pressure by at least 25% and the maximum allowable pressure should be clearly marked on the gauge.

Safety Valve PSV - Each boiler shall have at least one safety valve sized for the rated output of the boiler- The rated discharge capacity shall be at least equal to the maximum evaporative capacity of the boiler and this capacity should be achieved without causing the boiler pressure to increase to more than 110% of the set pressure.

There should be no intervening valves between the boiler and its protective safety valves or between the safety valve and its point of discharge to atmosphere.

6.2 Water Devices

Water Level control, cut-out mid limiting devices (LS, LS1, LS2)

The cut-out and limiting devices should be tilted in separate chambers or protection tubes. The safety of the boiler is determined by the control, cut-out and limiting devices fitted to it, and the manner in which it is supervised. Information on supervision is given in section 5 of this guidance

The following general requirements have been established to ensure uniform assessment of different water limiter devices:

► **Standard integrity limiters mid cut-outs** shall function independently of each other. Limiters and cut-outs may however, share common components (e.g., power supplies, bus systems, circuit boards, etc) provided that no adverse safety effect can occur from other faults in other limiters or related equipment.

► **High integrity limiters and cut-outs** shall comply with the above bullet point and be off fail-safe design so that a single fault in any related part does not lead to a loss of the safety function. This may be achieved by fault avoidance techniques, self monitoring, redundancy, diversity or the combination of these methods.

► **The 2nd low level limiter** shall operate in such a way that once it has been activated and sent the appropriate signals to cut off the heat supply, manual resetting is required after the water level has been restored to a safe level and all possible causes of the alarm have been corrected.

► **Internal protection tubes and external chambers** shall be designed to allow free movement of the water level to equalize with the level in the boiler.

► **Where controls, cut-outs and limiters are mounted in external chambers** it is necessary to blow down, these chambers and connecting pipes at least once in 24 hours. Blow down can either be performed automatically or manually. Self monitoring limiters mounted in external chambers should be fitted with automatic sequencing blowdown valves in order to be deemed to be self monitoring. These automatic valves must perform a routine test at maximum intervals of 12 hours.

► **Isolation of boiler level control chambers** whilst the boiler is operating should only be permitted under carefully controlled conditions. This should only be undertaken under expert supervision with appropriate precautions and written procedures. Isolating valves must be locked in the open position during normal operation or be of the type which cannot accidentally be left in the closed position-

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▶ **Drains from control chambers and water gauges** may be combined, but should be run independently from the main blowdown pipe to the blowdown vessel.

▶ **The use of sight glasses** in control chamber drain lines is not recommended as the sudden breakage of an unprotected sight glass is potentially dangerous.

▶ **Float devices.** Strict control should be maintained over water quality to avoid problems with sticking floats and sludge. The float should be guided and should be able to move freely.

▶ **Level Electrode Devices.** Strict control should be maintained over water quality to avoid foaming and coating of electrodes. The level electrodes should be designed, positioned, installed and protected in such a way that foam and turbulence of the boiler water do not affect their proper functioning. The minimum recommended distance between measuring electrodes to earth and to each other inside the pressure part shall be 14mm.

▶ **Limiters or cut-out electrode.** Only one limiter or cut-out electrode is permitted to be installed within a protection tube or external chamber. It is acceptable however, to install additional devices for control and other alarm functions

Water Level Control Device (LC)

Water level control can be either of the probe or float type, designed to hold the water level within specified parameters. This can be achieved by a number of methods including on/off control of the feedpump or modulating a control valve between the feedpump and boiler.

High Water Level Control Device or Alarm (LS+)

This can be incorporated on to the water level control device or can be a separate device. A risk assessment should be carried out to determine what action is required of this device when operated.

High Water Level Alarm (LS++)

This should be a separate device. Upon activation this device should at least ensure that the feedwater supply is isolated from the boiler

Level(Indicator (LI)

Each steam boiler rated over 145 kg/h should have a minimum of two independent means of indicating the water level. At least one of which should be a direct mounted gauge glass. The gauge shall be mounted so that the water level is visible in the gauge glass at the lowest and the maximum water levels. A suitable alternative device which indicates the water level can be used in place of a second gauge glass.

6.3 COMBUSTION SYSTEMS

Combustion Control System (CCS)

The control system will incorporate the following:

- ▶ Ignition flame, main flame detection and safety system
- ▶ Forced draught and induced draught fan proving systems as applicable
- ▶ Air and flue damper position proving systems as applicable

Combustion Control System(CCS+)

These high integrity systems should comply with CCS above but

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should also incorporate self checking systems monitoring flame detectors and the correct ratios of fuel and air. Unsafe fuel air ratios shall cause lock-out. Self checking flame safeguards may not be needed if the burner progresses through a restart on a daily basis

6.4 Burner Controls

Burner controls are required to ensure safe, efficient, environmentally acceptable operation at all times. Gas and liquid fuel burners and control systems are in use with levels of safety suitable for most applications. They incorporate burner management systems which control purge time, ignition, fuel/air ratio, modulation and flame monitoring.

The control of the ratio of fuel to air may be by mechanical, electronic or pneumatic means and is designed to maintain levels of excess air and carbon monoxide within the range required for safe operation of the plant. Generally micro-switches and pressure switches prove actuation of valves and dampers and operation of the combustion air fan.

These burner control systems incorporate a significant level of intrinsic safety. However, where boiler plant is not frequently attended and the burner inspected on a regular basis by a trained boiler attendant a fuel/air ratio monitoring system with integral shut down and alarm circuits should be considered. Flue gas analysis, direct or inferential fuel and air volume measurement systems may be used.

Correctly installed and maintained, fuel/air trim systems can provide additional safety as well as reducing operating costs by optimising the combustion efficiency. Emissions can also be reduced by these systems. Deviation from safe operating conditions will lead to lock-out and this should initiate a defined alarm condition.

A risk assessment of the operation of the plant and manning levels as well as plant design and maintenance regimes will determine the appropriate burner control integrity level which should be applied.

The following should be taken into account when a fuel/air limiter is to be fitted:

- One safety circuit should be provided per burner/furnace.
- On boilers with two or more furnaces, flue gas analysis should not be used as the monitoring technique unless the monitoring points are taken before flue gases from the separate furnaces converge.
- Where flue gas analysis is inappropriate or a higher integrity monitoring is required, direct or inferential measurement of the volume of air and fuel delivered to the burner may be considered

6.5 Water Quality Systems

Feedwater and Condensate Monitoring (QS+)

The importance of monitoring feedwater cannot be over emphasized. Feedwater provided to boilers should be in accordance with the boiler manufacturer's instructions and BS 2486: 1997 "Treatment of water for steam boilers and water heaters" in order to maintain correct internal water conditions.

Monitoring systems should align to the type of installation, the integrity of control systems the frequency of supervision and the risk of contamination. Depending on the integrity of the boiler system, boiler feedwater and condensate returns should be tested at least once per day and ion exchange systems should be tested three times a day. An adequate temperature should be maintained in the hotwell keeping dissolved oxygen to a minimum and reducing corrosion potential.

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Testing of feedwater (both condensate return and make-up water) may be automated where risk assessment can justify the adequacy of monitoring and test equipment. Where automated monitoring is used with less frequent supervision a high level of equipment integrity is essential, and it must fail to safety whilst calling for manual intervention.

For automated monitoring at unattended sites it may be necessary for the system to dump unsuitable feed water/condensate and then to lock-out, suspending boiler operations, if either supply remains inadequate, the equipment itself becomes defective or manual response is not made within a specified period of alarms being sent.

All manual water condition tests and checks of automated equipment must be recorded on log sheets.

Boiler water condition monitoring and Adjustments (WS)

The condition of the water in the boiler should be maintained within the limits specified by the boiler manufacturer and BS 2486: 1997 for the type of boiler.

This can be best accomplished by adherence to a site specific boiler water monitoring, testing and maintenance regime in conjunction with feedwater/condensate monitoring and adjustment.

Monitoring and testing can be done by daily manual testing, or for systems using less frequent supervision automated equipment can be used.

Adjustments should be made to maintain the internal treatment to:

- Prevent hard water sealing
- Condition suspended matter to prevent its adherence to boiler internals
- Eliminate oxygen from feedwater - thus helping prevent boiler internal corrosion
- Maintain alkalinity to reduce oxygen potential and reduce corrosion
- Provide protection against priming and foaming and tolerance to suspended and dissolved solids

The suspended solids can then be kept within specified limits by either manual or automated equipment to effect boiler blowdown.

Blowdown Systems (BD, QCB, QCS+)

Water quality in a boiler is of fundamental importance; it is therefore essential that systems are installed that will control the level of dissolved and suspended solids in boiler water. These systems can either be manual or automatic, depending on the safety level of the operation of the boiler.

Total Dissolved Solids (TDS) or top blowdown systems control the level of TDS in the boiler. Automatic systems will monitor the level of TDS within the boiler and blow down the boiler to maintain the boiler manufacturer's recommended levels. An alarm function may also be incorporated which operates when an excessively high TDS level is detected.

Bottom Blowdown systems are designed to remove solids/sludge from the bottom of the boiler and it is essential that this procedure be carried out on a regular basis, either manually or automatically. Automatic systems should prevent more than one boiler blowing down at a time and alarm function to indicate if the valve fails to open or close.

6.6 ALARMS

There have been many incidents where low water alarms have sounded a warning but have been so situated that the person responsible did not hear them. When a boiler is not continuously supervised it is not enough to have an alarm on the boiler.

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Alarms must be provided at points where persons who are competent to take appropriate action can hear them. Alarms that also give visible warning may in certain locations, be more acceptable. Remote alarm panels should provide sufficient information to determine which boiler(s) are in operation or alarm condition and, where appropriate, an emergency stop facility.

6.7 COMMUNICATIONS

Communications systems for alerting boiler attendants to alarm conditions on the boiler need to provide a similar level of integrity as the boiler controls themselves. The need for a rapid response to investigate and rectify alarm conditions from a safety point of view must be taken into account when the type and design of the communication system is determined.

For boilers with a control arrangement 1 or 2 (see section 5) it is essential that alarm conditions are brought to the attention of the boiler attendant by a reliable communications system that has been validated for safety applications. This will enable checks to be made that the boiler has shut down properly. The communications system should be tested for correct functioning whenever the boiler controls are tested. The boiler attendant should ensure that he always stays within range of the communication system and that the alarm signal will, if activated, gain his attention particularly in noisy or bright surroundings. He should also ensure that he can attend the boiler in a reasonable time following an alarm.

It may be necessary to have a duplicate or parallel communication systems to ensure that alarm situations are still recognised even when one component has failed. The system should not rely on a single telephone or pager to alert the boiler attendant.

For offsite monitoring of boilers, the control system detailed in arrangement 3 of section 5 is recommended. The communication system should ensure that the boiler is attended before it is reset locally following a lockout condition. Communication systems can be used for monitoring the status of boilers and alarms, but should not be used for controlling the operation of the plant.

Where the safety of a boiler plant relies on an effective communication system, failure of that system should automatically shut down the boilers

7. TESTING OF WATER LEVEL AND RELATED CONTROLS

It is strongly emphasised that the safe operation of an automatically controlled boiler depends on the correct functioning of its water level limiters and firing controls. Such limiters and controls should be regularly tested to ensure this with due consideration to the arrangement of the boiler equipment and supervision as suggested in Section 5 of this guidance. The frequency with which tests must be performed is related to the type of controls fitted to the boiler. Arrangement 1 relates to the lowest level of automatic and safety equipment, requiring the maximum level of supervision and manual testing. Arrangement 3 relates to the highest level of automatic and safety equipment, therefore requiring a lower level of attendance and testing.

AT NO TIME DURING A TEST SHOULD THE WATER BE LOWERED TO THE EXTENT THAT IT DISSAPPEARS FROM THE GAUGE GLASS.

Instructions for the operation and testing of all controls and safety devices should be prominently displayed in the boilerhouse. The test programme and sequence should be carried out strictly in accordance with the manufacturers instructions.

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7.1 MANUAL OPERATING TESTING

The following tests should be carried out by a trained boiler attendant who is familiar with the boiler controls:

▶ **Externally Mounted Water Level Controls**

These tests must always be performed at start-up of the boiler. They may also require to be carried out daily or at the beginning of each shift.

Procedure for test:

▶ With the level chamber drained, check that the feed water is being automatically supplied to the boiler.

▶ With the burner operating, check that, on draining the chamber, the alarm sounds and the fuel and/or air supply is cut off

Note that the water level control and first low water alarm are often in the same chamber and if so, the two will be checked simultaneously.

▶ Independent overriding control (Second low level limiter) - With the burner operating, check that on draining the water chamber the alarm sounds and the fuel and/or air supply is cut off and lock-out occurs. Lock-out should be verified by restoring water to normal level before pressing the reset button to ensure that an automatic restart does not occur.

▶ **Directly Mounted WaterLevel Controls**

These tests must always be performed at start-up of the boiler. They may also require to be carried out daily or at the beginning of each shift. Unless special equipment is provided for testing directly mounted controls they should be tested by an evaporation test as described below

7.2 EVAPORATION TEST

The following test should be carried out by suitably trained personnel. The test should normally be carried out weekly although the test period may be extended following satisfactory risk assessment.

▶ The feed water should be manually interrupted and the water level in the boiler lowered by evaporation, until first low water level is reached. Check that the alarm sounds and that the fuel and/or air supply is cut off

▶ The independent overriding low water control (second low level limiter) should be checked by continuing to lower the water level by controlled blowing down of the boiler until the alarm sounds and the fuel and/or air supply locks out. Lock out should be verified by restoring water to normal level before pressing the reset button to ensure that an automatic restart does not occur.

7.3 HIGH LEVEL ALARM TEST

The following test should be carried out by a trained boiler attendant or technician who is familiar with the boiler controls. The frequency of test should be appropriate for the type of controls fitted and should take account of the consequences of failure of the high level alarm function.

- Shut boiler main steam stop valve(s).
- Raise water level in the boiler until the first high water level alarm operates.
- Check that the alarm is operating with the water level still

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- visible in the gauge glass.
- Check that the control action associated with the high water alarm function has occurred
- Open steam valve(s). Reset burner lockout.
- Check feed water valve is operating automatically, or that the pump on/off level control system is operating automatically.
- Check that all alarms have been cleared when normal water level has been restored.

7.4 COMPLETION OF TESTS

After carrying out any or all of the above tests, the person responsible for them should ensure that the water level is restored and that all valves are in the correct operating position. The boiler should not be left until the person carrying out the test is satisfied that it is operating correctly.

7.5 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. A testing regime that ensures that the controls and trips can operate but does not actually trip out the plant except under controlled conditions should be established

7.6 COMBUSTION CHECKS

Daily combustion checks should be carried out. Certain checks such as visual flame examination or furnace inspection may not be possible or practicable on some designs of boiler so an alternative check such as a CO test may be required. All checks should be recorded on the log sheet and admissible limit data should be readily available. Suitably qualified persons should investigate any problems and take corrective action.

All daily, weekly and monthly manufacturer's recommended checks should be carried out with special attention to:

- Check photocell operation and record by removing cell whilst the burner is firing, prove lock-out, and manually reset. Or a continuous process a self-checking photocell should be used.
- Check correct operation of forced ventilation and/or ensure natural ventilation is unobstructed.

Fuel leak checks

- **Gas.** If any significant gas leak is suspected shut down plant immediately and report 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.

On dual fuel installations the stand-by fuel should be tested frequently.

8 MAINTENANCE, REPAIR AND MODIFICATION

8.1 MAINTENANCE

The importance of adequate maintenance on boiler control and alarm systems cannot be over emphasized. Responsibility can be divided between those who own and operate the boiler house and those who maintain it. As this can be different in each case it is imperative that

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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:

- Only original or equivalent quality spares should be used.
- Boiler attendants must 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 attendant in the presence of the maintenance personnel before the boiler is placed on line.

8.2 MODIFICATIONS & REPAIRS

It may be necessary to carry out modifications or repairs to the boiler and burner control and alarm systems. Significant modifications and repairs, where they affect integrity and/or safety of the system, its controls and software, should be properly considered and the competent person should be kept fully informed of proposals.

9 RECORDS

The following records should be kept on site or at a designated central location and be available for scrutiny by the competent person, responsible person or other interested parties:

- Examination reports
- Record of periodic tests
- Written scheme of examination
- Records of servicing, repairs and modifications
- Maintenance of controls
- Training records for boiler attendants
- Audit reports for boiler attendants
- Test log
- Water treatment records

10 REFERENCES

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

- ▶ The Pressure Systems Safety Regulations 2000 (SI 2000 No 128)
 - ▶ Pressure Systems and Transportable Gas Containers Rules (Northern Ireland) 1991. No 471.
 - ▶ Health and Safety at Work etc. Act 1974
 - ▶ BS 2486 1997 Recommendations for treatment of water for land boilers
 - ▶ BS EN 676: 1997 Automatic Forced Draught Burners for Gaseous Fuels.
 - ▶ BS EN 746: 1997 Part 2 safety requirements for Combustion and Fuel Handling Systems.
 - ▶ BS EN 298: 1994 Automatic Gas burners control systems for gas burners and gas burning appliances with or without fans.
- BS 799: Part 4: 1991 Specifications for atomising burners (other than monobloc type) together with associated equipment for single burner & multi-burner installations.
- ▶ DIN VDE 0116 Testing of burner management systems.
 - ▶ DIN 4787 Part 2. Type testing of Flame monitors.
 - ▶ DIN 4788 Part 3. Type testing of Flame monitors.

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