

BS EN 12953-6:2011



BSI Standards Publication

Shell Boilers

Part 6: Requirements for equipment for the boiler

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National foreword

This British Standard is the UK implementation of EN 12953-6:2011. It supersedes BS EN 12953-6:2002 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PVE/2, Water Tube And Shell Boilers.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Foreword

This document (EN 12953-6:2011) has been prepared by Technical Committee CEN/TC 269 “Shell and water-tube boilers”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2011, and conflicting national standards shall be withdrawn at the latest by August 2011.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12953-6:2002.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

Annex F provides details of significant technical changes between this European Standard and the previous edition.

The European Standard EN 12953 concerning shell boilers consists of the following parts:

- *Part 1: General*
- *Part 2: Materials for pressure parts of boilers and accessories*
- *Part 3: Design and calculation for pressure parts*
- *Part 4: Workmanship and construction of pressure parts of the boiler*
- *Part 5: Inspection during construction, documentation and marking of pressure parts of the boiler*
- *Part 6: Requirements for equipment for the boiler*
- *Part 7: Requirements for firing systems for liquid and gaseous fuels for the boiler*
- *Part 8: Requirements for safeguards against excessive pressure*
- *Part 9: Requirements for limiting devices of the boiler and accessories*
- *Part 10: Requirements for boiler feedwater and boiler water quality*
- *Part 11: Acceptance tests*
- *Part 12: Requirements for firing systems for solid fuels for the boiler*
- *Part 13: Operating instructions*

CR 12953-14: *Guidelines for the involvement of an inspection body independent of the manufacturer.*

Although these parts can be obtained separately, it should be recognized that the parts are inter-dependent. As such, the design and manufacture of shell boilers requires the application of more than one part in order for the requirements of the standard to be satisfactorily fulfilled.

For any questions arising when using these standards the Boiler Helpdesk of CEN/TC 269 may be contacted:

<http://www.boiler-helpdesk.din.de>

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This part of this European Standard specifies the minimum requirements for safety related equipment for shell boilers as defined in EN 12953-1, to ensure the boiler operates within the allowable limits (pressure, temperature, etc.) and if the limits are exceeded the energy supply shall be interrupted and locked out without manual (human) intervention at the boiler.

NOTE 1 The maximum time of operation without manual (human) intervention should be defined for each boiler system.

NOTE 2 Annex C (informative) gives recommendations of operation and testing of the boiler system with a maximum time of operation without manual (human) intervention of 72 hours.

2 Normative references

The following referenced documents are indispensable for the application of this European Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12953-1:2002, *Shell boilers — Part 1: General*

EN 12953-2:2002, *Shell boilers — Part 2: Materials for pressure parts of boilers and accessories*

EN 12953-7:2002, *Shell boilers — Part 7: Requirements for firing systems for liquid and gaseous fuels for the boilers*

EN 12953-8:2001, *Shell boilers — Part 8: Requirements for safeguards against excessive pressure*

EN 12953-9:2007, *Shell boilers — Part 9: Requirements for limiting devices of the boiler and accessories*

EN 12953-10:2003, *Shell boilers — Part 10: Requirements for feedwater and boiler water quality*

EN 12953-12:2003, *Shell boilers — Part 12: Requirements for grate firing systems for solid fuels for the boiler*

EN 50156-1:2004, *Electrical equipment for furnaces and ancillary equipment — Part 1: Requirements for application design and installation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12953-1:2002 and the following apply.

3.1 controls

devices used for maintaining the variable to be controlled (pressure, temperature, etc.) at a specific value (set point)

3.2 limiter

limiting device that, on reaching a fixed value (pressure, temperature, etc.) is used to interrupt and lock-out the energy supply and requires manual unlocking before restart

limiting device requires:

— measuring or detection function, and

— activation function for correction, or shutdown, or shutdown and lockout,

and which is used to carry out safety related functions as defined in the Pressure Equipment Directive "PED" 97/23/EC [1], either on its own or as part of a protective system (e.g. sensors, limiters, etc.) (see also Figure 1)

NOTE 1 If this is achieved by multi channel systems, then all items or limiters for safety purposes are included within the protective system.

NOTE 2 Manual resetting can be realised as a part of the limiter or as a part of the safety logic. This will be achieved by the responsible operator taking into account of the physical situation.

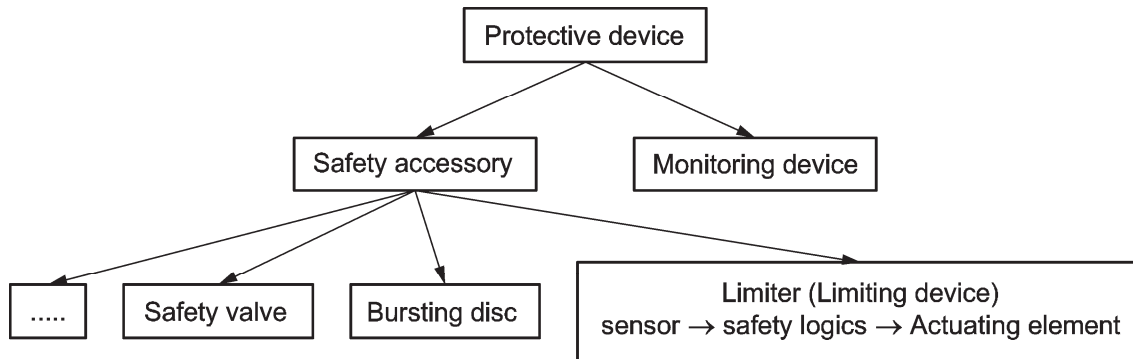


Figure 1 — Protective devices and safety accessories according to PED 97/23/EC

3.3 independent

ability to function as required without dependence upon other equipment

3.4 lock-out

safety shut-down condition of the protective system, 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

3.5 functional check

testing of the safety device to ensure it performs its intended function

3.6 electrically heated steam boilers

steam boilers in which water is heated by an electric current flowing between electrodes or by immersion heaters

3.7 electrically heated hot water boilers

hot water boilers in which water is heated by an electric current flowing between electrodes or by immersion heaters

3.8 expansion vessels

containers to compensate for temperature dependent changes in water volume

— closed expansion vessels are pressurised

— open expansion vessels are vented to atmospheric pressure and are not pressurised

3.9

allowable heat output

maximum heat output (water mass flow times the difference between outlet and inlet enthalpy) that can be generated during continuous operation and at which hot water boilers can be operated

3.10

allowable flow temperature

highest temperature, measured at the outlet branch at which the hot water boiler can be operated (see 6.5.2.3)

3.11

maximum continuous rating (MCR)

maximum continuous steam output that can be generated during continuous operation taking the specified steam condition into consideration

3.12

internal steam cushion

steam filled space located within the steam boiler to accommodate changes in volume

3.13

external steam cushion

steam filled space located outside the steam boiler to accommodate changes in volume

3.14

gas cushion

gas-filled space to accommodate changes in volume

3.15

effective heat transfer

3.15.1

for a hot water boiler, the heat supply is on and flow of water is greater than or equal to a specified minimum value

3.15.2

for a steam boiler, the heat supply is on, the start-up or steam valve is open and the temperature is greater than the saturation temperature at ambient pressure

3.16

normal operation

automatic operation, with all regulating circuits and controls (open loops/closed loops) in automatic mode and with the set points and parameters valid for normal operation

NOTE Normal operation also includes the automatic switching on and off of the assigned actuators (e.g. burner).

3.17

normal shut down

controlled switch off of the boiler either operated manually or automatically

3.18

make-up water

water which compensates for losses of water and steam from the system

3.19

feedwater

mixture of returned condensate and/or make up water supplied to the boiler inlet

3.20

pressurization equipment

external system for keeping the hot water system pressure within the required pressure limits

NOTE In order to prevent corrosion caused by oxygen infiltration, systems that prevent the system water being in direct contact with air should be preferred.

3.21

boiler attendant

boiler operator

skilled person appointed for operating the boiler plant

4 General requirements for steam boilers and hot water boilers

4.1 Safeguards (safety valves) against excessive pressure

Each steam boiler and hot water boiler, except open vented hot water boiler, shall be equipped with safeguards (safety valves) against excessive pressure in accordance with EN 12953-8.

Superheaters and economizers shall be protected in accordance with EN 12953-8. Where a superheater or an economizer can be isolated a pressure gauge connection shall be provided.

4.2 Materials for valves, fittings, flanges and bolting

The conditions and requirements to select the material shall be in accordance with EN 12953-2.

4.3 Protective systems

4.3.1 All limiters and their installation shall be designed in accordance with EN 12953-9. The protective systems shall be in accordance with EN 50156-1.

4.3.2 The application design and installation of the electrical safety circuit as well as the electrical and control equipment for the heat supply and its auxiliary equipment shall be in accordance with EN 50156-1.

A hazard analysis shall be carried out for each limiting device function and appropriate levels of functional safety implemented.

NOTE 1 Typical Safety Integrity Level (SIL) requirements for boiler protective systems are not less than 2.

NOTE 2 It should be possible to stop the boiler by additional devices outside the boiler such as shut-off valve, emergency shut-off, fire detectors, etc.

4.3.3 Functional check of all limiters shall be possible at any time during operation e.g. by simulation where appropriate in accordance with manufacturer's operating instructions (see Clause 7).

4.3.4 When a limiter activates, information shall be given to indicate which limiter has activated.

4.3.5 After lock out, the steam boiler/hot water boiler shall be physically checked by the boiler attendant (operator), before start-up (see 4.4.2).

4.4 Heat supply

4.4.1 General

The requirements for heat supply to steam boilers and hot water boilers shall be in accordance with either EN 12953-7 or EN 12953-12 depending on fuel type.

The combustion process shall be completed within the furnace.

The heat supply shall be automatically controlled and in all operating stages rapidly adapted to the variation of the heat demand. Steam pressure influences heat demand of steam boilers and hot water boilers with internal steam cushion (see Figures A.3 and A.4). For other hot water boilers, heat demand is influenced by flow temperature (see Figures A.1 and A.2).

In the event of normal shutdown or lock out, residual heat accumulated in the furnace and flue-gas passes shall not cause unacceptable metal temperatures (e.g. by evaporation of the water) in the steam boiler/hot water boiler.

This requirement is fulfilled if it is proved that, after interruption of the heat supply from the full load steady state condition, the flue-gas temperature at the highest point of the heating surface (HHS) falls to below 400 °C before the water level has sunk from the lowest permissible water level (LWL) to 50 mm above the highest point of the heating surface (HHS).

For solid fuels it may be necessary that an additional automatic emergency cooling system shall be provided to ensure adequate cooling of the heating surfaces in case of a sudden loss of essential operational parameters (energy supply, feed water supply, combustion air or similar). The function of the emergency cooling system shall ensure that no adverse side effects can occur.

4.4.2 Start up

When a boiler is started-up after normal shutdown or lockout, the boiler attendant/operator shall be present and remain with the boiler until it is operating correctly under normal operation.

When designing the controls for the start up sequence, the manufacturer shall take account of effective heat transfer to avoid unacceptable local over heating or thermal stresses or other stresses of any pressurised parts of the boiler or parts connected to the boiler, with particular regard to the heating up sequence and flow rates. These controls may be in the form of installed control systems and/or software and/or operating instructions.

The start-up sequence shall consider as a minimum the following points which are to be defined by the manufacturer:

- lock out by i.e. limiters;
- minimum flow of water for hot water boilers to avoid over heating and to reach effective heat transfer;
- minimum temperature of water for hot water boilers to avoid corrosion;
- minimum temperature of critical parts of boilers to avoid unacceptable thermal stresses;
- steam output as a function of pressure of steam boilers to improve internal mixing (flow) and to avoid thermal stresses (effective heat transfer);
- sequence shall contain times (or pressures) and burner loads for a gentle start-up to avoid thermal stresses;
- additional heat supply requirements like i.e. maximum permitted low loads, minimum number of burner steps for stepped burner or minimum burner adjustment time between low and high load for infinitely variable burners.

4.4.3 Normal shut down

The control sequence designed for normal shutdown shall involve the low load position of heat supply before switching off the boiler.

4.5 Flue-gas heated economizers

Economizers shall be fitted with a temperature indicating device on the water outlet.

4.6 Drain and blowdown devices

4.6.1 Drain and blowdown equipment shall be installed to prevent accidents (see also Annex D).

4.6.2 Each steam boiler shall be fitted with drain lines placed at, or as near as practicable to, the lowest point of the steam boiler.

NOTE On some steam boilers, drain valves can be used for blowdown purposes.

4.6.3 Where lines from two or more steam boilers are connected to a common discharge, two valves shall be fitted to each drain line, one being of a non-return type to prevent the contents of one steam boiler passing to another.

4.6.4 The drain line between the steam boiler and the drain valve shall, if exposed to furnace heat, be protected by brickwork or other insulating material so arranged that the pipe may be inspected and is not constrained against expansion.

4.6.5 Taper-plug valves where fitted, shall be of the bolted cover type with separately packed glands and shall not be used with design pressures over 13 bar.

4.6.6 Where drain or the steam boiler blowdown valves are not self closing or capable of being locked in the closed position, a further shut-off device shall be installed in the line.

4.7 Water quality

4.7.1 The water quality shall be in accordance with EN 12953-10 and manufacturer's operating instructions.

4.7.2 It shall be possible at any time during operation to safely take reliable samples of the boiler water, feed-water, make-up water and if relevant the condensate and/or the recirculation water. Depending on the temperature of the media the samples shall be taken through one or more sample coolers.

4.8 Water quality protection

4.8.1 Steam boiler water

The boiler water conductivity shall be continuously monitored to ensure the water quality remains within the allowable limits prescribed by the manufacturer's operating instructions and EN 12953-10.

If the limit values prescribed by the manufacturer can be exceeded, an adequate suitable device shall automatically cut off and lock out the heat supply.

NOTE The device should comply with the general requirements for limiting devices in EN 12953-9:2007, Clause 4. In addition, the suitability of the device should be verified by type testing.

4.8.2 Condensate in steam boiler plants

A hazard analysis shall be carried out to identify if there is a risk that harmful matter (e.g. oil, grease, organic material, acid, lye, seawater, hardness etc.) can enter with the condensate into the feed water system and/or into the boiler that will compromise the safety of the boiler or the operation of the limiters within the period of operation without manual intervention.

NOTE If the intermediate circuit of a double circuit system is filled with softened water, it is not considered that there is a hazard that harmful matter may enter the system.

If it is assessed in the hazard analysis that harmful matter can enter the condensate return to the feed water system, adequate monitoring shall be installed which is able to detect the contamination. If the maximum concentrations of the harmful matter as set out by the hazard analysis can be exceeded, a suitable protection method shall be used. If the method of protection is a device, which automatically interrupts the supply of, or diverts, the contaminated water from the system, or ultimately cuts off and locks-out the heat supply to the boiler, then the device shall comply with the general requirements for limiting devices in EN 12953-9:2007, Clause 4.

The monitoring shall be continuous unless justified by hazard analysis.

4.8.3 Water circulating system in hot water boiler plants

A hazard analysis shall be carried out to identify if there is a risk that harmful matter (e.g. oil, grease, organic material, acid, lye, seawater, hardness etc.) can enter the water circulating system that will compromise the safety of the boiler or the operation of the limiters within the period of operation without manual intervention.

NOTE If the intermediate circuit of a double circuit system is filled with softened water, it is not considered that there is a hazard of harmful matter entering the system.

If it is assessed in the hazard analysis that harmful matter can enter the water circulating system, adequate monitoring shall be installed which is able to detect the contamination. If the maximum concentrations of the harmful matter as set out by the hazard analysis can be exceeded, a suitable protection method shall be used. If the method of protection is a device, which automatically interrupts the supply of, or diverts, the contaminated water from the system, or ultimately cuts off and locks-out the heat supply to the boiler, then the device shall comply with the general requirements for limiting devices in EN 12953-9:2007, Clause 4.

The monitoring shall be continuous unless justified by hazard analysis.

4.8.4 Make-up water

4.8.4.1 If it is assessed that a significant change of the total hardness value in the make-up water downstream of the make-up water treatment plant or storage tanks can occur, the total hardness value of the make-up water shall be monitored automatically. In the case of demineralised make-up water the conductivity value can be monitored instead of the total hardness. If the limit values prescribed by the manufacturer are exceeded, an adequate suitable device shall automatically interrupts the supply of, or diverts, the make-up water downstream, or ultimately cuts off and locks-out the heat supply.

NOTE A significant change of the total hardness value are not necessarily the same as the limit value as stated in EN 12953-10 (total hardness < 0,01 mmol/l alt. 0,05 mmol/l).

The monitoring shall be continuous unless justified by hazard analysis.

4.8.4.2 If it is assessed that there is a risk that other harmful matter (e.g. oil, grease, organic material, acid, lye, seawater etc.) can enter the make-up water that will compromise the safety of the boiler or the operation of the limiters within the period of operation without manual intervention then a suitable monitoring system shall be installed. If the limit values prescribed by the manufacturer are exceeded, an adequate suitable device shall automatically interrupt the supply of, or diverts, the make-up water downstream, or ultimately cuts off and locks-out the heat supply.

The monitoring shall be continuous unless justified by hazard analysis.

5 Special requirements for steam boilers

5.1 Water level indication

5.1.1 Each steam boiler shall have at least one means of indicating the water level, which shall be a gauge with an indicating column made of transparent material (the gauge glass).

5.1.2 The gauge(s) shall be mounted so that the lowest water level (LWL) and the maximum water level is visible in the gauge glass. The lowest permissible water level (LWL) shall be additionally marked on the gauge glass. The maximum water level shall be specified by the boiler manufacturer but need not be marked on the gauge glass. The water level indicating device shall be so arranged that the value "50 mm above HHS" is visible if there is a risk from accumulated heat in the furnace or in the flue gas passes.

5.1.3 The (LWL) of the steam boiler (see Figure 2), which shall be permanently and legibly marked on the steam boiler, visible at all times, and identified by the letters "LWL", shall be the greater of:

- a) 100 mm above the highest point of the heated surface "HHS"; or
- b) if the flue gas temperature exceeds 400 °C, and the steam boiler has slow acting combustion (e.g. combustion of wood or other solid fuels), a height above "HHS" shall be fixed to allow for a sinking time of not less than 7 min.

The sinking time t is the time taken for the water level to sink from the lowest permissible water level to the highest point of the heated surface in the case of complete loss of feedwater supply and at maximum continuous rating, i.e.

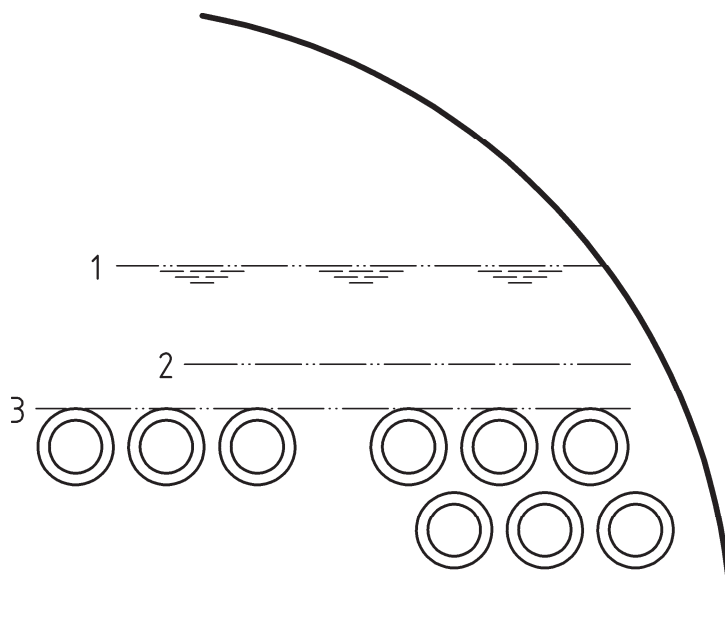
$$t = V/(Q_{st} v) \quad (1)$$

where

Q_{st} is the maximum continuous rating, in kg/min;

V is the water volume of the steam boiler between LWL and HHS, in m³;

v is the specific volume of water, in m³/kg.

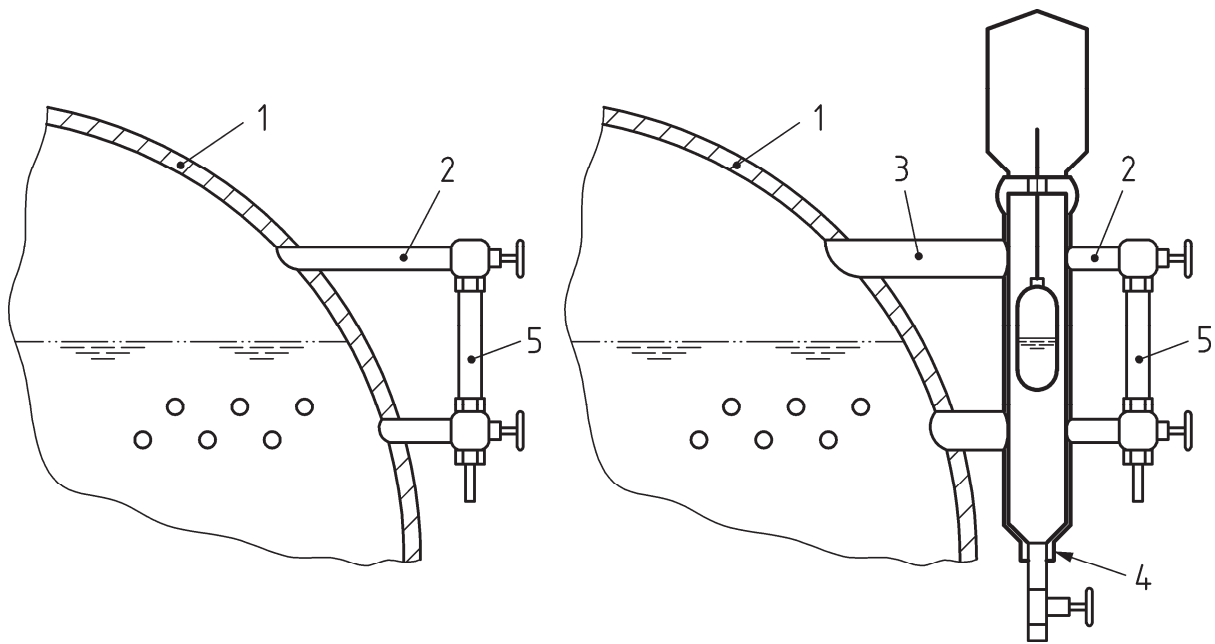


Key

- 1 controlled water level
- 2 LWL
- 3 HHS

Figure 2 — Water level indication

5.1.4 All tubes and fittings connecting a water level gauge directly to a steam boiler or via an external chamber shall be as short as possible and constructed so that no undrained pocket is formed between the steam boiler and the gauge. There shall be no other outlet from this connection except for regulators, steam pressure gauges and drains or other similar apparatus which does not permit the escape of a significant amount of steam (see Figure 3).



Key

- 1 steam boiler
- 2 tube internal diameter $\geq 20\text{mm}$
- 3 tube internal diameter $\geq 40\text{mm}$
- 4 external chamber
- 5 water level gauge

Figure 3 — Example of water level gauge connections

5.1.5 Tubes connecting a water level gauge to the steam boiler shall be not less than 20 mm internal diameter. Where the water gauge is fitted to an external chamber, the tubes connecting the external chamber to the steam boiler shall not be less than 40 mm internal diameter (see Figure 3). If the external chamber contains additionally a limiter, then the requirements of EN 12953-9 shall also be considered.

5.1.6 The water level gauge shall be designed to prevent an excessive discharge of steam and water should breakage of the transparent glass occur during operation.

When leaving the boiler house, the operator shall close the valves isolating the water level gauge from the steam boiler.

5.1.7 Water level gauges shall be capable of being isolated from the steam boiler and blowdown system.

The normal working position of the valve shall be indicated.

Water level gauges shall be capable of being blown down.

5.2 Steam pressure and temperature indication

5.2.1 Each steam boiler shall have a steam pressure gauge, with a minimum dial diameter of 100 mm, connected to the steam space either directly or through the water level gauge column or its steam connection.

5.2.2 The steam pressure gauge shall be connected to a siphon or similar device of sufficient capacity to keep the gauge tube filled with water. The pipe shall be of sufficient size and should have provision for blowing through, if possible.

5.2.3 Steam pressure gauge connections shall be suitable for the maximum allowable pressure of the steam boiler.

5.2.4 Pressure gauges shall be graduated to indicate the pressure at least in bar. The maximum allowable pressure shall be indicated by a fixed and readily visible red mark on the pressure gauge.

5.2.5 Each steam boiler shall be provided with a valve connection for the specific purpose of connecting a test gauge when the steam boiler is in service so that the accuracy of the boiler pressure gauge can be ascertained.

5.2.6 Temperature indication shall be installed to indicate the maximum temperature of the superheated steam.

5.3 Valves for connections

5.3.1 Steam outlets

The stop valve connecting the boiler to the steam pipe shall be attached to the steam boiler. In the case of a steam boiler with a superheater, the stop valve shall be located at the outlet from the superheater header.

NOTE 1 The valve should preferably be of a type which positively indicates whether it is open or closed.

Where more than one steam boiler is connected to a common header or steam manifold, the steam connections for each steam boiler shall be provided with two stop valves, one of which shall be of the non-return type, with a free blowing drain valve between them.

NOTE 2 It is preferable that the valve nearest the steam boiler be a non-return type.

5.3.2 Feed pipe connections

Each feed pipe to any steam boiler shall be provided with a stop valve and a non-return valve. The stop valve shall be nearest the steam boiler. Where there is an integral economiser, the foregoing valves shall be placed at the inlet to the economiser.

If the stop valve and non-return valve are not installed in direct connection to each other, it shall be possible to vent the pressure in the interconnecting piping.

In the event of backflow through a feed pump, where the suction pipework may be of a lower pressure rating than the discharge line provisions shall be made to avoid dangerous overpressure in the suction pipe.

5.4 Feed water supply

The steam boiler shall be provided with an adequate supply of feed water.

5.5 Feed water control

5.5.1 The water level shall be controlled automatically.

5.5.2 One automatic device shall be provided to prevent the maximum water level from being exceeded. This device does not have to be an additional device.

5.5.3 Where the feedwater supply is interrupted, the heat supply shall be cut off simultaneously if there is a risk of the economisers overheating due to the interrupted feed.

5.6 Limiting devices

5.6.1 Low water protection

Each steam boiler shall be equipped with two water level limiters to cut off and lock out the heat supply when the water level falls to the "LWL" position.

As an alternative to the two water level limiters the equivalent functions can be combined in a complex electronic and/or mechanical system which shall be fail-safe, self monitoring and redundant.

NOTE For the option of two water level limiters, it is not necessary for both limiters to act simultaneously.

5.6.2 Pressure limitation

Each steam boiler shall be equipped with one pressure limiter to cut off and lock out the heat supply before the set pressure of the safeguard against excessive pressure (safety valve) is reached.

5.6.3 Temperature limitation

If the design metal temperature does not exceed the maximum calculated metal temperature under all operating conditions by a safety margin defined by the manufacturer taking account of the hazard analysis, then the following shall be required:

- the superheated steam temperature shall be controlled automatically;
- a temperature limiter shall be provided to cut-off and lock out the heat supply.

5.7 Electrically heated steam boilers

NOTE Electrical safety matters require consideration.

5.7.1 Steam boilers heated by electric current flowing between electrodes

All the requirements of Clause 5 shall apply except 5.4 and 5.6.1.

5.7.2 Steam boilers heated by immersion heaters

5.7.2.1 All the requirements of Clause 5 shall apply except for 5.1.3 a), 5.1.3 b) and 5.6.1.

5.7.2.2 The lowest water level (LWL) as defined in 5.1.3 a) shall be 30 mm above the uppermost surface of the immersion heaters.

For low water protection, each boiler shall be equipped with one water level limiter to cut off and lock out the heat supply when the water level falls to the "LWL" position.

6 Special requirements for hot water boilers

6.1 Hot water generating systems (for example see Annex A)

6.1.1 Open vented systems shall be directly connected to the atmosphere (see Figure A.1).

6.1.2 Closed systems shall not be connected to the atmosphere (see Figures A.2 and A.3). They are subdivided into:

- a) internally pressurised systems where the pressure is generated by the saturation pressure corresponding to the flow temperature (see Figure A.3); and
- b) externally pressurised systems where the pressure is generated by such systems as gas cushions, pressure pumps, or external steam cushions (see Figures A.7 to A.12).

6.1.3 The heated water is normally used in a closed cycle, but if steam discharge is intended, Clause 5 shall additionally apply.

In the case of steam discharge, the pressure shall also be held under all operating conditions.

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

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

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

6.1.7 Hot water boilers operating:

- with an internal steam cushion shall be designed to ensure that no steam can enter outlet and return pipes;
- without an internal steam cushion, the outlet pipe shall be at the highest point of the hot water boiler.

6.2 Expansion and feed lines for open vented systems

To ensure safe operation of the hot water boiler the internal diameter of the feed and expansion lines shall be determined by the following (see also Figure 4):

Open vented systems shall be directly connected to the atmosphere.

Dimensions shall be deemed adequate if the internal diameter, d_i of the feed and expansion lines is determined by the following:

$$\text{expansion line: } d_i = 15 + 1,397 \sqrt{Q_h} \quad (2)$$

$$\text{feed line: } d_i = 15 + 0,9273 \sqrt{Q_h} \quad (3)$$

where

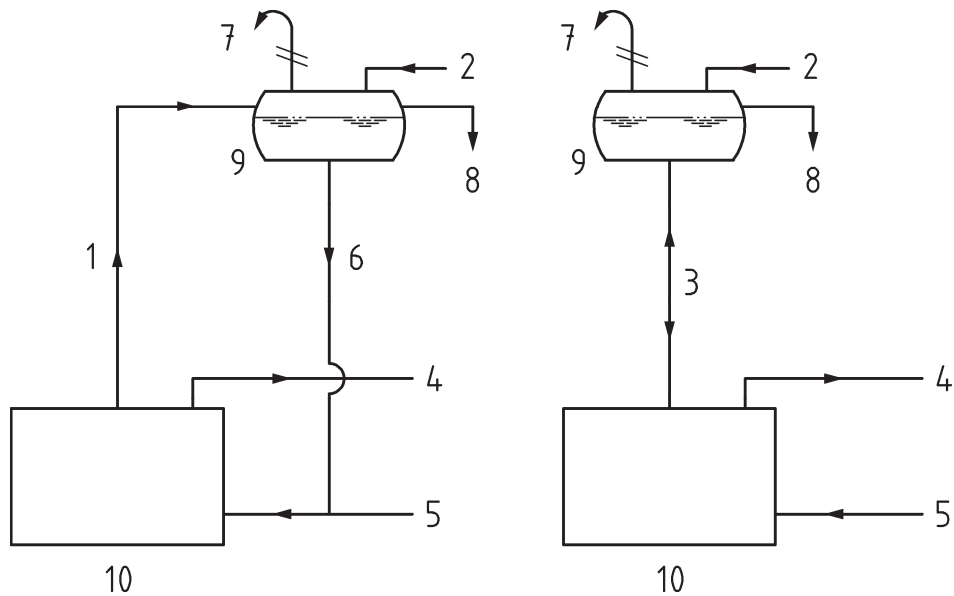
Q_h is the heat output from the hot water boiler, in kW

In the case of a combined feed/expansion line the following formula shall be used:

$$\text{combined: } d_i = 1,25 (15 + 1,397 \sqrt{Q_h}) \quad (4)$$

In no case shall the internal diameter d_i be less than 25 mm.

Vent lines shall be protected against blockage and freezing.



Key

- 1 expansion line
- 2 make-up water-line
- 3 combined feed and expansion line
- 4 flow-line
- 5 return-line
- 6 feed line
- 7 vent line
- 8 over-flow line
- 9 expansion vessel
- 10 boiler

Figure 4 — Open vented system

6.3 Water supply

The hot water boiler system shall be provided with an adequate supply of water.

6.4 Water level indication

6.4.1 For hot water boilers operating with an internal steam cushion, the requirements for the water level indicators shall be the same as for steam boilers and the requirements of Clause 5 shall also apply.

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

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

NOTE Membrane expansion vessels with pre-pressurized gas cushion are not provided with a water content indication and are not recommended for application in industrial hot water systems.

6.4.3 “LWL” shall be marked on each hot water boiler operating with an internal steam cushion, a closed expansion vessel with a steam cushion (see Figure A.12), a gas cushion (see Figure A.11) or an open expansion vessel associated with pump pressurisation systems (see Figure A.8).

6.4.4 For hot water boilers operating with an internal steam cushion, the requirements for LWL shall be the same as for steam boilers and the requirements of Clause 5 shall apply, except that the sinking time shall be the time taken for the water level to sink from the lowest water level (LWL) to the highest point of the heated surface (HHS) in the case of interruption to the water circulation and at the allowable heat output, i.e.

$$t = V / (Q_{st, equiv} v) \quad (5)$$

where

$Q_{st, equiv}$ is the equivalent steam generation calculated according to the allowable heat output, in kg/min;

t is the sinking time, in min;

V is the water volume of the boiler between LWL and HHS, in m³;

v is the specific volume of water, in m³/kg.

6.5 Limiting devices

6.5.1 Low water protection

6.5.1.1 All types of hot water generating systems shall be provided with water level limiters, to cut off and lock out the heat supply in the event of loss of water.

For open vented systems, instead of the water level limiter, a low pressure limiter shall be sufficient when the allowable heat output is less or equal to 1,5 MW.

6.5.1.2 For hot water systems operating with an internal steam cushion, the requirements for water level limiters shall be the same as for steam boilers and the requirements of 5.6.1 shall apply.

6.5.1.3 In the case of expansion tanks which are open to the atmosphere or are operating with a steam or gas cushion in direct contact with the system water or the expansion water, a water level limiter LZA- shall be installed (see Figures A.8 and A.11).

A water level limiter LZA- is not required if the expansion vessel is with a gas and a water compartment which are separated by a membrane protecting the hot water system from gas or air penetration (see Figures A.9 and A.10).

6.5.1.4 In all other cases, one low-water limiter shall be fitted either in, or adjacent to, the top of the hot water boiler.

6.5.2 Pressure and temperature limitation

6.5.2.1 With the exception of open vented systems all hot water boilers shall be fitted with a maximum and minimum pressure limiter to cut off and lock out the heat supply to ensure that the pressure is maintained within the allowable limits (see Figure A.1, Figures A.2 to A.4 and Figures A.7 to A.12).

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

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

6.5.2.3 For plants with external pressure generation and open venting systems, a temperature limiter shall be provided to cut off and lock out the heat supply if the allowable flow temperature is exceeded (see Figure A.2).

6.5.3 Circulation limitation

Unintentional steam generation, evaporation, and exceeding the allowable metal temperature shall be prevented within the hot water boiler.

The minimum circulating flow rate of water through the boiler shall be ensured by means of a flow limiter, which shall be provided to cut off and lock out the heat supply if the actual flow falls below the minimum allowable flow rate.

This limiting device shall be installed close to the hot water boiler.

6.6 Vent valves

For hot water systems, other than open vented systems or those with an internal steam cushion, a vent valve shall be provided at or above the highest point of the hot water system.

NOTE This valve may be used when filling and emptying the hot water boiler and when testing the function of the low water limiter fitted in accordance with 6.5.1.3.

6.7 Pressure and temperature indication

6.7.1 One temperature indicating device shall be installed in both the flow and return lines of each hot water system. The maximum flow temperature shall be marked on the indicating device.

6.7.2 Provision shall be made for checking the indicated flow temperature and the set point of the temperature limiter.

6.7.3 In addition to the pressure gauge on the hot water boiler, one pressure indicator (PI) shall be provided on the gas or the water side of expansion systems operating with a steam or gas cushion (see Figure A.6.6).

In case of pressurization systems equipped with pumps the PI shall be installed next to the pressure sensor of the controller (see Figure A.1, Figures A.2 to A.4 and Figures A.7 to A.12).

6.8 Pressure controller

Each closed system shall be equipped with a pressure controller (PCA \pm) (see Figures A.7, A.8, A.10 and A.12):

- in systems with internal pressure generation, on either the hot water boiler or the expansion vessel;
- in systems with external pressure generation by controlled gas cushion or an external steam cushion, the pressure controller (PCA \pm) being installed on or next to the expansion vessel;
- in systems with external pressure generation by pressure pumps downstream of the pump.

This shall not apply to systems with external pressure generation by a pre-pressurized gas cushion in the closed expansion vessel.

6.9 Discharge from safety valves

The hot water discharge from the safety valve shall be discharged safely. If necessary, a flash vessel of adequate design shall be installed (see also EN 12953-8:2001, 4.5).

6.10 Electrically heated hot water boilers

NOTE Electrical safety matters require consideration.

6.10.1 Hot water boilers operating with an internal steam cushion

All the requirements of clause 6 shall apply except any reference to Clause 5 shall be replaced with reference to 5.7.

6.10.2 Hot water boilers without internal steam cushion

6.10.2.1 Hot water boilers heated by electric current flowing between electrodes

All the requirements of Clause 6 shall apply except 6.5.1.

6.10.2.2 Hot water boilers heated by immersion heaters

All the requirements of Clause 6 shall apply.

6.11 Parallel mode of operation of hot water boilers

Parallel operation of hot water boilers with steam cushion shall only be permitted:

- for hot water boilers with internal steam cushion if subject to a specific design assessment;
- for hot water boilers with one common expansion vessel.

7 Operational aspects including maintenance and testing

Operating instructions covering operation, maintenance and testing of the boiler plant shall be available for the boiler operator at any time.

Before the boiler is left unsupervised, the boiler attendant/operator shall ensure the safe condition of the boiler plant (including all limiters and safety circuits) in accordance with the manufacturer operating instructions and other relevant documents. Furthermore the boiler attendant shall ensure that all control circuits necessary for the safe operation of the boiler including the heat supply are under automatic control.

All controls and limiters shall be:

- properly operated and maintained to ensure reliability in accordance with the manufacturer's operating instructions;
- regularly and periodically functionally checked and/or tested as defined by the manufacturer's operating instructions, which shall include the shut-down of the fuel supply system. The method of testing shall take into consideration the type of fuel. The inspection intervals shall be defined on the basis of the operating conditions and the water treatment products used. The result of each check shall be clearly demonstrated to the boiler operator. Results of observations, testing, checking and faults shall be recorded in a logbook and kept on site.

Continuous supervision shall be provided after a fault has been rectified until a suitable period of time has elapsed to ensure that the boiler and its controls are operating properly.

NOTE Annex C (informative) gives recommendations of operation and testing of the boiler system with a maximum time of operation without manual (human) intervention of 72 hours.

8 Alarms and monitoring from the boiler plant

The safety of the boiler plant shall not rely on the effective operation of the remote alarm and monitoring system.

For information on alarms and monitoring, see Annex E.











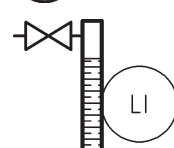


Annex A (informative)

Examples of steam and hot water boiler systems

A.1 General

This annex gives examples of steam boilers systems and hot water generating systems.

A.2 Key to figures

	Stop valve
 NO	Stop valve normally locked in open position
 NRV	Non return valve
	Shut-off valve (self-closing on power loss)
 SOV	
 PCV	Pressure control valve, opens by rising pressure (controlled by actuator or self-actuating overflow type)
 PCV	Pressure control valve, opens by decreasing pressure (controlled by actuator or self-actuating overflow type)
 PSV	Pressure safety valve
 P	Pump
 C	Compressor
 LI	Water level indicator
 PI	Pressure indicator (with master gauge connection valve)
 TI	Temperature indicator

Letter symbols for data processing function (ISO 14617-6).

Measured or initiating variable:

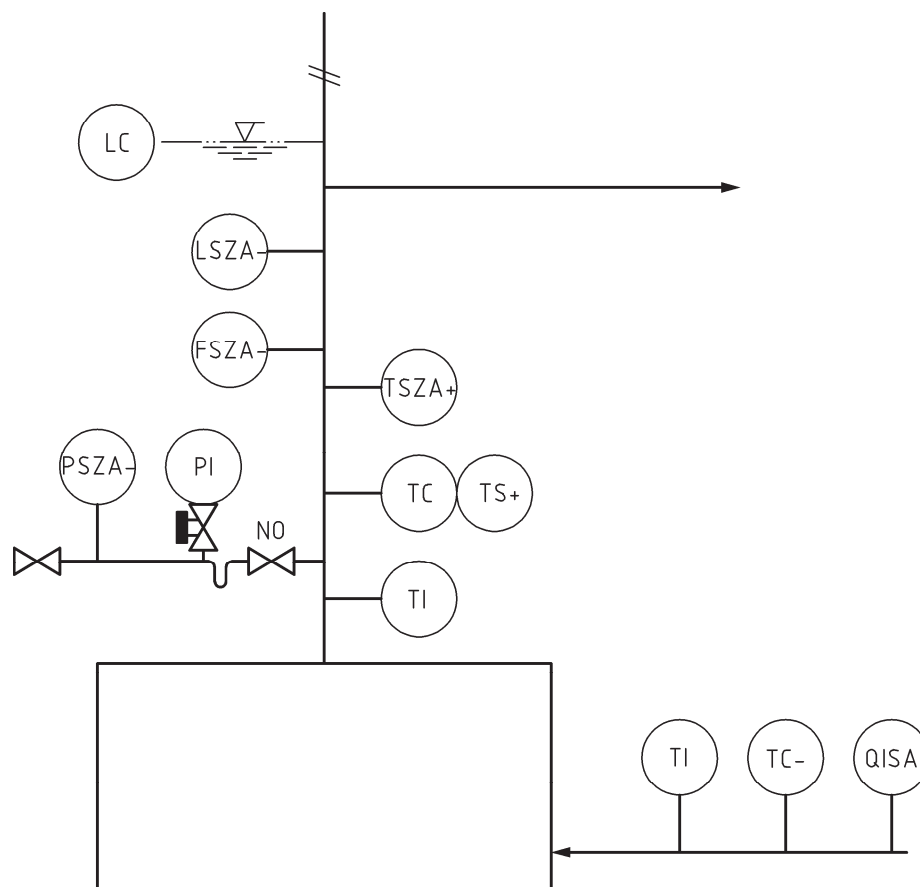
- F** Flow rate
- L** Level
- P** Pressure
- Q** Quality
- T** Temperature

When two or more code letters for function occur, the order of sequence should be:

I, C, S, Z, A

- I** Indicating
- C** Controlling
- S** Switching
- Z** Emergency or safety acting
- A** Alarming
- +** High state
- Low state

A.3 Plant with open vented system



Key

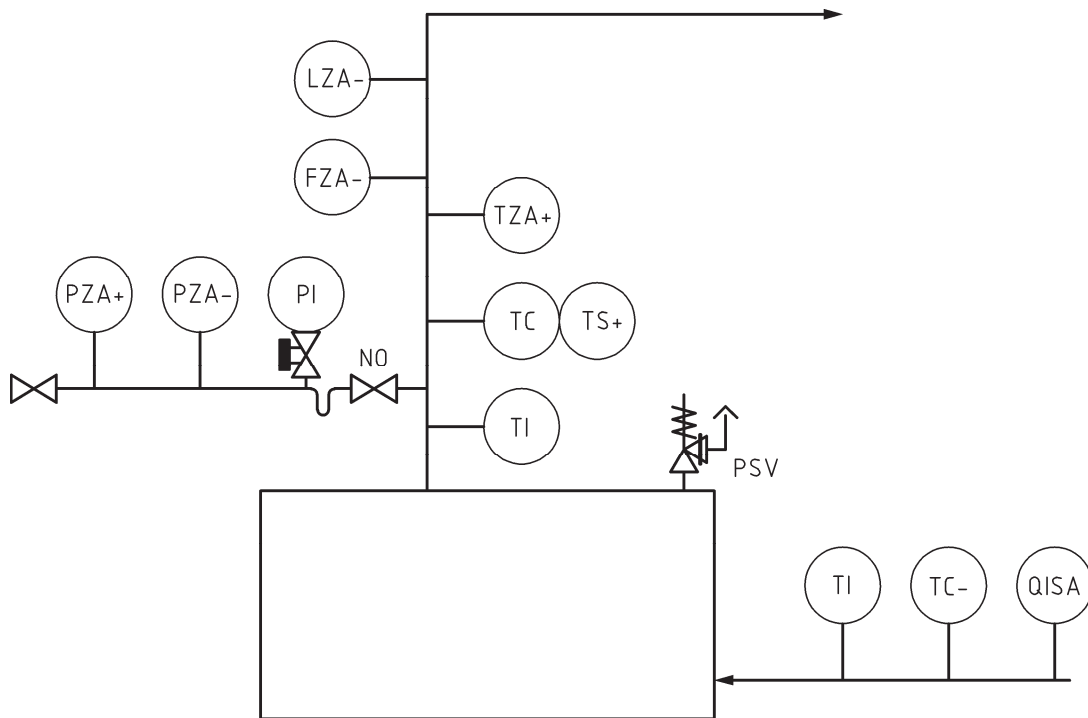
- LC** Automatic water level controller.
- LSZA-** Minimum water level limiter (- alarm). For boilers with an allowable heat output less or equal to 1,5 MW, a low pressure limiter should be sufficient (see 6.5.1.1).
- FSZA-** Minimum flow limiter (-alarm) (see 6.5.3).
- NO** Stop valve locked in open position.
- PSZA-** Minimum pressure limiter (- alarm) (see 6.5.2.1).
- PI** Pressure indicator (with master gauge connection valve) (see 6.7.3).
- TSZA+** Maximum temperature limiter (+ alarm) (see 6.5.2.3). For solid fuels it may be necessary that an additional emergency cooling system be started (see 4.4.1).
- TC** Temperature controller (see 4.4.1).
- TS+** High temperature controller (integrated function in the temperature controller).
- TI** Temperature indicator (see 6.7.1).
- TC-** Minimum temperature controller. If required in accordance with 6.1.4.
- QISA** Water quality indicator/controller (alarm). If required in accordance with 4.8.3.

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

Figure A.1 — Open vented hot water system

A.4 Plant with closed system

A.4.1 Hot water system with external pressure generating and expansion system

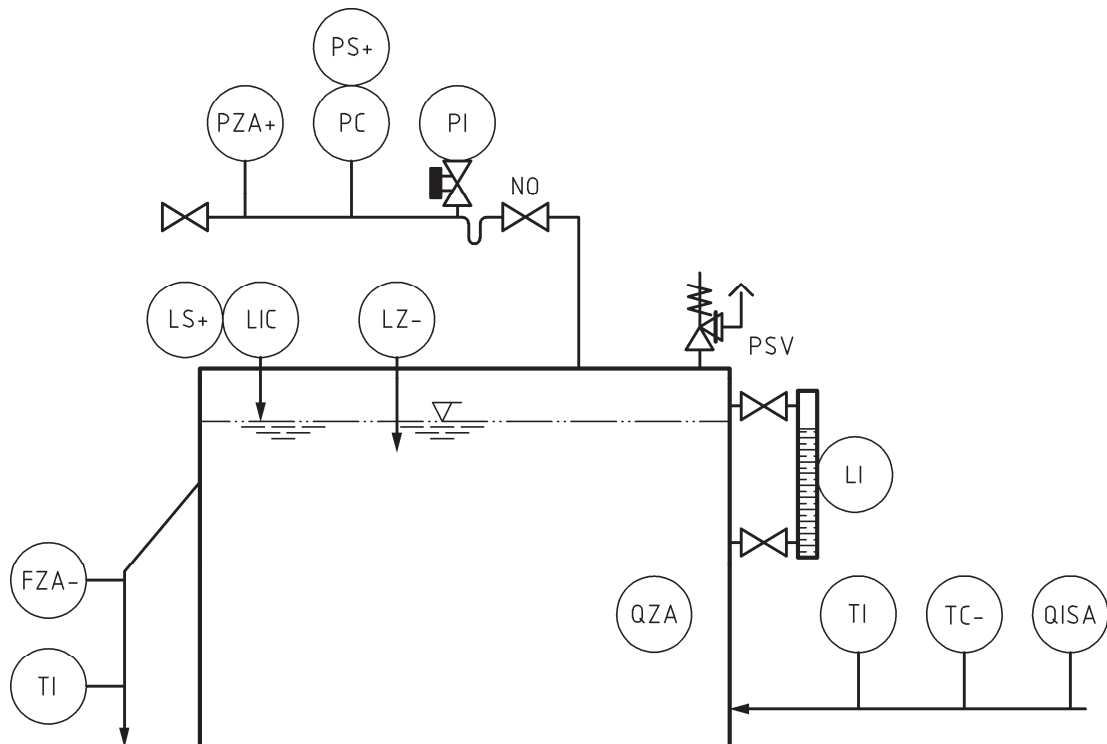


Key

- PSV** Pressure safety valve. If required a flash vessel in accordance with 6.9 should be installed.
- LZA-** Minimum water level limiter (- alarm) (see 6.5.1.1).
- FZA-** Minimum flow limiter (- alarm) (see 6.5.3).
- NO** Stop valve locked in open position.
- PZA+** Maximum pressure limiter (+ alarm) (see 6.5.2.1).
- PZA-** Minimum pressure limiter (- alarm) (see 6.5.2.1).
- PI** Pressure indicator (with master gauge connection valve) (see 6.7.3).
- TZA+** Maximum temperature limiter (+ alarm) (see 6.5.2.3). For solid fuels it may be necessary that an additional emergency cooling system be started (see 4.4.1).
- TC** Temperature controller (see 4.4.1).
- TS+** High temperature controller (integrated function in the temperature controller).
- TI** Temperature indicator (see 6.7.1).
- TC-** Minimum temperature controller. If required in accordance with 6.1.4.
- QISA** Water quality indicator/controller (alarm). If required in accordance with 4.8.3.

Figure A.2 — Hot water system with external pressure generating and expansion system

A.4.2 Hot water system with internal pressure generating and expansion system - Steam cushion in the boiler



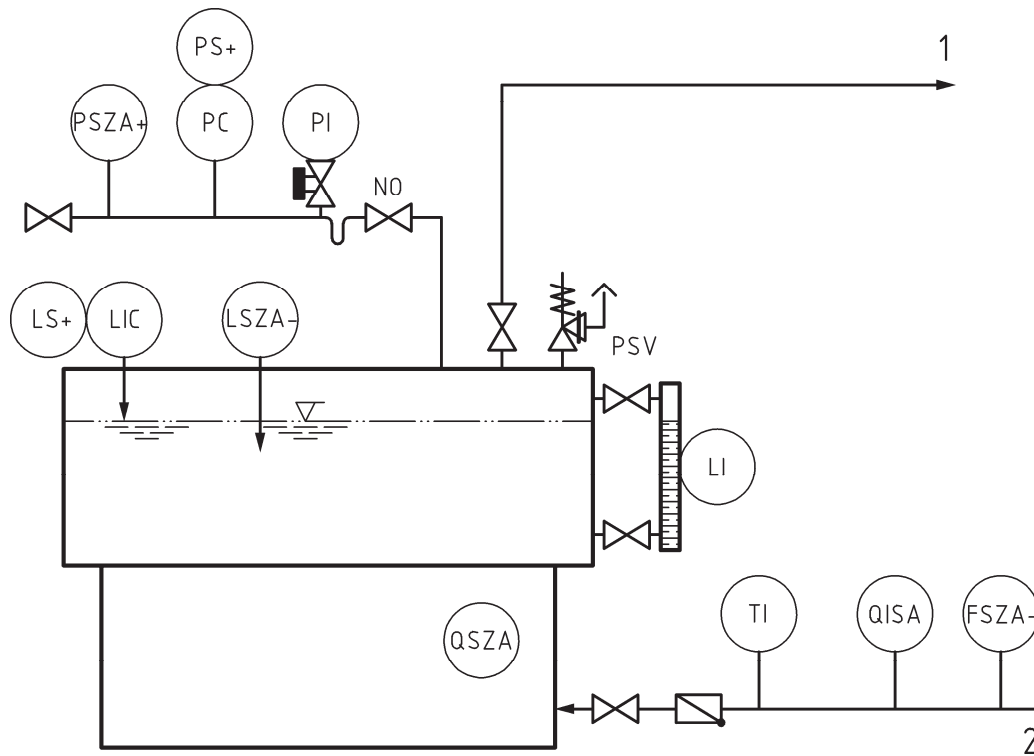
Key

PSV	Pressure safety valve.
NO	Stop valve locked in open position.
PZA+	Maximum pressure limiter (+ alarm) (see 6.5.2.1). For solid fuels it may be necessary that an additional emergency cooling system be started (see 4.4.1).
PC	Pressure controller (see 4.4.1).
PS+	High pressure controller (integrated function in the pressure controller).
PI	Pressure indicator (with master gauge connection valve) (see 6.7.3).
LZ-	Minimum water level limiter (- alarm) (see 6.5.1.1).
LIC	Water level controller. Water level indicator may be integrated in the level controller (see 5.5.1).
LS+	High level controller (integrated function in the level controller) (see 5.5.2).
LI	Water level indicator in accordance with 6.4.1.
FZA-	Minimum flow limiter (- alarm). If required depending on the boiler construction (see 6.5.3).
QZA	Conductivity limiter (alarm). If required in accordance with 4.8.3.
TI	Temperature indicator (see 6.7.1).
TC-	Minimum temperature controller. If required in accordance with 6.1.4.
QISA	Water quality indicator/controller (alarm). If required in accordance with 4.8.3.

NOTE Pressure controlling and limiting is preferred for boilers with internal pressure generating and expansion system by reasons that a quicker and more precise control of the heat supply will be achieved. If the manufacturer wants to control the heat supply by the outgoing flow temperature in accordance to 4.4.1 the boiler should be fitted with a TC- Temperature controller TZA+ maximum temperature limiter (+ alarm) (see 6.5.2.3) and PZA- minimum pressure limiter (- alarm) (see 6.5.2.1).

Figure A.3 — Hot water system with internal pressure generating and expansion system - Steam cushion in the boiler

A.4.3 Steam boiler

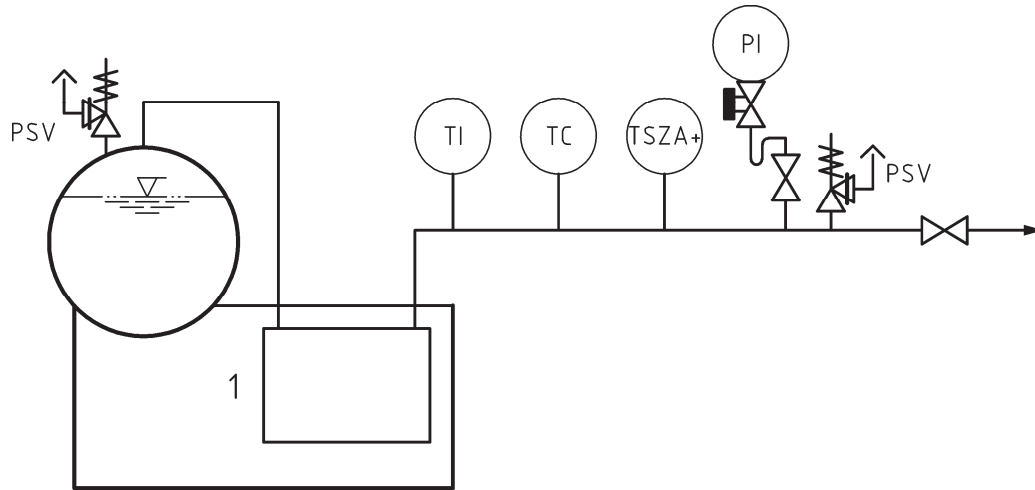


- Key**
- PSV** Pressure safety valve.
 - NO** Stop valve locked in open position.
 - PSZA+** Maximum pressure limiter (+ alarm) (see 5.6.2). For solid fuels it may be necessary that an additional emergency cooling system be started (see 4.4.1).
 - PC** Pressure controller (see 4.4.1).
 - PS+** High pressure controller (integrated function in the pressure controller).
 - PI** Pressure indicator (with master gauge connection valve) (see 5.2).
 - LSZA-** Minimum water level limiter (- alarm) (see 5.6.1).
 - LIC** Water level controller. Water level indicator may be integrated in the level controller (see 5.5.1).
 - LS+** High level controller in accordance with 5.5.2 (may be integrated function in the level controller).
 - LI** Water level indicator in accordance with 5.1.
 - QSZA** Conductivity device (alarm). If required in accordance with 4.8.1.
 - QISA** Feed water quality indicator/controller (alarm) (see 4.8.2).
 - TI** Temperature indicator.
 - FSZA-** Minimum flow limiter (- alarm). If required depending on the boiler construction (see 5.5.3).
 - 1** steam.
 - 2** feedwater.

Figure A.4 — Steam boiler

A.5 Superheater and economiser

A.5.1 Superheater

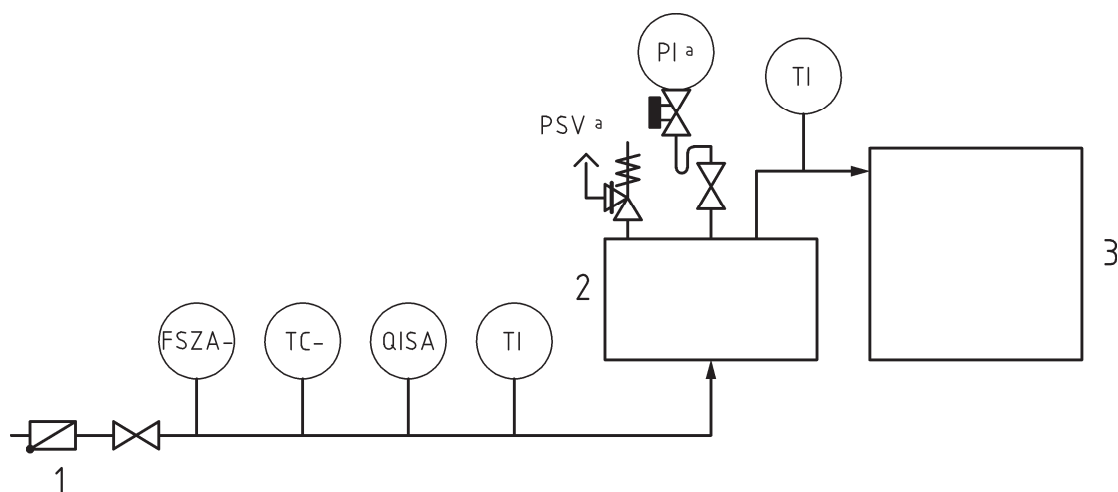


Key

- PSV** Pressure safety valve.
- PI** Pressure indicator (with master gauge connection valve) (see 5.2).
- TI** Temperature indicator (see 5.2.6).
- TC** Temperature controller if required (see 5.6.3).
- TSZA+** Maximum temperature limiter (+ alarm) if required (see 5.6.3).
- 1** superheater.

Figure A.5 — Superheater

A.5.2 Economiser



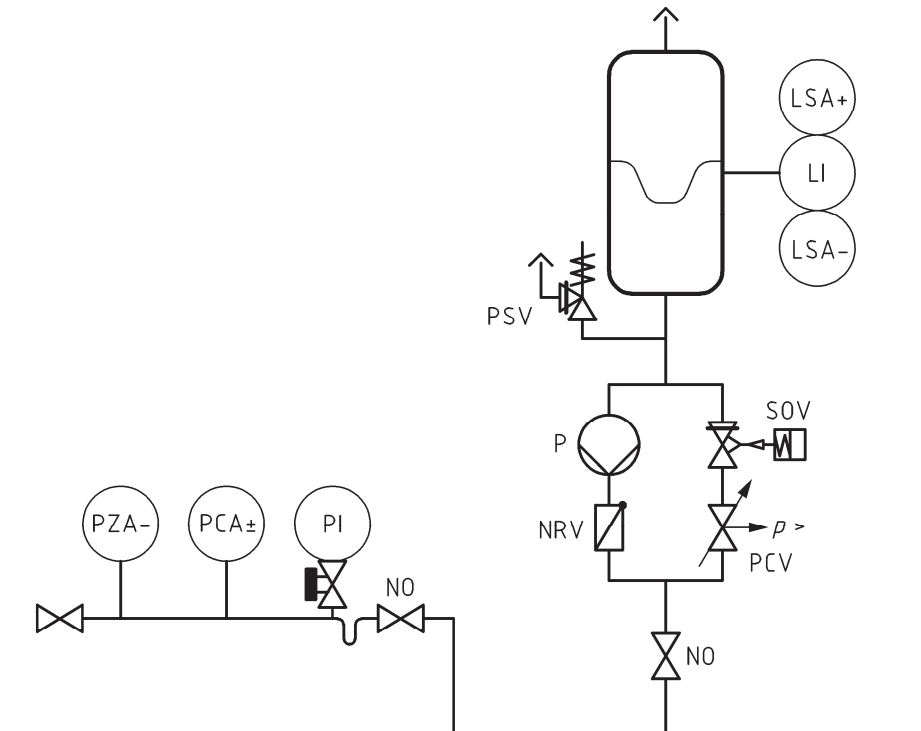
- Key**
- PSV** Pressure safety valve.
 - FSZA-** Minimum flow limiter (- alarm). If required depending on the economiser construction (see 5.5.3).
 - TC-** Minimum temperature controller. If required depending on the economiser construction (see 6.1.4).
 - QISA** Water quality indicator/controller (alarm). If required in accordance with 4.8.2 and 4.8.3.
 - TI** Temperature indicator.
 - PI** Pressure indicator (with master gauge connection valve) (see 5.2).
 - a) If the economiser can be isolated from the safeguards (safety valves) against excessive pressure of the boiler, the economiser should be provided with PSV and PI (see 4.1).
 - 1** feedwater.
 - 2** economiser.
 - 3** steam of hot water boiler.

Figure A.6 — Economiser

A.6 Expansion and pressure holding for hot water boiler system

NOTE Pressure pump-controlled system can be combined with open, gas or steam pressurized expansion vessels.

A.6.1 Pressure pump-controlled system with pressureless membrane type expansion vessel



Key

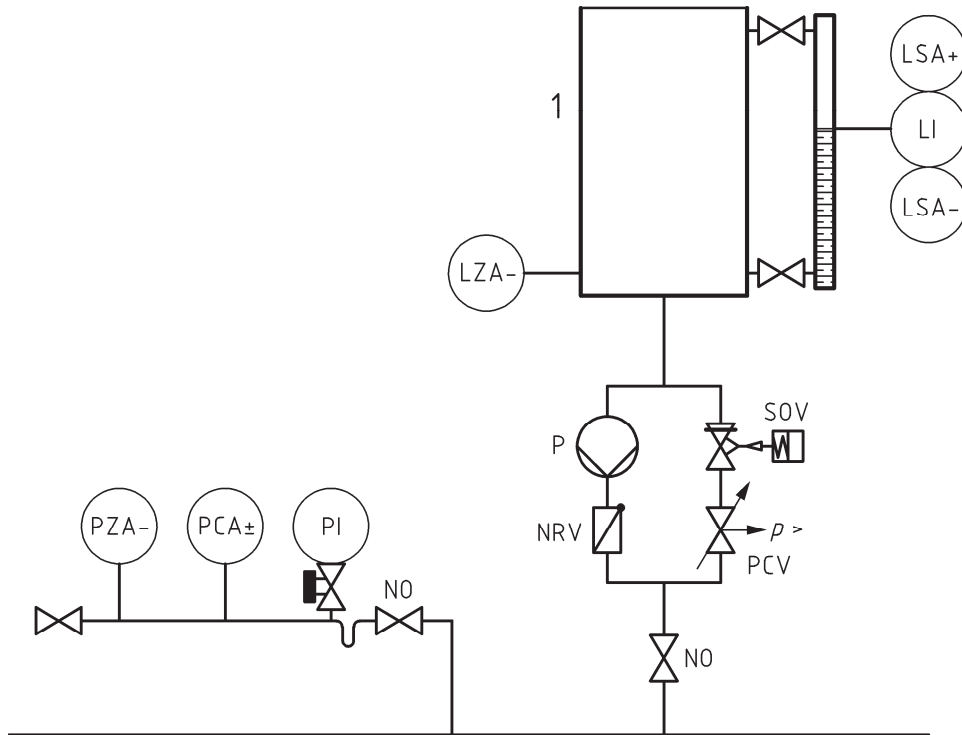
- NO** Stop valve locked in open position.
- P** Pressure pump.
- NRV** Non return valve.
- PCV** Pressure control valve.
- SOV** Shut-off valve (self-closing on power loss).
- PSV** Pressure safety valve (designed for thermal expansion and only necessary if PS of the expansion vessel is lower than PSV of the system).
- LI** Water level indicator (may be achieved by means of a vessel weight transducer) (see 6.4.2).
- LSA+** High water level controller (may be integrated in the LI equipment, + alarm).
- LSA-** Low water level controller (may be integrated in the LI equipment, - alarm).
- PI** Pressure indicator (with master gauge connection valve) (see 6.7.3).
- PCA±** Pressure controller.
- PZA-** Minimum pressure limiter (- alarm) (closes SOV) (see 6.5.2.2).

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

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

Figure A.7 — Pressure pump-controlled system with pressureless membrane type expansion vessel

A.6.2 Pressure pump-controlled system with open expansion tank



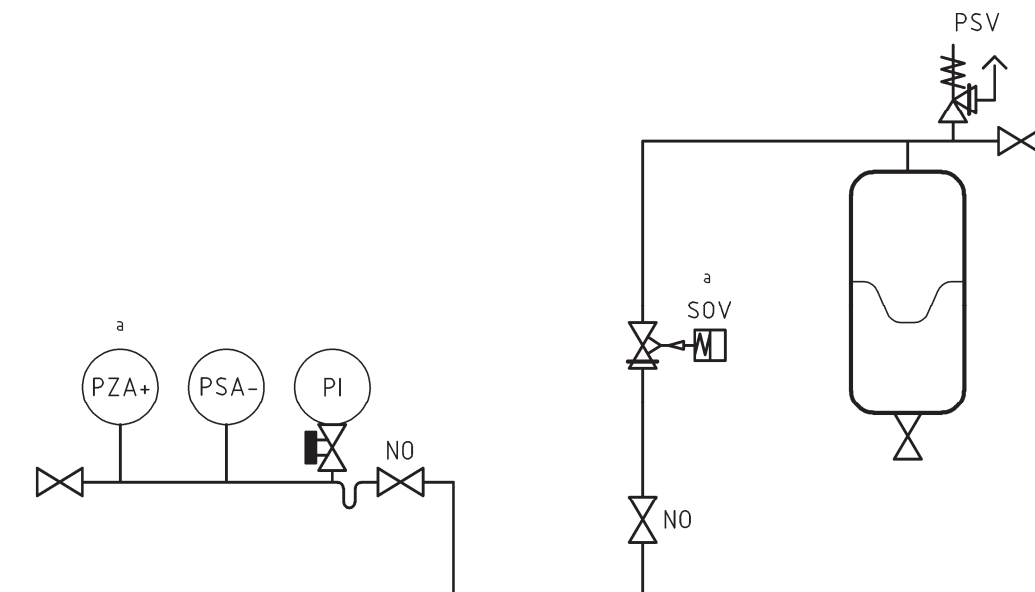
Key

- NO** Stop valve locked in open position.
- P** Pressure pump.
- NRV** Non return valve.
- PCV** Pressure control valve.
- SOV** Shut-off valve (self-closing on power loss).
- LI** Water level indicator (may be achieved by means of a vessel weight transducer) (see 6.4.2).
- LSA+** High water level controller (may be integrated in the LI equipment, + alarm).
- LSA-** Low water level controller (may be integrated in the LI equipment, - alarm).
- LZA-** Minimum water level limiter (stops the pressure pump, - alarm) (see 6.5.1.3).
- PI** Pressure indicator (with master gauge connection valve) (see 6.7.3).
- PCA±** Pressure controller (controls the pump P and the PCV if it is not selfactuating, ± alarm) (see 6.8).
- PZA-** Minimum pressure limiter (- alarm). (closes SOV) (see 6.5.2.2).
- 1** open expansion tank.

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

Figure A.8 — Pressure pump-controlled system with open expansion tank

A.6.3 Membrane type expansion vessel with pre-pressurized gas cushion



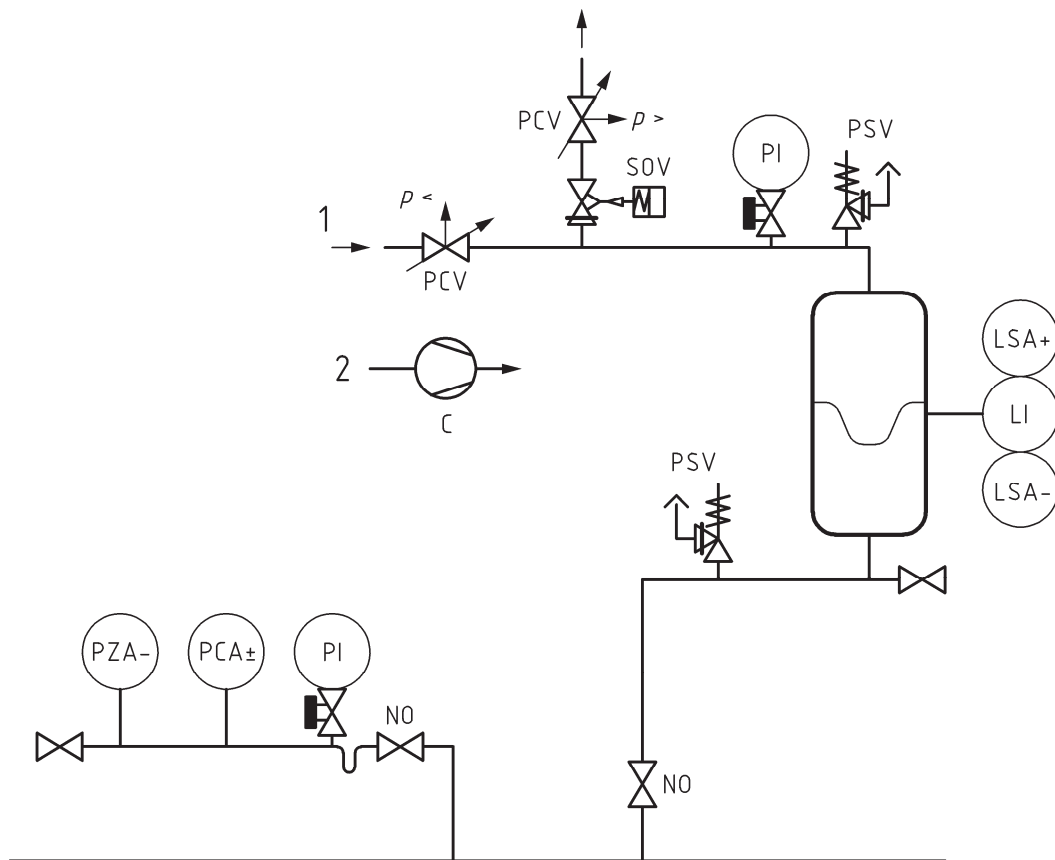
Key

- NO** Stop valve locked in open position.
- PSV** Pressure safety valve (designed for thermal expansion and only necessary if PS of the expansion vessel is lower than the PSV of the system).
- PI** Pressure indicator (with master gauge connection valve) (see 6.7.3).
- PSA-** Low pressure controller (- alarm).
- SOV** Shut-off valve (self-closing on power loss).
- PZA+** Maximum pressure limiter (closes SOV at pressure higher than PSV of the vessel).
- a) Equipment only necessary if PS of the expansion vessel is lower than the PSV of the system.

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

Figure A.9 — Membrane type expansion vessel with pre-pressurized gas cushion

A.6.4 Membrane type expansion vessel with controlled gas cushion



Key

NO	Stop valve locked in open position.
SOV	Shut-off valve. (self-closing on power loss).
PCV	Pressure control valve.
C	Compressor (option).
PSV	Pressure safety valve (designed for thermal expansion and/or maximum gas pressure).
LI	Water level indicator (may be achieved by means of a vessel weight transducer) (see 6.4.2).
LSA+	High water level controller (may be integrated in the LI equipment, + alarm).
LSA-	Low water level controller (may be integrated in the LI equipment, - alarm).
PI	Pressure indicator (with master gauge connection valve) (see 6.7.3).
PCA±	Pressure controller (controls the C and the PCV if they are not selfactuating, ± alarm) (see 6.8).
PZA-	Minimum pressure limiter (- alarm).
1	gas
2	option

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

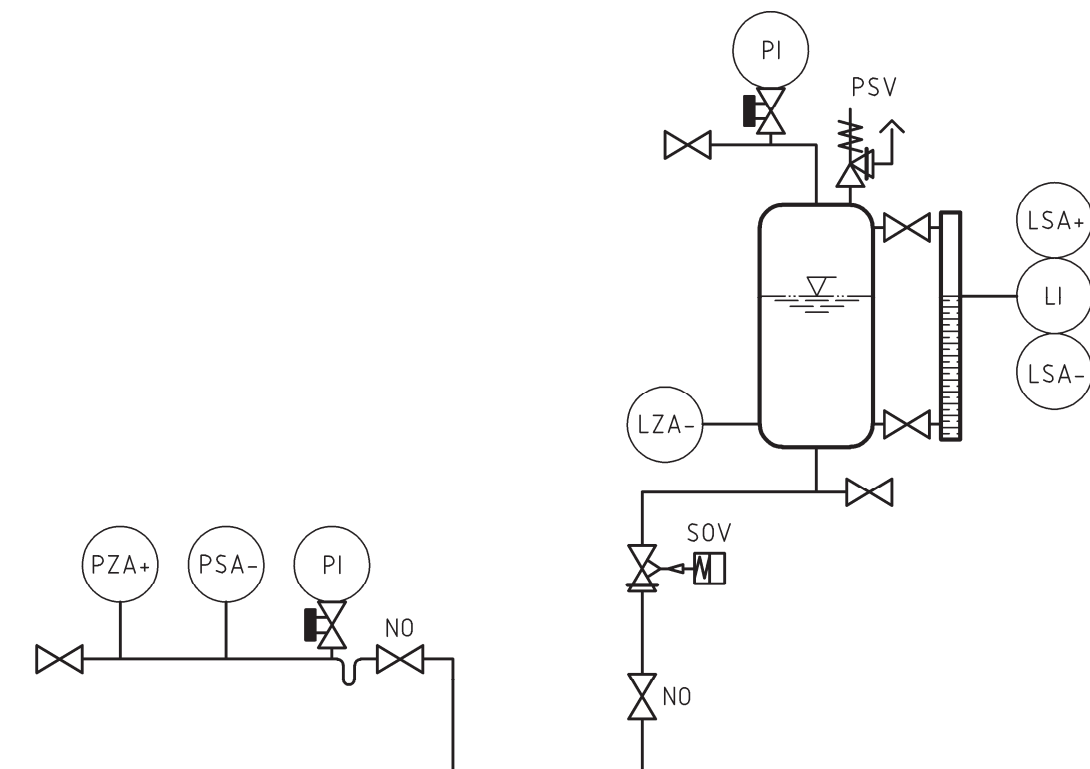
NOTE 2 PI may be integrated in a PCA± equipment.

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

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

Figure A.10 — Membrane type expansion vessel with controlled gas cushion

A.6.5 Closed expansion vessel with pre-pressurized gas cushion



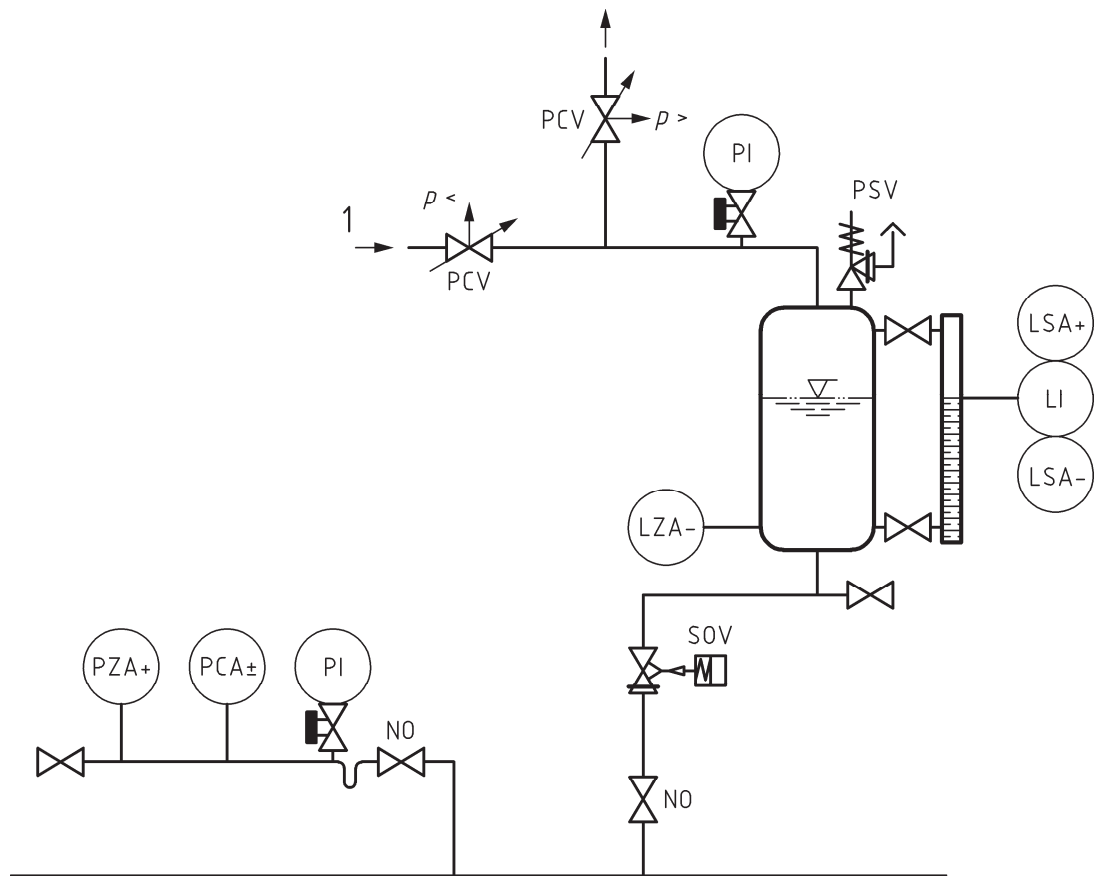
Key

- NO** Stop valve locked in open position.
- SOV** Shut-off valve (self-closing on power loss).
- PSV** Pressure safety valve (designed for thermal expansion).
- LI** Water level indicator (may be achieved by means of a vessel weight transducer) (see 6.4.2).
- LSA+** High water level controller (may be integrated in the LI equipment, + alarm).
- LSA-** Low water level controller (may be integrated in the LI equipment, - alarm).
- LZA-** Minimum water level limiter (closes SOV, - alarm) (see 6.5.1.3).
- PI** Pressure indicator (with master gauge connection valve) (see 6.7.3).
- PSA-** Low pressure controller (- alarm, may be integrated in PZA-).
- PZA+** High pressure limiter (closes SOV at pressure higher than allowed for expansion system) (see 6.5.2.2).

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

Figure A.11 — Closed expansion vessel with pre-pressurized gas cushion

A.6.6 Closed expansion vessel with gas or steam cushion



Key

- NO** Stop valve locked in open position.
- SOV** Shut-off valve (self-closing on power loss).
- PCV** Pressure control valve
- PSV** Pressure safety valve (designed for thermal expansion and/or maximum gas pressure).
- LI** Water level indicator (see 6.4.2).
- LSA+** High water level controller (may be integrated in the LI equipment, + alarm).
- LSA-** Low water level controller (may be integrated in the LI equipment, - alarm).
- LZA-** Minimum water level limiter (closes SOV, - alarm) (see 6.5.1.3).
- PI** Pressure indicator (with master gauge connection valve) (see 6.7.3).
- PCA±** Pressure controller (controls the PCV if they are not selfactuating, ± alarm) (see 6.8).
- PZA+** High pressure limiter (closes SOV at pressure higher than allowed for expansion system) (see 6.5.2.2).
- 1** gas

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

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

Figure A.12 — Closed expansion vessel with gas or steam cushion

Annex B (normative)

Dimensioning of expansion space

B.1 General

This annex shall supplement and be used only in conjunction with the rules for equipment in accordance with this European Standard.

B.2 Required data

B.2.1 Depending on type and plant the following data shall be required to dimension the pressure expansion vessel or tank:

- total water volume of the plant V_A , in l;
- expanded volume of the plant V_e , in l;
- nominal volume of the vessel or tank V_n , in l;
- effective volume of the plant and vessel or tank V_o , in l;
- initial water volume in the vessel or tank V_v , l;
- maximum allowable flow temperature t , in °C;
- initial pressure p_o , in bar;
- filling pressure, p_a in bar;
- static pressure p_{st} , in bar;
- steam pressure p_D , in bar;
- final pressure p_e , in bar;
- safety valve set pressure, in bar;
- safety valve reseating pressure, in bar.

When using the indicated units in the equations, all volumes obtained are in litres and all pressures obtained are in bar (gauge pressure).

B.2.2 Generally, the total water volume of the plant V_A shall be calculated from the water volumes of

- heat generators;
- piping;
- heating dissipation unit.

B.2.3 The rate of water expansion n in % at maximum flow temperature t shall be determined by the following relationship:

$$n = 3,9 \times 10^{-4} t^2 + 0,31 \quad (\text{B. 1})$$

from which the expanded volume (volume changed due to temperature change) V_e at filling temperature of 10 °C shall be calculated as follows:

$$V_e = n (V_A/100) \quad (\text{B. 2})$$

B.2.4 Expansion vessels with a nominal volume V_n up to 15 l shall contain at least 20 % of their nominal volume as initial water volume (liquid volume stored in the expansion vessel at lowest plant temperature) V_v . Expansion vessels with greater nominal volumes shall contain at least 0,5 % of the water volume V_A , but at least 3 l as initial volume.

In the case of water losses caused by equipment, greater initial water volumes shall be taken into account.

B.2.5 The initial pressure (gas pressure in the expansion vessel, before pressurising the system) p_o shall be at least equal to the sum of static pressure p_{st} and steam pressure p_D (pressure corresponding to the max. allowable flow temperature):

$$p_o \geq p_{st} + p_D \quad (\text{B. 3})$$

B.2.6 The final pressure p_e shall not be higher than the safety valve set pressure (gauge) minus the reseating pressure. If required, the static pressure difference between the location of expansion vessel installation and the safety valve shall be taken into account.

B.3 Formulas for dimensioning

B.3.1 Expansion tanks

The nominal volume of the expansion tank shall be at least

$$V_{n \min} = 2 V_e^{1)} \quad (\text{B.4})$$

B.3.2 Expansion vessels without membrane

The nominal volume shall be at least

$$V_{n \min} = 3 V_e^{2)} \quad (\text{B.5})$$

B.3.3 Expansion vessel with membrane and internal pressure generation

The nominal volume shall be at least

$$V_{n \min} = 1,5 (V_e + V_v) \quad (\text{B.6})$$

1) The factor 2 considers the respective initial water volume for expansion tanks.

2) The factor 3 considers the initial water volume for physically safeguarded plants with a sufficient gas cushion.

B.3.4 Membrane type expansion vessel

The nominal volume shall be at least

$$V_{n \min} = (V_e + V_v) [(p_e + 1)/(p_e - p_o)] \quad (\text{B.7})$$

For the effective volume V_o the following condition shall additionally be met:

$$V_o \geq V_e + V_v \quad (\text{B.8})$$

To ensure that the membrane expansion vessel contains the initial water volume for the cold plant condition, the filling pressure shall at least attain the following value:

$$p_{a \min} = [V_n(p_o + 1)/(V_n - V_v)] - 1 \quad (\text{B.9})$$

where

V_n is the nominal volume of the selected vessel size.

To ensure that at maximum flow temperature the final pressure p_e (see B.2.6) is not exceeded, the filling pressure shall not exceed the following value:

$$p_{a \max} = \frac{p_e + 1}{1 + \frac{V_e(p_e + 1)}{V_n(p_o + 1)}} - 1 \quad (\text{B.10})$$

To ensure that the filling pressure is correctly set, $p_{a \max}$ shall be at least 0,2 bar higher than $p_{a \min}$. If this is insufficient, a greater expansion space shall be selected.

B.3.5 Expansion vessels with a membrane and external pressure generation (e.g. pressure pump or compressed gas system)

The nominal volume shall be at least

$$V_{n \min} = V_v + V_e \quad (\text{B.11})$$

The following condition shall additionally be met

$$V_o \geq V_v + V_e \quad (\text{B.12})$$

B.3.6 Requirements for expansion vessels and tanks

Expansion vessels and tanks shall be designed to safely withstand the mechanical and thermal loadings. Adequate corrosion protection shall be provided.

Annex C (informative)

Aspects of boiler operation

C.1 General

This Annex gives recommendations of operation and testing of the boiler system with a maximum time of operation without manual (human) intervention of 72 hours.

C.2 Maintenance

An inspection organisation or the supplier's maintenance service should be responsible for the checking and/or testing of the controls and limiting devices at regular intervals, at least half yearly or more frequently if problems are experienced.

C.3 Boiler operation and testing

The following Tables C.1 and C.2 are recommendations for observation and testing of the boiler system. This information should be part of the boiler manufacturer's instruction manual together with specified corrective actions for the equipment supplied.

Table C.1 – Check list for steam boiler

Observation and testing	Clauses	3 days	1 month	3 months	6 months	12 months	Remarks
Safeguards against excessive pressure (safety valves)	4.1	O			T		See NOTES 1 and 2
Water level indication	5.1	T					Compared with limiters and controls
Drain and blow-down devices	4.6	T					-
Valves	5.3	O			T		As per manufacturer's instruction manual
Feed water control	5.5	O			T		-
Low water protection	5.6.1	O	T				Functional check by lowering the water level to the switching points
Steam pressure and temperature indication	5.2	O					Compared with limiters and controls
Pressure limitation	5.6.2	O	T				Functional check by increasing the pressure to the switching points
Temperature limitation	5.6.3	O	T				-
Devices for water quality protection	4.8	O	T (1)		T (2)		(1) Comparison of the measured values with the reliable samples (see 4.7.2) (2) Performed by a suitably qualified and competent person
Protective systems	4.3	O			T (3)		(3) Electrical and mechanical testing performed by a suitably qualified and competent person
Pressure parts (pipes, inspection openings, flanges, gaskets, joints...)	-		O				

Table C.1 (continued)

Observation and testing	Clauses	3 days	1 month	3 months	6 months	12 months	Remarks
Pressure controller and temperature controller	4.4.1	O			T		
Feed water supply	5.4	O		T			
Water quality	4.7	T (4)					(4) see EN 12953-10
Heat supply	4.4	O				T (5)	(5) Performed by a suitably qualified and competent person as per manufacturer's instruction manual but not less than once a year
(O) Observation of abnormal noises, smells or other noticeable factors.							
(T) Checking and/or testing the functional behaviour of equipment parts, including observation.							

Table C.2 – Check list for hot water boiler

Observation and testing	Clauses	3 days	1 month	3 months	6 months	12 months	Remarks
Safeguards against excessive pressure (safety valves)	4.1	O			T		See NOTES 1 and 2
Water level indication	6.4	O					-
Drain and blow-down devices	4.6	O					-
Vent valves	6.6	O			T		As per manufacturer's instruction manual
Low water protection	6.5.1	O		T			May be carried out by simulation according to 4.3.3
Pressure and temperature indication	6.7	O					Compared with limiters and controls
Pressure limitation	6.5.2	O		T			May be carried out by simulation according to 4.3.3
Temperature limitation	6.5.2	O		T			May be carried out by simulation according to 4.3.3
Circulation limitation	6.5.3	O	T				-
Devices for water quality protection	4.8.3	O	T (1)		T (2)		(1) Comparison of the measured values with the reliable samples (see 4.7.2) (2) Performed by a suitably qualified and competent person
Protective systems	4.3	O			T (3)		(3) Electrical and mechanical testing performed by a suitably qualified and competent person
Pressure parts (pipes, inspection openings, flanges, gaskets, joints...)	-		O				-
Pressure controller and temperature controller	4.4.1 6.8	O			T		-

Table C.2 (continued)

Observation and testing	Clauses	3 days	1 month	3 months	6 months	12 months	Remarks
Water supply	6.3	O		T			-
Water quality	4.7		T (4)				(4) see EN 12953-10
Heat supply	4.4	O				T (5)	(5) Performed by a suitably qualified and competent person as per manufacturer's instruction manual but not less than once a year
(O) Observation of abnormal noises, smells or other noticeable factors. (T) Checking and/or testing the functional behaviour of equipment parts, including observation.							

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

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

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

Annex D (informative)

Drain and blowdown devices

D.1 General

This Annex gives guidelines related to the design of the drain and blowdown devices.

D.2 Design of the drain and blowdown devices

D.2.1 Blowdown vessels should be designed to take into account the worst possible blowdown condition for the boiler(s) to which it is connected, particularly the maximum momentary surge pressure occurring during a blowdown. If this pressure can exceed 0,5 bar then the vessel should comply with the requirements of the PED 97/23/EC.

This necessitates detailed analysis for the discharge condition, vessel size and vent diameter. In the absence of such analysis the design pressure of the blowdown vessel should be 25 % of the maximum allowable pressure of the boilers and the design temperature should be steam saturation temperature at the design pressure. This ensures that the thickness of the vessel incorporates some provision for corrosion and/or erosion in service.

D.2.2 The blowdown vessel should have sufficient strength to withstand the shock loading of intermittent blowdown and external loading from pipes and attachments.

D.2.3 The blowdown pipework should be designed to withstand the rapid pressurisation, high velocity, thermal shock and vibration associated with blowdown. The pipework should be suitably supported.

D.2.4 The size of the blowdown vessel and the quantity of standing water in the tank should be sufficient to ensure adequate cooling of the blowdown water (at the maximum blowdown rate and duration) before it enters the drain. The space above the standing water should be sufficient to allow for expansion of flash steam.

D.2.5 The inlet pipe can either discharge into the standing water or above the water line. In the latter case areas of the shell which are exposed to water impingement from the inlet flow should be protected from erosion/corrosion.

D.2.6 The vent pipe should be designed in order that:

- the accumulation pressure during blowdown does not exceed the vessel design pressure, in the absence of such analysis the diameter of the vent pipe should be 4 times the diameter of the inlet pipe;
- flash steam is vented safely and there is no carry over of water at the exit of the vent pipe;
- it is as straight as possible with no valve or other obstruction to prevent free flow.

D.2.7 The drain pipe should:

- be designed so it is of sufficient size to prevent excessive accumulation of water during blowdown, in the absence of such analysis the outlet should have an internal diameter of at least 1,5 times the internal diameter of the inlet pipe;
- be connected so that the blowdown vessel remains approximately half full of water after each blowdown and flash steam is prevented from entering the drain.

D.2.8 The external surface of the blowdown vessel should normally be left without insulation to permit cooling of the standing water. The installation should therefore incorporate barriers or other means of protection to prevent accidental contact with the hot surfaces.

Annex E (informative)

Alarms and monitoring from the boiler plant

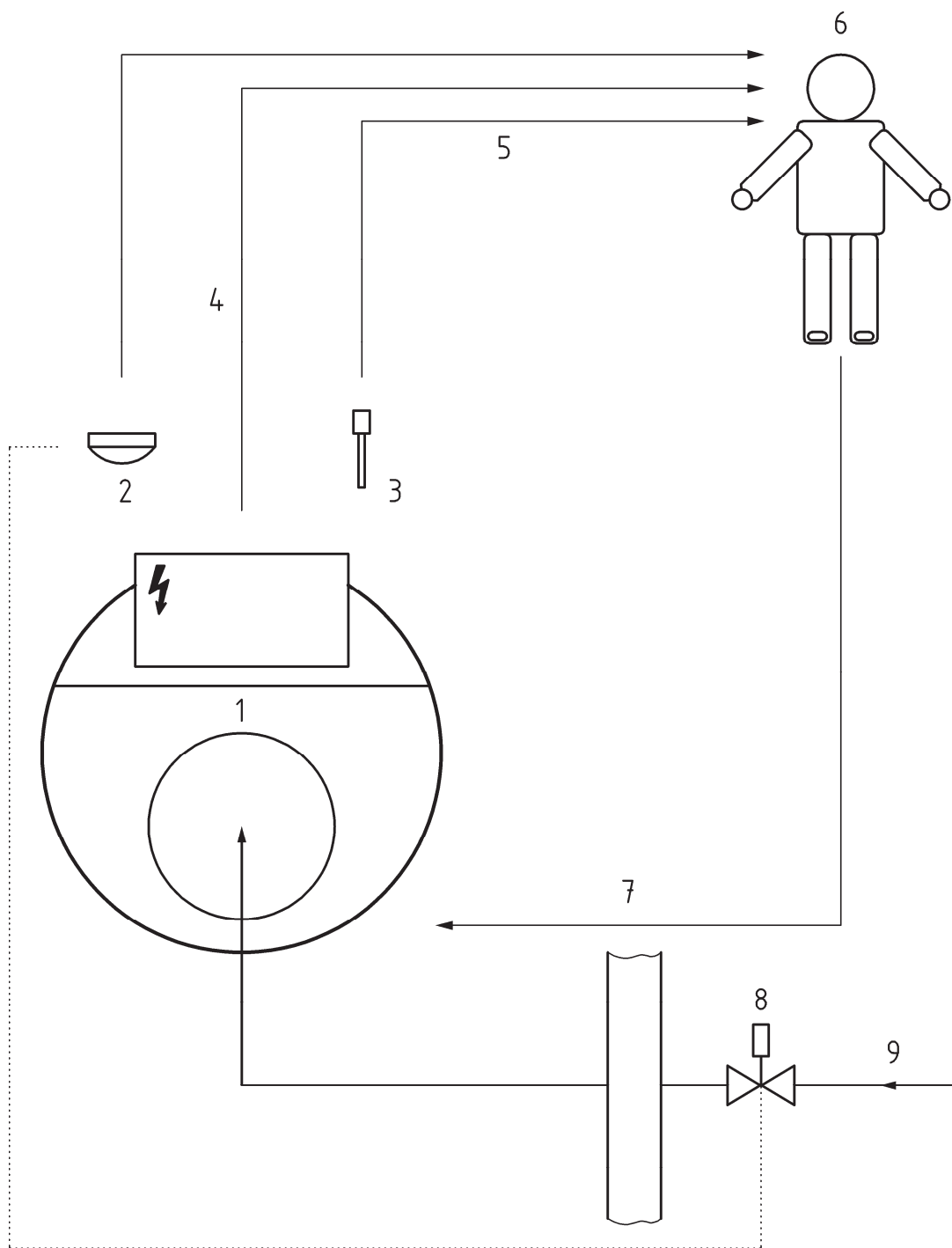
E.1 General

This Annex gives information on alarms and monitoring.

E.2 Conditions for alarms and monitoring

The conditions for alarms and monitoring the boilers at a site separated from the boiler location should be as follows (see also Figures E.1 and E.2):

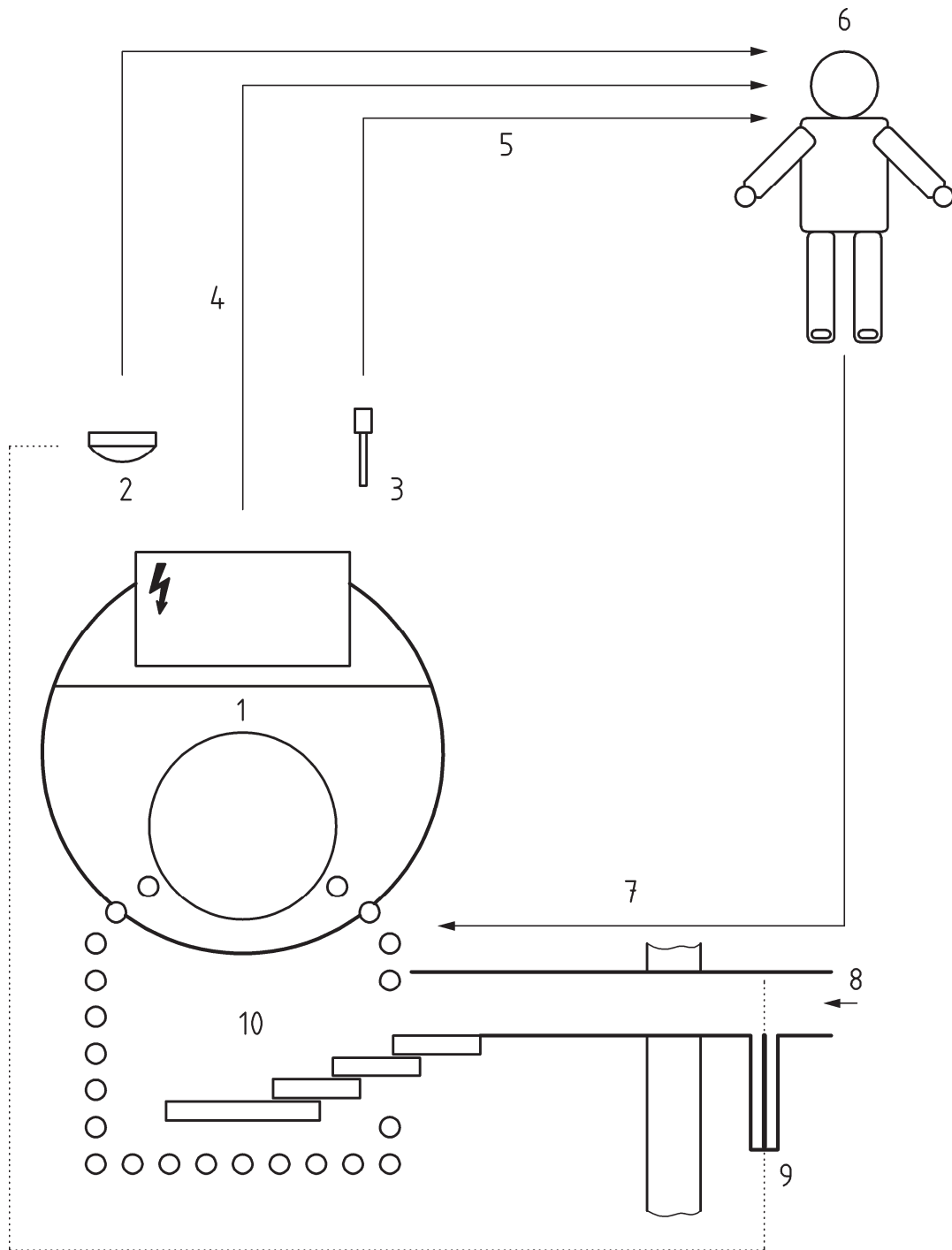
- a boiler may not be reset remotely after a lockout condition; it should be attended by the boiler operator and should be reset locally (in the boiler location) (see 4.3.5);
- remote alarm panels should provide sufficient information to determine which boiler(s) are in operation or alarm condition and, where appropriate, an additional emergency stop facility;
- if remote emergency shutdown/lockout of the boiler is provided, then acknowledgement and completion of this command should be transmitted back to the remote system;
- if a rapid response is required to a lock-out to maintain the steam/hot water flow to the downstream process then duplicate or parallel systems should be provided;
- the remote system should be able to gain the attendants attention in the ambient conditions present at its location.



Key

- 1 boiler
- 2 fire sensor
- 3 moisture sensor
- 4 boiler alarm
- 5 alarms have to reach the boiler attendant via radio or phone (or other suitable technical possibilities)
- 6 boiler attendant
- 7 the boiler attendant has to be able to reach the boiler location within X hours
- 8 main valve
- 9 fuel

Figure E.1 — Alarms for oil or gas applications



Key

- 1 boiler
- 2 fire sensor
- 3 moisture sensor
- 4 boiler alarm
- 5 alarms have to reach the boiler attendant via radio or phone (or other suitable technical possibilities)
- 6 boiler attendant
- 7 the boiler attendant has to be able to reach the boiler location within X minutes
- 8 solid fuel
- 9 shut-off
- 10 furnace

Figure E.2 — Alarms for solid fuel applications

Annex F (informative)

Significant technical changes between this European Standard and the previous edition

Clause/Paragraph/Table/Figure	Change
General	The revision of EN 12953-6:2002 was dedicated to fulfil the European Guidelines 8/15 and 9/20 related to the essential safety requirements of Annex I of the PED 97/23/EC regarding boilers intended for operation without continuous supervision.
2 / Normative references	References updated.
4.3 / Protective systems 4.7 / Water quality 4.8 / Water quality protection 5.6 / Limiting devices	Revision of sub-clauses for introduction of technical recommendations related to the shell boiler operation without manual (human) intervention.
7 / Operational aspects including maintenance and testing	New sub-clause introduced.
Annex C / Aspects of boiler operation	New annex introduced giving recommendations for operation and testing of the boiler system with a maximum time of operation without manual (human) intervention of 72 h.
Annex E / Alarms and monitoring from the boiler plant	New annex introduced.
Annex ZA / Relationship between this European Standard and the Essential Requirements of EU Directive 97/23/EC	Modification of the annex.
<p>NOTE The technical changes referred include the significant technical changes from the EN revised but is not an exhaustive list of all modifications from the previous version.</p>	

Annex ZA (informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 97/23/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission to provide a means of conforming to Essential Requirements of the New Approach Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Directive 97/23/EC

Clause(s)/subclause(s) of this EN 12953-6	Essential Requirements (ESRs) of Directive 97/23/EC	Qualifying remarks/Notes
4.6.3, 5.1.6, 5.1.7, 5.3.1, 6.9	2.3	Provisions to ensure safe handling and operation
4.6, 6.6	2.5	Means of draining and venting
4.6.1, 5.5.2, 6.9	2.9	Provisions for filling and discharge
4.1, 4.3, 4.4, 4.5, 4.8.1, 5.1, 5.2, 5.6, 6.4, 6.5, 6.7, 6.8	2.10	Protection against exceeding allowable limits
4.3.1, 4.3.2, 4.3.3, 4.8.1, 4.8.2, 4.8.3, 7	2.11.1	Safety accessories
4.4, 4.5, 5.6.1, 5.6.3, 6.5.1, 6.5.2.3, 6.5.3	5 a	To avoid any risk of local and general overheating
4.7.2	5 b	Sampling points to avoid risks related to deposits and/or corrosion
4.7, 4.8	5 c	To eliminate risks of damage from deposits
4.4.1	5 d	Safe removal of residual heat after shutdown

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

- [1] Council Directive 97/23/EC of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment (Pressure Equipment Directive "PED")
- [2] ISO 14617-6, *Graphical symbols for diagrams — Part 6: Measurement and control functions*
- [3] EN 12953-3:2002, *Shell boilers — Part 3: Design and calculation for pressure parts*

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