BRITISH STANDARD

BS EN
12953-6:2002

Shell boilers —

Part 6: Requirements for equipment for the boiler

The European Standard EN 12953-6:2002 has the status of a British Standard

ICS 27.060.30; 27.100

National foreword

This British Standard is the official English language version of EN 12953-6:2002. It partially supersedes BS 2790:1992 which will be withdrawn on publication of BS EN 12953 Parts 1, 2, 3, 4, 5, 6, 8 and 9.

When the reference to this European Standard has been published in the Official Journal of the European Communities (OJ), compliance with it will confer a presumption of conformity with the essential requirements covered by the standard in respect of the Pressure Equipment Directive.

The UK participation in its preparation was entrusted to Technical Committee PVE/16, Shell boilers, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

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Shell boilers - Part 6: Requirements for equipment for the boiler

Chaudières à tubes de fumée - Partie 6: Exigences pour l'équipement de la chaudière

Großwasserraumkessel - Teil 6: Anforderungen an die Ausrüstung für den Kessel

This European Standard was approved by CEN on 15 May 2002.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Contents

Foreword

This document (EN 12953-6:2002) 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 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 standard.

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 November 2002, and conflicting national standards shall be withdrawn at the latest by November 2002.

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.

Annex A is normative and Annexes B and C are informative.

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

1 Scope

This Part of this European Standard specifies requirements for safety related equipment for shell boilers as defined in EN 12953-1, irrespective of the degree of supervisions.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 12953-1, *Shell boilers - Part 1: General.*

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

EN 12953-3:2002, *Shell boilers - Part 3: Design and calculation for pressure parts.*

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

prEN 12953-9, *Shell boilers - Part 9: Requirements for limiting devices and safety circuits of the boiler and accessories.*

prEN 50156-1, *Electrical equipment for furnaces and ancillary equipment - Part 1: Requirements for application design and installation.*

3 Terms and definitions

For the purposes of this Part of this European Standard, the terms and definitions given in EN 12953-1 apply in addition to the following.

3.1
controls
devices used for maintaining the variable to be controlled (e.g. water level, pressure, temperature) at a specific value (set point)

3.2
limiters
device that, on reaching a fixed value (e.g. pressure, temperature, flow, water level) is used to interrupt and lock-out the energy supply and lock-out requires manual unlocking before restart

3.3
independent
ability to function as required without dependence upon other equipment

3.4
lock-out
isolation of energy supply which requires a manual intervention to reinstate

3.5
functional check
testing of the safety device to ensure it performs its intended function

3.6
electrically heated boilers
boilers in which water is heated by an electric current flowing between electrodes or by immersion heaters

3.7
expansion vessels and tanks
containers to compensate for temperature dependent volume changes of the water

— expansion vessels are pressurised

— expansion tanks are not pressurised

3.8
allowable heat output of a hot water generator
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 generators can be operated

3.9
allowable flow temperature
highest temperature, measured at the outlet branch at which the hot water generator can be operated (see 6.8.2.3)

3.10
maximum continuous rating (MCR)
maximum continuous steam output that can be generated during continuous operation taking the specified steam condition into consideration

4 General requirements for steam boilers and hot water generators

4.1 Safeguards against excessive pressure

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

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 Limiting devices and safety circuits

4.3.1 All limiters and their installation shall be designed in accordance with prEN 12953-9. The electrical safety circuits shall be in accordance with prEN 50156-1:1999, Table 1 and Annex B.

4.3.2 Functional checking of all limiters shall be possible at any time during operation e.g. by simulation where appropriate.

4.3.3 If a limiter responds, a signal shall be given to indicate the reasons for boiler/generator malfunction.

4.3.4 After lock out, it shall only be possible to manually restart the boiler/generator from the boiler house.

4.4 Temperature measurement of the furnace wall

If in accordance with EN 12953-3:2002, 5.4 it is established that temperature measurement of the furnace wall is necessary, the temperature signal shall be transmitted to a temperature limiter. The limiting temperature shall be determined by the manufacturer.

4.5 Heat supply

4.5.1 The heat supply shall be automatically controlled in relation to heat demand and the combustion process shall be completed within the furnace. In the event of shutdown, residual heat shall not cause unacceptable metal temperatures (e.g. by evaporation of the water).

4.5.2 The design of the heat supply system and the boiler/generator shall ensure that no excessive evaporation of the water inside the boiler/generator occurs due to the heat accumulation in the combustion chamber and in the boiler/generator passes upon "cut off" of the heat supply.

NOTE This requirement is deemed to have been met for oil and gas firing systems:

— if it is proved that, after switching off the heat supply system from full load steady state condition, the flue gas temperature at the highest point of the heated surface (HHS) falls to a value below 400 °C before the water level has sunk from the lowest water level (LWL) to 50 mm above the highest point of the heated surface (HHS), or
— if adequate feed water is ensured (see 5.5).

4.5.3 Automatic start-up of the boiler/generator and the system shall be permitted provided that equipment is installed to ensure that start-up is conducted safely. Automatic restarting after normal shut-down shall not be considered as a start-up.

4.6 Flue-gas heated economizers

Economizers shall be fitted with a temperature indicating device on the water outlet, and each economizer that can be isolated, shall be provided with a pressure gauge in addition to the safety pressure relief device (see EN 12953-8:2001, 4.1.4).

5 Special requirements for steam boilers

5.1 Water level indication

5.1.1 Each steam boiler, except for low pressure boilers, shall have at least two independent means of indicating the water level, one of which shall be a gauge of transparent material directly connected to the boiler shell. The other device may be a remote water level indicator or alternate device.

For low pressure boilers only one direct water level indicator shall be required.

5.1.2 The gauge(s) of transparent material shall be mounted so that the water level is visible in the gauge glass at the lowest alarm level, i.e. at the lowest permissible water level (LWL) which shall be marked on the gauge glass, and also at the maximum water level which shall be specified by the boiler manufacturer. The water level indicating device shall be so arranged that the value "50 mm below LWL" is visible unless otherwise dictated by the requirements in 4.5.2.

5.1.3 The (LWL) of the boiler (see Figure 5.1-1), which shall be permanently and legibly marked on the 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 equipment, 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 during which the water level will 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.

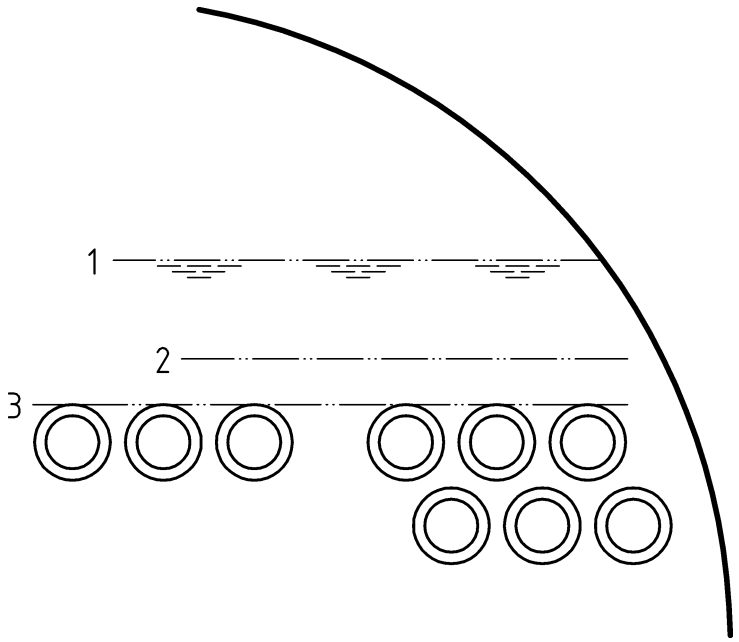
$$t = V/(Q_{st}\, v) \qquad (5.1\text{-}1)$$

where

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

V is the water volume of the boiler between LWL and HHS, in m^3;

v is the specific volume of water, in m^3/kg.



Key

1 Controlled water level
2 LWL
3 HHS

Figure 5.1-1 — Water level indication

5.1.4 Tubes and fittings connecting a water level gauge to a boiler shall be as short as possible and constructed so that no undrained pocket is formed between the boiler and the gauge. There shall be no outlet therefrom except for regulators, steam pressure gauges and drains or other similar apparatus which does not permit the escape of a significant amount of steam.

Tubes connecting a water level gauge to the boiler shall be not less than 25 mm bore, but it may be reduced to 20 mm at the connection with the gauges. Where the water gauge is fitted to the chamber of a safety control or alarm device, the connecting tubes to the boiler shall have a bore of not less than 40 mm.

5.1.5 Cylindrical water level gauge glasses shall be fitted with protectors.

5.1.6 Water level gauges shall be capable of isolation from the boiler and blowdown equipment. Where the valves used are cocks, the flow direction shall be indicated.

Blowdown equipment for water level gauges, regulators and limiters shall be so installed as to prevent accidents.

5.2 Steam pressure and temperature indication

5.2.1 Each 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 made suitable for the design working pressure of the boiler.

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

NOTE In addition, the operating pressure and the safety valve set pressure can also be indicated.

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

5.2.6 Temperature measuring instruments shall be installed at the outlet of each superheater stage.

5.3 Drain and blowdown devices

5.3.1 Each boiler shall be fitted with drain valves placed at, or as near as practicable to, the lowest point of the apparatus.

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

5.3.2 Where drain valves from two or more 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 boiler passing to another.

5.3.3 The drain pipe between the apparatus and the drain valve shall, if exposed to furnace heat, be protected by brickwork or other heat-resisting material so arranged that the pipe may be inspected and is not constrained against expansion.

5.3.4 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.

5.3.5 Where drain 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.

5.4 Valves for connections

5.4.1 Steam outlets

The stop valve connecting the boiler to the steam pipe shall be attached directly to the boiler. In the case of a boiler with a superheater, the stop valve shall be located at the outlet from the superheater header. The valve should preferably be of a type which positively indicates whether it is open or closed.

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

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

5.4.2 Feed connections

Each feed pipe to any boiler shall be provided with a non-return valve and a separate stop valve near the 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 relieve the pressure in the interconnecting piping.

The feed line and internal pipe connection to the boiler shall be so arranged that in the case of leakage of the non-return valve, the boiler cannot empty itself to a level less than 50 mm above the highest point of the heating surface containing gases at a temperature of more than 400 °C.

In the event of backflow through a feed pump, where the suction pipework is of a lower pressure rating than the discharge line, then pressure gauges shall be installed to clearly indicate the pressure head. Also, a warning notice shall be provided indicating the possible dangers of closing an isolating valve (if fitted) in the suction line.

5.5 Feed water supply

The boiler shall be provided with an adequate supply of feed water. Where feed water supply shall be ensured as required in 4.5.2, two feed water supplies shall be provided.

5.6 Feed water control

5.6.1 The water level shall be controlled automatically.

5.6.2 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. Where the feedwater supply is interrupted, the heat supply shall be cut off simultaneously if the economisers are endangered due to the interrupted feed.

5.6.3 It shall be ensured that no harmful matter (oil, grease, seawater etc.) can enter the feed water or boiler system.

5.7 Limiting devices

5.7.1 Low water protection

Two independent (both mechanically and electrically) water level limiters shall be provided to cut off and lock out the heat supply when the water level falls to the "LWL" position.

NOTE It is not necessary for both limiters to act simultaneously.

5.7.2 Pressure and temperature limitation

For all boilers, a pressure limiter shall be provided to cut off and lock out the heat supply to ensure that the allowable pressure is not exceeded.

Where a control in accordance with 5.8.2 is required, a temperature limiter shall be provided to cut-off and lock out the heat supply to ensure that the allowable metal temperature is not exceeded.

5.8 Heat supply

5.8.1 The pressure of each boiler shall be controlled automatically by regulating the heat input.

5.8.2 The superheated steam temperature shall be controlled automatically unless the design metal temperature is higher than the maximum attainable metal temperature.

5.9 Electrically-heated boilers

5.9.1 Steam boilers heated by electric current flowing between electrodes

All the requirements of clause 5 shall apply except 5.4.2 paragraph 3, 5.5, 5.7.1 and 5.8.2.

Contrary to 5.1.1, only one means of indicating the water level is sufficient.

5.9.2 Steam boilers heated by immersion heaters

5.9.2.1 All the requirements of clause 5 shall apply except for 5.4.2 paragraph 3 and 5.1.3, where the water level shall not be allowed to fall below the uppermost surface of the immersion heaters.

Contrary to 5.1.1, only one means of indicating the water level is sufficient.

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

Contrary to 5.7.1, only one safety device is sufficient.

6 Special requirements for hot water generators

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 Figures A.3-1 and A.3-2)

6.1.2 Closed systems shall not be connected to the atmosphere. They are subdivided into:

a) internally pressurised systems where the pressure is generated by the saturation pressure corresponding to the flow temperature (see Figures A.3-3 and A.3-4);

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.4-1 to A.4-5).

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 generator 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 generator 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. A separate expansion vessel or tank shall be used unless the steam space in the hot water generator 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 The system shall be equipped with a protective device against back flow (non-return valves) and a shut-off device. The same shall apply to the make-up water line.

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

6.2 Expansion and feed lines for open vented systems

To ensure safe operation of the generator the internal diameter of the feed and expansion lines shall be determined by the following (see also Figure 6.2-1):

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

expansion line: $$d_i = 15 + 1{,}397\sqrt{Q_h} \quad (6.2\text{-}1)$$

feed line: $$d_i = 15 + 0{,}9273\sqrt{Q_h} \quad (6.2\text{-}2)$$

where

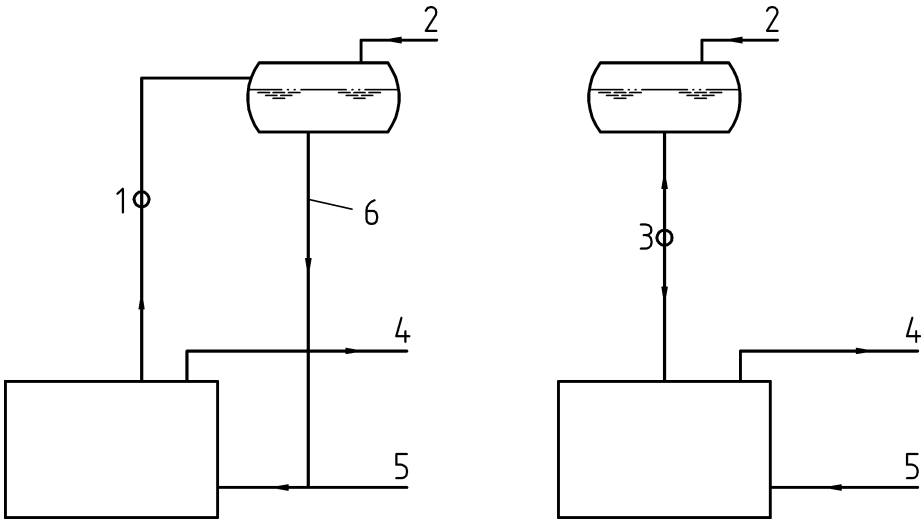
Q_h is the heat output from the boiler, in kW

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

combined: $d_i = 1{,}25\ (15 + 1{,}397\ \sqrt{Q_h})$ (6.2-3)

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

Figure 6.2-1 — Open vented system

6.3 Water supply

6.3.1 The generator system shall be provided with an adequate supply of water.

6.3.2 If the possibility exists that harmful matter (oil, grease, seawater, etc) may enter the water circulating systems, thus endangering the hot water generator, the quality of the water returning to the hot water generator shall be monitored.

6.4 Circulating pumps

6.4.1 Circulating pump(s) shall be provided to maintain circulation.

6.4.2 For generators fitted with manually operated solid fuel firing systems, two circulating pumps shall be provided with independent power supply.

6.4.3 Should the circulating pump(s) fail, then the heat supply shall automatically be cut off and locked out.

NOTE This does not apply to manually operated systems.

6.5 Drain devices

If the drain device is not self-closing or capable of being locked in the closed position a further shutoff device shall be installed in the line. The requirements for drain devices shall be in accordance with 5.3.

6.6 Water level indication

6.6.1 "LWL" shall be marked on each hot water generator operating with an internal steam cushion, a closed expansion vessel with a steam cushion (see Figures A.3-4 and A.4-5), a gas cushion (see Figure A.4-3) and an open expansion vessel associated with pump pressurisation systems (see Figure A.4-4).

6.6.2 For hot water generators 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 during which the water level will sink from the lowest water level (LWL) to the highest point of the heated surface (HHS) in the case of interrupted feeding and recirculation and at the allowable heat output, i.e.

$$t = V/(Q_{st,\,equiv}\, v) \qquad (6.6\text{-}1)$$

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 m^3;

v is the specific volume of water, in m^3/kg.

6.6.3 For hot water generators operating with a steam cushion, the flow and return pipes shall terminate at least 50 mm below the lowest water level (LWL).

6.6.4 For hot water generators operated without a steam space, the flow pipe shall be connected at the highest point of the hot water generator.

6.6.5 For hot water generators 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 apply.

6.6.6 Water level indicators shall be fitted to closed expansion vessels operating under a steam cushion (see Figures A.3-4 and A.4-5), a gas cushion (see Figure A.4-3) and open expansion tanks associated with pump pressurisation systems (see Figure A.4-4 and also Table 6.16-1).

6.7 Water supply control

The water level shall be controlled automatically if required by operation or plant design.

6.8 Limiting devices

6.8.1 Low water protection

6.8.1.1 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.

6.8.1.2 For hot water generators operating with an internal steam cushion, the requirements for water level limiters shall be the same as for steam boilers and the requirements of clause 5 shall apply.

6.8.1.3 For hot water generators with an external steam cushion in closed expansion vessels, water level limiters shall be fitted to the vessels (see Figures A.3-4 and A.4-5)

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

6.8.2 Pressure and temperature limitation

6.8.2.1 With the exception of open vented systems all hot water generators shall be fitted with a maximum pressure limiter to cut off and lock out the heat supply to ensure that the allowable pressure is not exceeded.

6.8.2.2 To prevent unintentional steam generation, each system, with external pressure generation shall be equipped with a minimum pressure limiter which shall ensure that the heat supply is cut off and locked-out if the pressure falls below the minimum gauge pressure individually determined for each system.

In systems with membrane type expansion vessels, a test gauge connection shall be provided with which it is possible to check whether the vessel is properly filled with gas.

In systems with external pressure generation by pressure pumps, the cross-over pipe (shut-off valve in return line to suction side of pressure pump) shall be automatically closed if the minimum pressure limiter responds.

6.8.2.3 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.

6.9 Vent valves

For hot water generators, other than open vented systems and for other than those with internal steam cushion, a test valve shall be provided at or above the highest point of the generator.

NOTE This valve is used when filling and emptying the generator and when testing the function of the low water limiter fitted in accordance with 6.8.1.4.

6.10 Steam pressure and temperature indication

6.10.1 One temperature indicating device shall be installed in both the flow and return line of each hot water generator. The maximum flow temperature shall be marked on the indicating device.

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

6.10.3 In addition to the pressure gauge on the hot water generator, one pressure gauge shall be provided on expansion vessels operating with a steam cushion (see Figures A.3-4 and A.4-5) or a gas cushion (see Figure A.4-2 and A.4-3).

6.11 Pressure controller

Each closed system shall be equipped with a pressure controller. This shall not apply to systems with external pressure generation by a non-refillable gas cushion in the closed expansion vessel (see Figure A.4-1)

The pressure controllers shall be installed as follows:

— in systems with internal pressure generation (see Figures A.3-3 and A.3-4), on either the hot water generator or the expansion vessel;

— in systems with external pressure generation by a refillable gas cushion (see Figures A.4-2 and A.4-3) or an external steam cushion (see Figure A.4-5), on the expansion vessel;

— in systems with external pressure generation by pressure pumps (see Figure A.4-4) downstream of the pump.

6.12 Discharge from safety valves

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

6.13 Heat supply

6.13.1 The flow temperature of the hot water generator shall be controlled automatically by influencing the heat input (temperature controller).

6.13.2 For internal steam cushioned hot water generators, the steam pressure may be controlled automatically in lieu of the flow temperature, in which case the temperature controller may be replaced by a pressure controller and the temperature limiters by one pressure limiter.

6.14 Electrically heated hot water generators

For electrically heated hot water generators operating with an internal steam cushion, the requirements shall be the same as for steam boilers and the requirements of clause 5 shall apply.

6.15 Parallel mode of operation of hot water generators

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

— for hot water generators with internal steam cushion if subject to a specific design assessment;

— for hot water generators with one common expansion vessel.

6.16 Safety equipment for hot water generators

The number of safety devices to be installed shall be in accordance with Table 6.16-1.

Table 6.16-1 — Safety equipment for hot water generators

Equipment (No. in clause A.2)	Location	Plants with internal pressure generation			Plants with external pressure generation				
		Open vented system [a]	Closed system under steam pressure						
			steam cushion in the boiler [b]	steam cushion in the expansion vessel [c]	with gas cushion (closed expansion vessel) [d]	with gas cushion (Air or N_2) [e]	with gas cushion (N_2) [f]	with pressure pump [g]	with external steam cushion [h]
pressure indicator (3)	generator expansion vessel	1 —	1 —	1 1	1 —	1 1	1 1	1 —	1 1
pressure controller (23)	generator expansion vessel	— —	1 —	1 or 1	— —	— 1	— 1	1 on return line	1
max. pressure limiter (2)	generator expansion vessel	— —	1 —	1 or 1	1 —	1 —	1 —	1 —	1 —
min. pressure limiter (14)	generator return line	— —	— —	— —	1 or 1	1 or 1	1 or 1	1 or 1	1 or 1
safety valve (6)	generator expansion vessel	— —	1 —	1 1	1 —	1 1	1 1	1 —	1 1
water level indicator (25)	generator expansion vessel	— 1	2 —	— 2	— —	— —	— 1	— 1	— 1
water level controller (4)	generator expansion vessel	— 1	1 —	— 1	— —	— —	— 1	— 1	— 1
min. water level limiter (7)	generator expansion vessel	1 —	2 —	— 2	1 —	1 —	1 1	1 1	1 1
max. water level controller (16)	generator expansion vessel	— —	1 —	— 1	— —	— —	— 1	— —	— 1
vent valve (11)	generator	—	—	1	1	1	1	1	1
temperature indicator (10)	generator return line	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
temp. control (9)	generator	1	—	—	1	1	1	1	1
min. temp. control (30)	return line	1 [i]	1 [i]	1 [i]	1 [i]	1 [i]	1 [i]	1 [i]	1 [i]

Table 6.16-1 (*continued*)

Equipment (No. of Legend)	Location	Plants with internal pressure generation			Plants with external pressure generation				
		Open vented system [a]	Closed system under steam pressure						
			steam cushion in the boiler [b]	Steam cushion in the expansion vessel [c]	with gas cushion (closed expansion vessel) [d]	with gas cushion (Air or N_2) [e]	with gas cushion (N_2) [f]	with pressure pump [g]	with external steam cushion [h]
max. temp. limiter (8)	generator	1	—	—	1	1	1	1	1
pressure pump (22)	expansion tank	—	—	—	—	—	—	1	—
Constant pressure valve (27)	line to expansion tank	—	—	—	—	—	—	1	—
automatic shut-off valve (24)	line to expansion tank	—	—	—	—	—	—	1	—

[a] See Figures A.3-1 and A.3-2
[b] See Figure A.3-3
[c] See Figure A.3-4
[d] See Figure A.4-1
[e] See Figure A.4-2
[f] See Figure A.4-3
[g] See Figure A.4-4
[h] See Figure A.4-5
[i] If required in accordance with 6.1.4

7 Small shell boilers

7.1 Steam boilers

For equipment for steam boilers with a pressure less than 32 bar or a pressure volume product less than 200 bar l the requirements of clauses 4 and 5 shall apply except that the number of the devices shall be in accordance with Table 7.1-1.

Table 7.1-1 — Equipment for small steam boilers

Equipment	number
Safety valve	1
Minimum water level limiter	1
Maximum water level imiter	—
Water level indicator	1 [a]
Temperature indicator (Superheater)	—
[a] direct or indirect	

7.2 Hot water generators

For equipment for hot water generators with a pressure less than 32 bar or a pressure volume product less than 200 bar l the requirements of clauses 4 and 6 shall apply except that the number of the devices shall be in accordance with Table 7.2-1.

Table 7.2-1 — Equipment for small hot water generators

Equipment	number
Safety valve	1
Pressure controller	—
Minimum water level limiter	1
Water level controller	—
Water level indicator	1 [a]
Maximum temperature limiter	1
Temperature indicator	1
Circulating pump	1 [b]
[a] only required for hot water generators with steam cushion [b] if required	

8 Operational aspects

Information on operational aspects are given in Annex C.

Annex A
(informative)

Examples of hot water generating systems

A.1 General

This annex gives examples of hot water generating systems.

A.2 Legend to figures

1 Hot water generator
2 Maximum pressure limiter [PSZ + A +]
3 Pressure indicator [PI]
4 Water level controller [LC]
5 Flash vessel (see 6.12)
6 Safety valve [PSV]
7 Minimum water level limiter [LSZ-A-]
8 Temperature limiter [TSZ + A +]
9 Temperature controller [TC]
10 Temperature indicator [TI]
11 Vent valve for checking the water level
12 Stop valve (safeguarded against unintentional closing) [V]
13 Expansion vessel
14 Minimum pressure limiter [PSZ-A-]
15 Protective device against backflow
16 High water protection (may be integrated in water level controller (4)) [LS + A +]
17 Shut-off valve [V]
18 Line to expansion vessel
19 Feed pump
20 Heat supply system [B]
21 Pressure reducing valve [PCV]
22 Pressure pump
23 Pressure controller [PC]
24 Automatic shut-off valve (self-closing on power loss)
25 Water level indicator [LIG]
26 Expansion tank
27 Constant pressure valve (if self-closing or if actual pressure is less than the pressure on power loss, then 24 may be omitted)
28 Stop valve with master pressure gauge connection [V]
29 Three-way-valve [V]
30 Minimum temperature controller [TC] (if required in accordance with 6.1.4)
31 Drain device [V]
32 Level control valve [LCV]

A.3 Plant with internal pressure generation

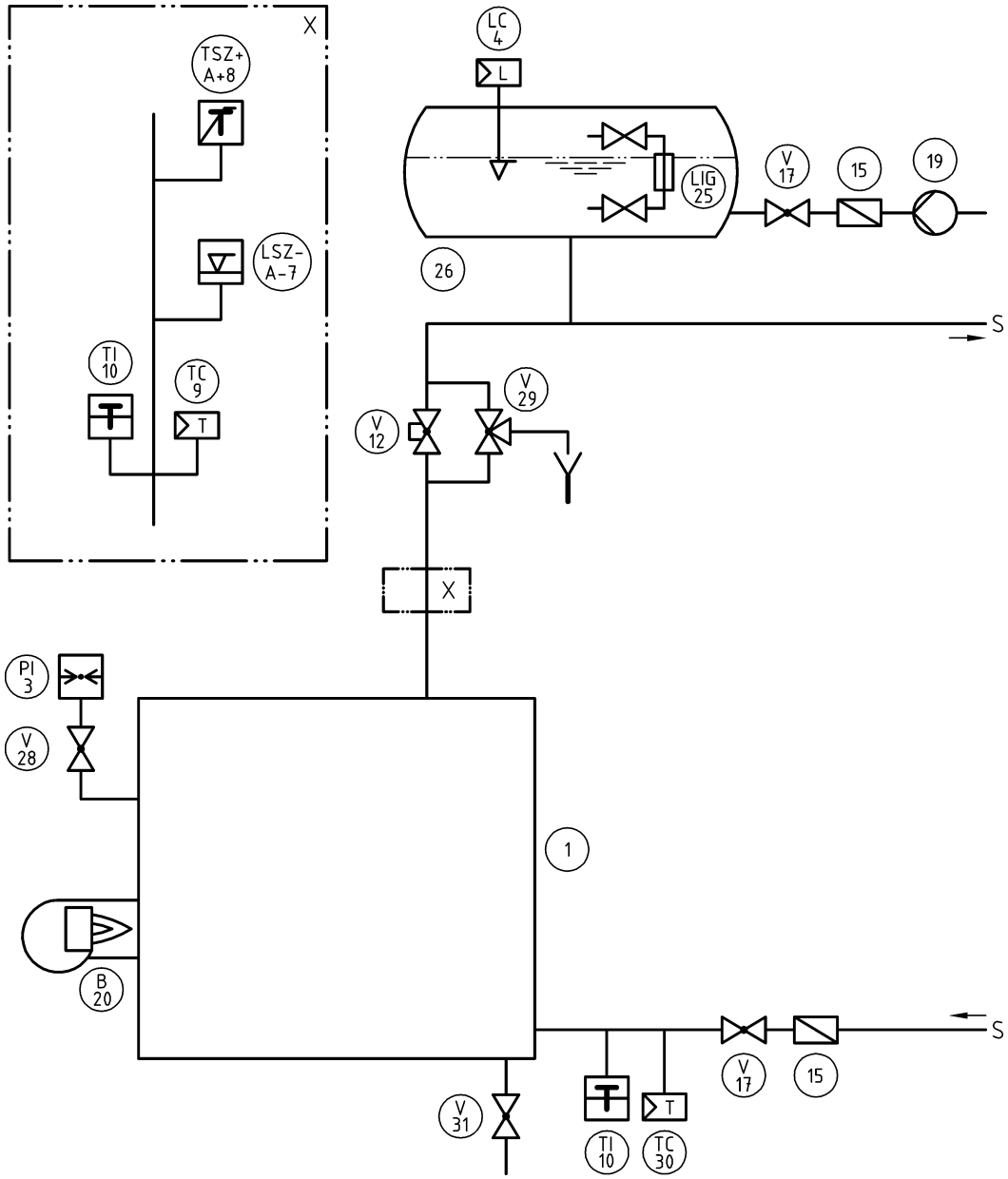


Figure A.3-1 — Open vented system
Example A

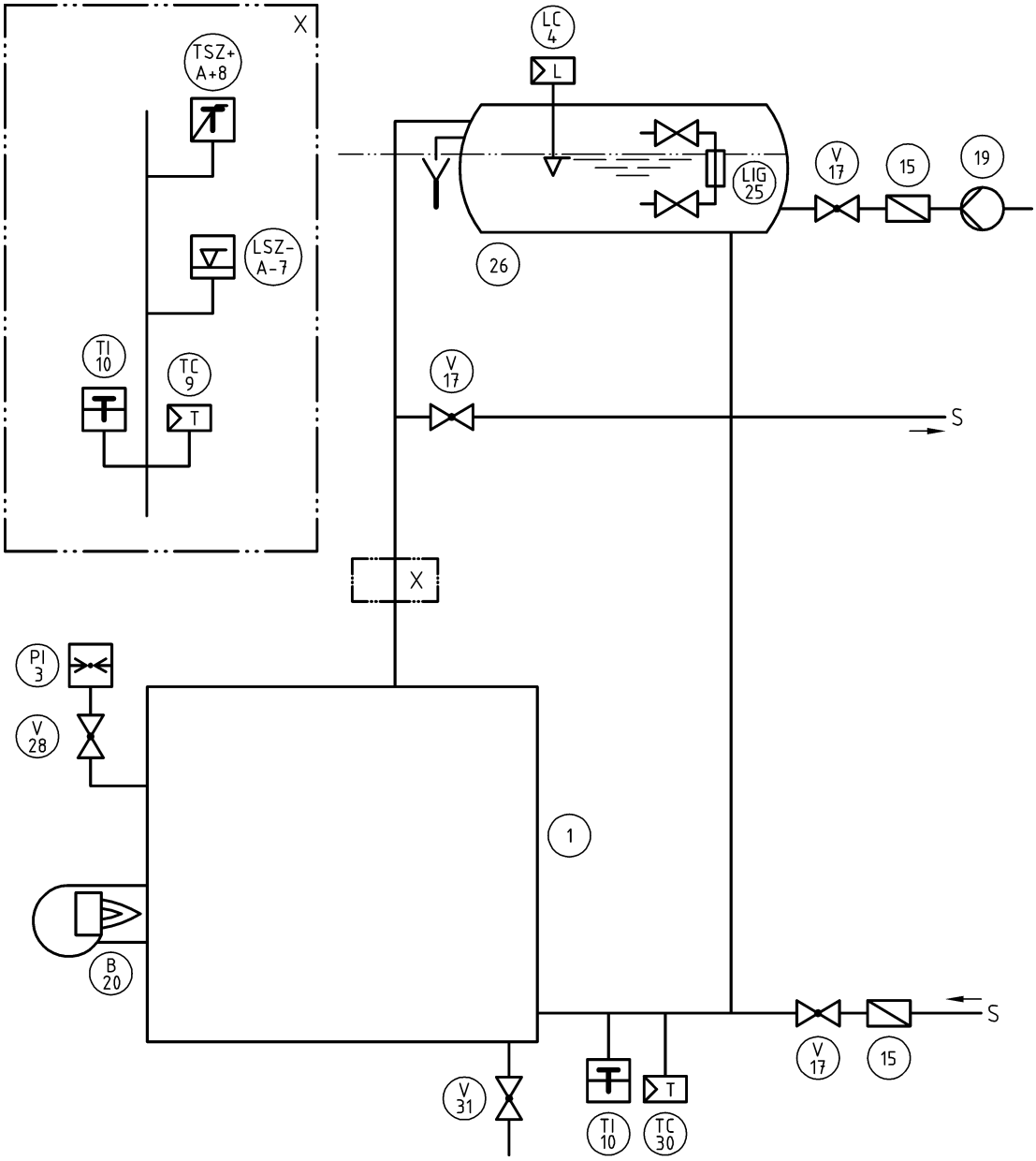


Figure A.3-2 — Open vented system
Example B

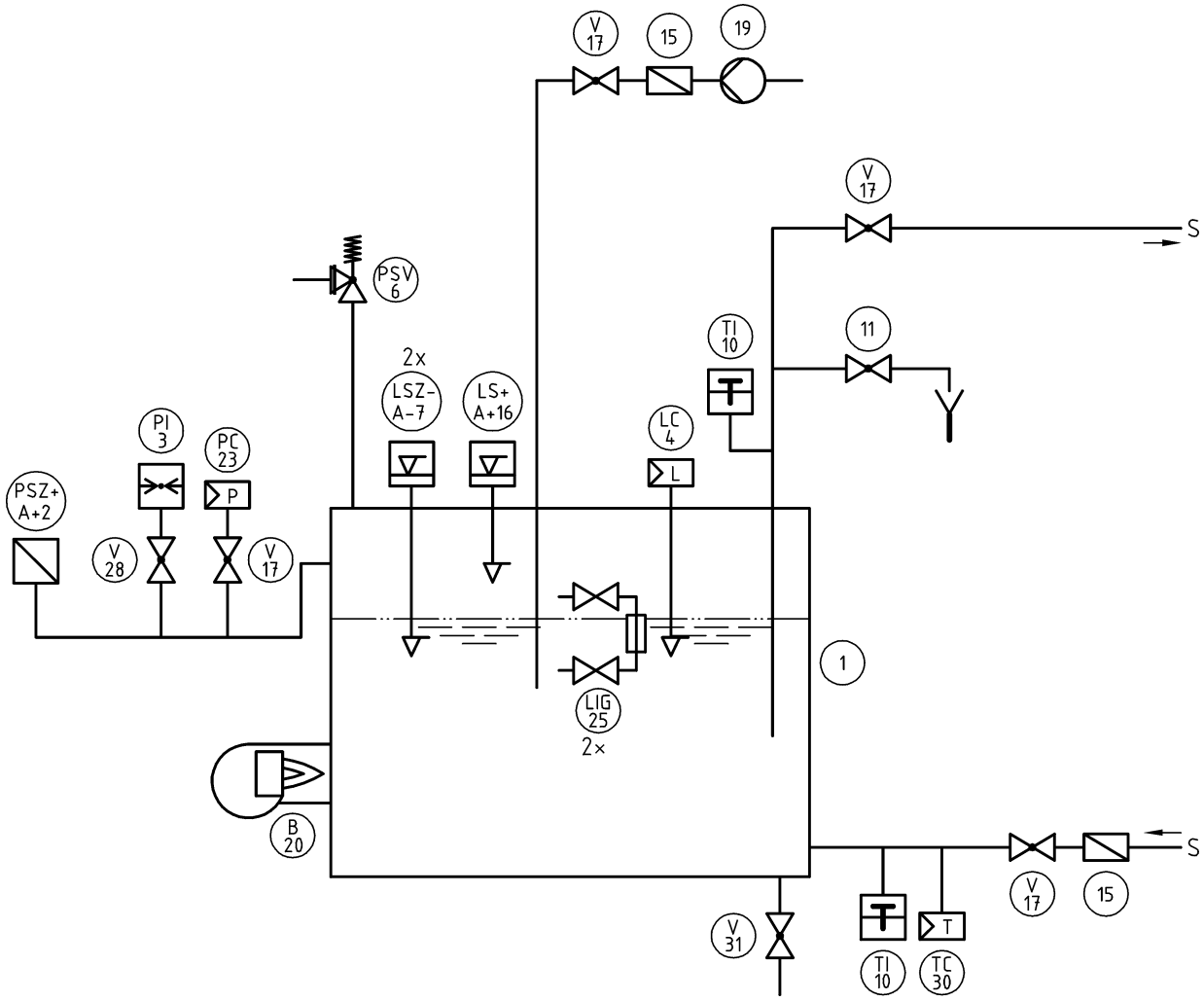
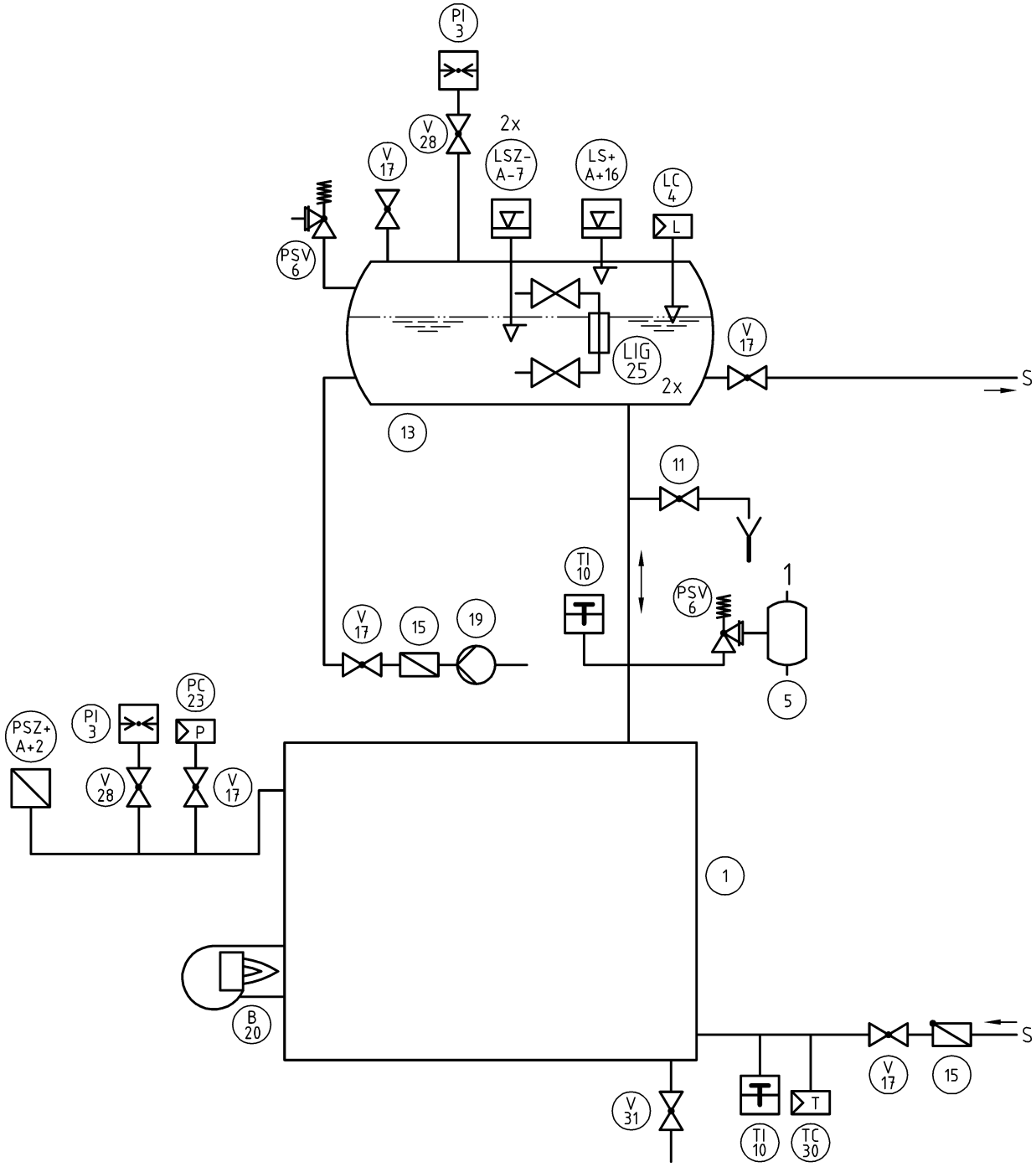


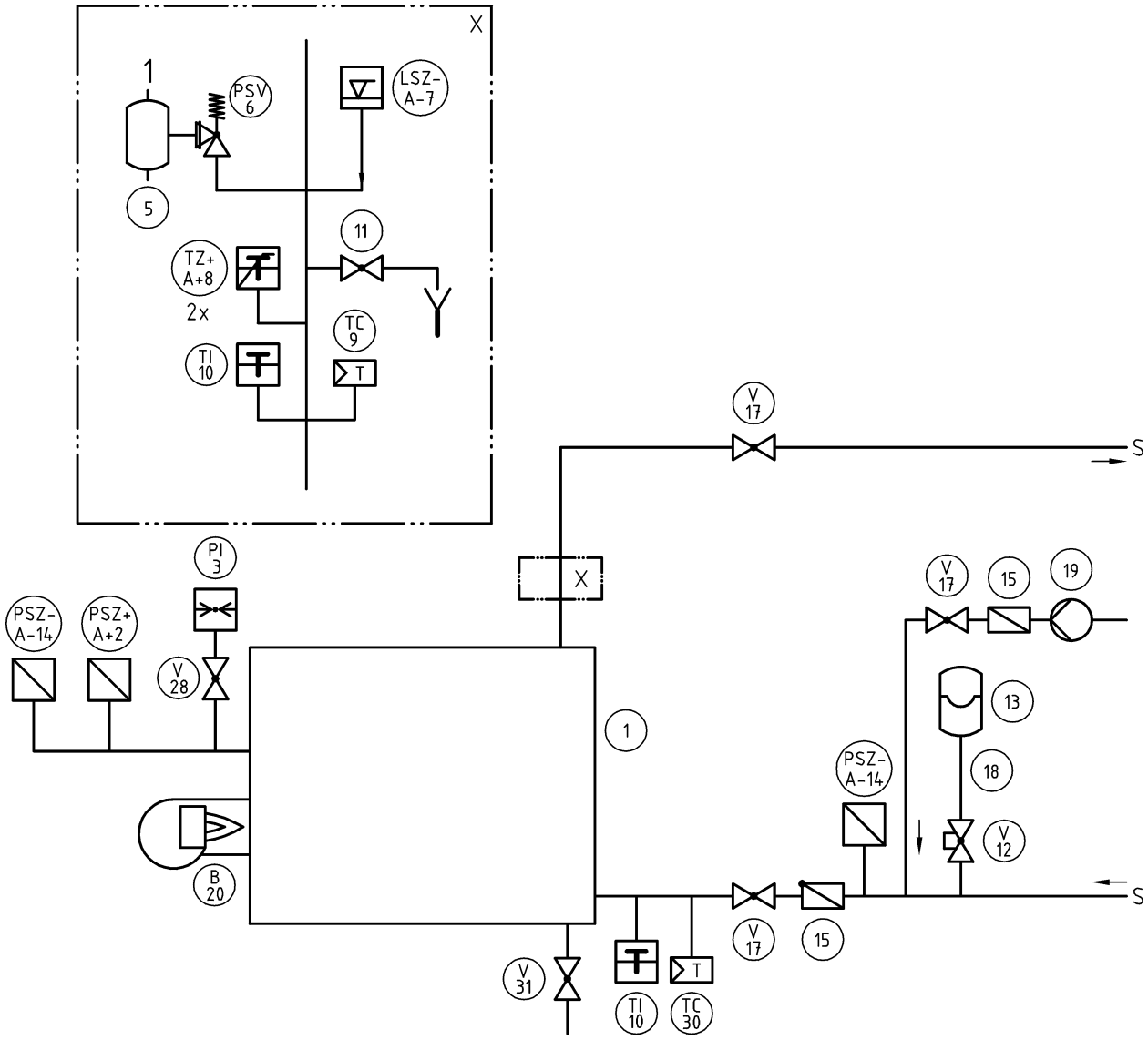
Figure A.3-3 — Closed system under steam pressure
Steam cushion in the boiler



1 If required in accordance with 6.12

Figure A.3-4 — Closed system under steam pressure
Steam cushion in the expansion vessel

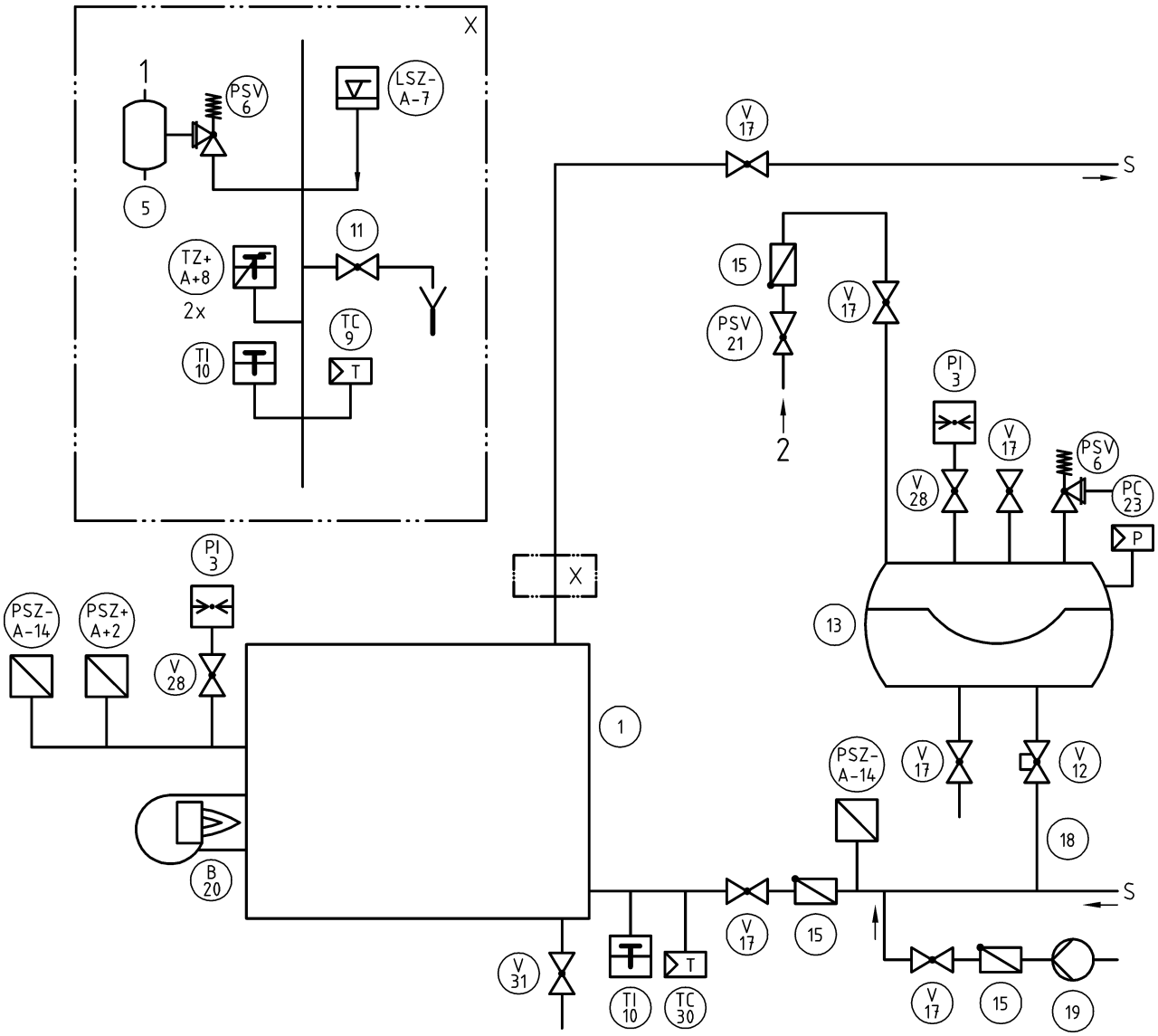
A.4 Plant with external pressure generation



Key

1 If required in accordance with 6.12

Figure A.4-1 — Plant with gas cushion (closed expansion vessel)

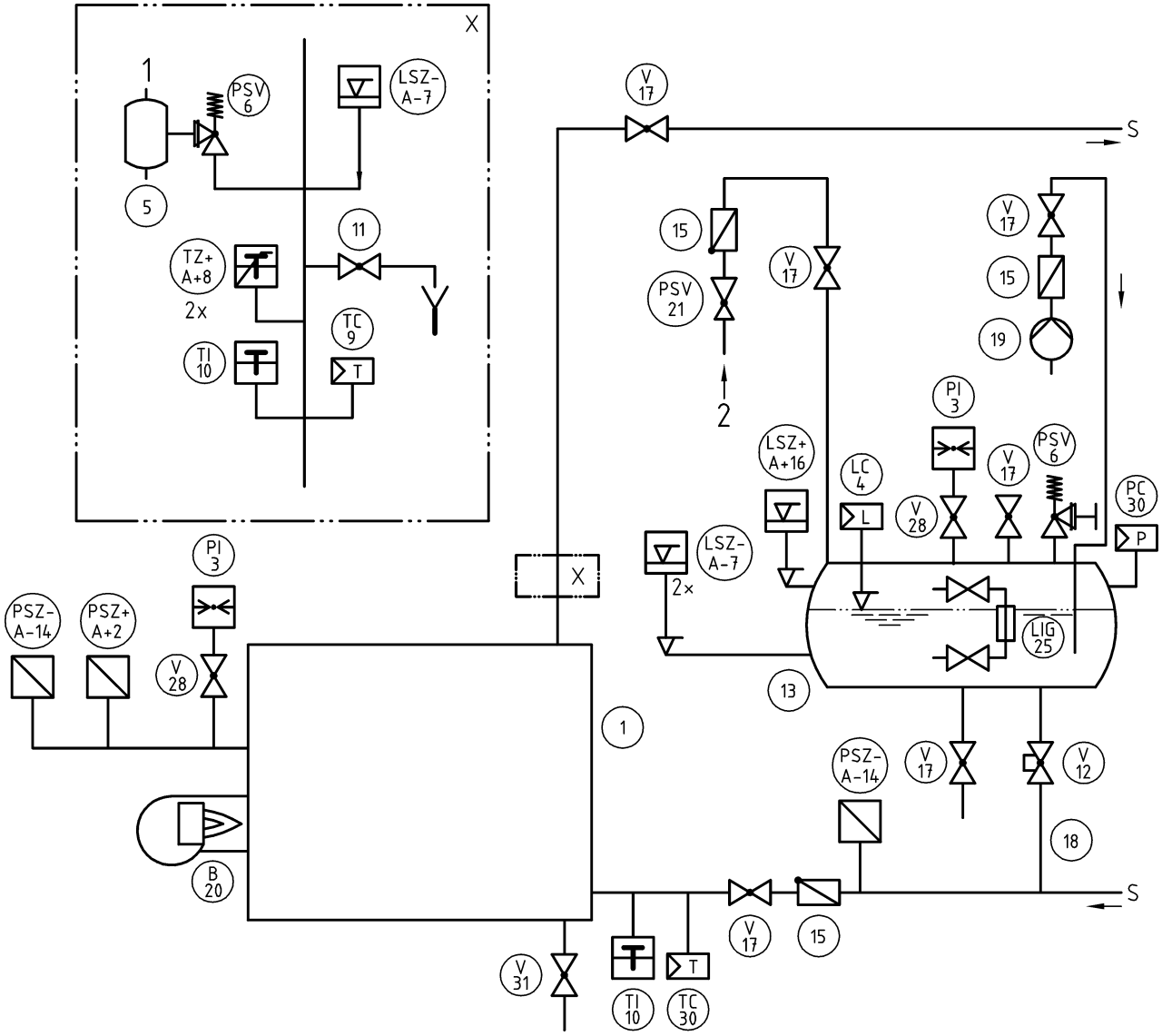


Key

1 If required in accordance with 6.12

2 Air or N_2

Figure A.4-2 — Plant with gas cushion (Air or N_2)

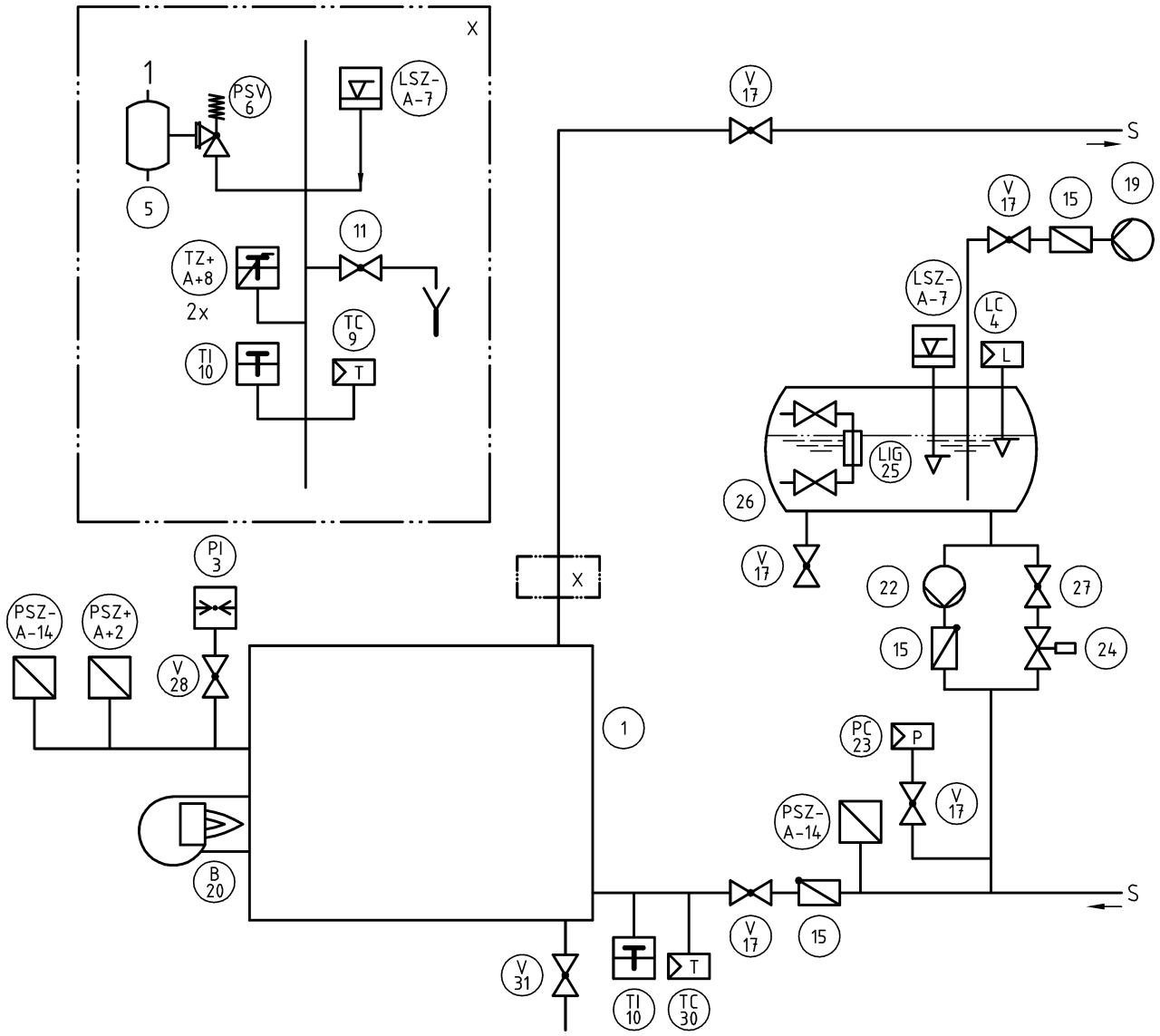


Key

1 If required in accordance with 6.12

2 N_2

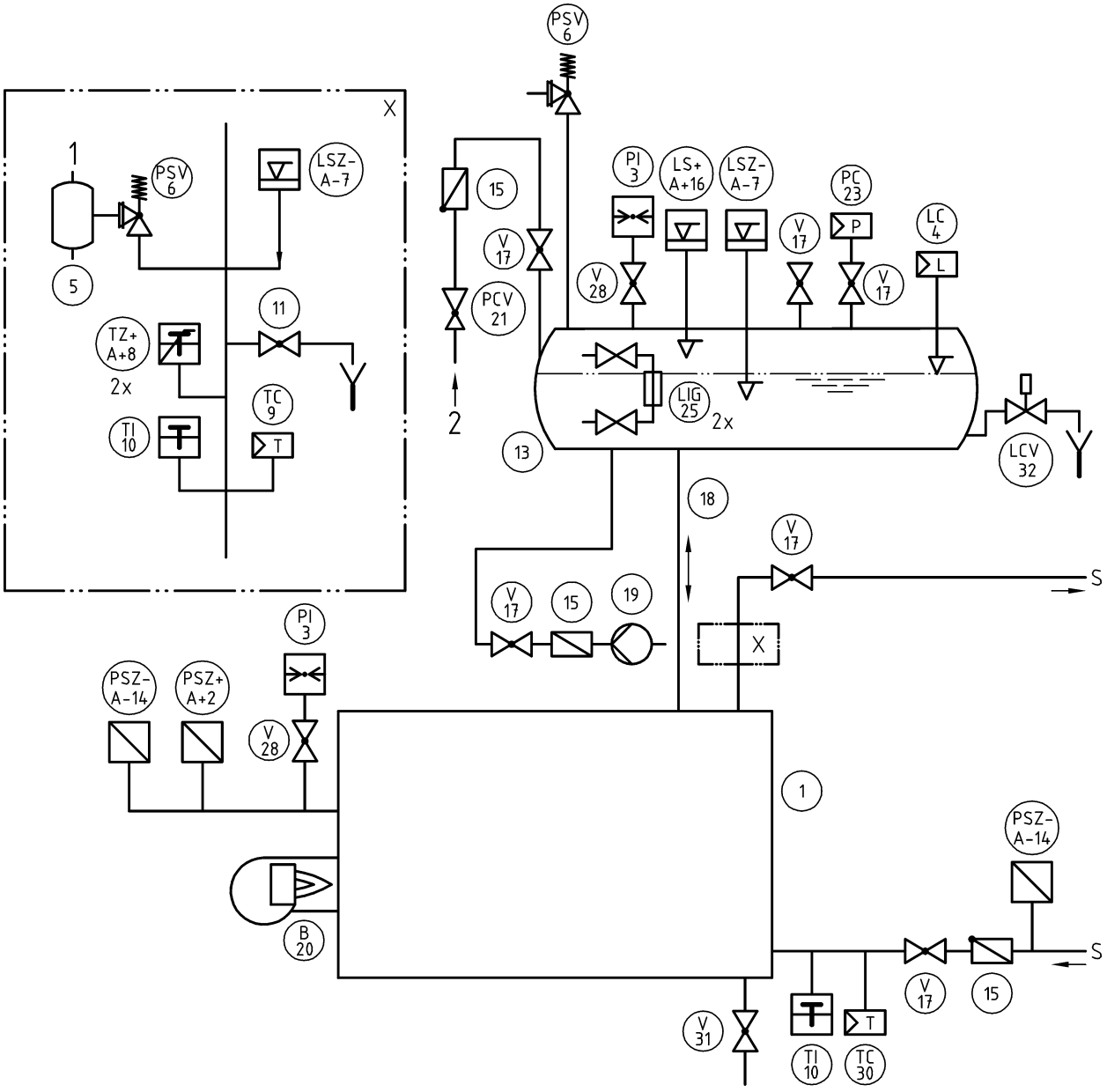
Figure A.4-3 — Plant with gas cushion (N_2)



Key

1 If required in accordance with 6.12

Figure A.4-4 — Plant with pressure pump



Key

1 If required in accordance with 6.12
2 External steam

Figure A.4-5 — Plant with external 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 Part of 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:

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

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

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

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):

$$p_o \geq p_{st} + p_D \qquad \text{(B.2-3)}$$

B.2.6 The final pressure p_e shall not be taken 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

$$V_{n\,min} = 2\ V_e \ ^{1)} \qquad \text{(B.3-1)}$$

B.3.2 Expansion vessels without membrane

The nominal volume shall be at least

$$V_{n\,min} = 3\ V_e \ ^{2)} \qquad \text{(B.3-2)}$$

B.3.3 Expansion vessel with membrane and internal pressure generation

The nominal volume shall be at least

$$V_{n\,min} = 1{,}5\ (V_e + V_v) \qquad \text{(B.3-3)}$$

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

$$V_{\text{n min}} = (V_{\text{e}} + V_{\text{v}})\ [(p_{\text{e}} + 1)/(p_{\text{e}} - p_{\text{o}})] \quad \text{(B.3-4)}$$

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

$$V_{\text{o}} \geq V_{\text{e}} + V_{\text{v}} \quad \text{(B.3-5)}$$

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

$$P_{\text{a min}} = [V_{\text{n}}\ \ (p_{\text{o}} + 1)/(V_{\text{n}} - V_{\text{v}})] - 1 \quad \text{(B.3-6)}$$

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:

$$P_{a\ \text{max}} = \frac{p_e + 1}{1 + \dfrac{V_e\ (p_e + 1)}{V_n\ (P_o + 1)}} - 14 \quad \text{(B.3-7)}$$

To ensure that the filling pressure is correctly set, $p_{a\ \text{max}}$ shall be at least 0,2 bar higher then $p_{a\ \text{min}}$. If this is not sufficient, a greater expansion space shall be selected.

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

The nominal volume shall be at least

$$V_{\text{n min}} = V_{\text{v}} + V_{\text{e}} \quad \text{(B.3-8)}$$

The following condition shall additionally be met

$$V_{\text{o}} \geq V_{\text{v}} + V_{\text{e}} \quad \text{(B.3-9)}$$

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. The wall thickness shall not be less than 2 mm.

Annex C
(informative)

Operational aspects

C.1 Operational aspects of steam boilers

C.1.1 All controls and safety devices should be properly maintained to ensure reliability. In addition, an inspection organisation or the supplier's maintenance service should be charged with the checking of this equipment at regular intervals, at least half yearly or more frequently if problems are experienced. All control and limiting devices should be functionally tested during these checks.

C.1.2 The operation and maintenance of boiler plants should only be assigned to properly trained persons familiar with the special conditions of the plant.

C.1.3 During operation, the boiler operator should satisfy himself of the proper condition of the boiler plant. This should be done within one hour after each start up and at least once every 24 h. In the event of failure of the automatic controls or safety devices and where the boiler is capable of being brought under manual control safety, operation under manual control should be in accordance with a clearly defined written emergency procedure that should include the immediate presence of a trained attendant. Operation of the boiler without flame monitoring is not allowed for oil and gas firing.

Continuous supervision should be provided until the fault has been rectified and a suitable period of time has elapsed to ensure, by testing, that the boiler and its controls are operating normally. Each automatic quick-closing fuel shut-off device should be functionally tested once a week.

C.1.4 Unless the requirements of 4.5.3 have been provided then during start-up from cold the boiler operator should be present in the boiler house. The start-up comprises the period until attainment of that operating condition which permits checking and observation of the proper functioning of all control and monitoring devices.

If an alarm is activated during start up a responsible person should be available to take appropriate action.

C.1.5 The result of each unit or functional check should be clearly recognizable to the boiler operator.

C.1.6 Manuals covering operation, maintenance and testing of equipment, including control and safety devices should be provided and located in the boiler house.

C.1.7 During the period of operation without supervision, the water gauges as defined in 5.1 may be closed off.

C.1.8 Steam boilers should be operated with suitable feedwater and boiler water which has been adequately treated, see prEN 12953-10. For this purpose, the essential values should be checked and evaluated daily by the operating staff.

C.1.9 An operating log should be kept in the boiler house.

C.2 Operational aspects of hot water generators

The requirements for operation and maintenance of hot water generators should be the same as for steam boilers with the following exception.

Hot water generating systems should be operated with properly treated water. For this purpose, the essential values should be checked at monthly intervals at the latest, or more frequently depending upon the type of system.

Annex ZA
(informative)

Clauses of this European Standard addressing essential requirements or other provisions of EU Directives

This European Standard 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 Pressure Equipment Directive 97/23/EC.

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

The following clauses of this standard given in Table ZA.1 are likely to support essential safety requirements of the Pressure Equipment Directive 97/23/EC.

Table ZA.1 — Comparison between EN 12953-6and the Pressure Equipment Directive 97/23/EC with respect to requirements for equipment for shell boilers

EN 12953-6 harmonized clauses	Content	Pressure Equipment Directive 97/23/EG Annex I
4 5.1, 5.2, 5.7, 5.8 6.1, 6.2, 6.10, 6.11	Protection against exceeding allowable limits	2.10
5.3, 6.5, 6.9	Means of draining and venting	2.5
5.4 to 5.6 6.6 to 6.8	Protection to restrict operating parameters	5a
6.16	Safety accessories	2.11

Compliance with the clauses of this standard provides one means of conforming with the specific essential requirements of the Directive concerned and associated EFTA regulations.

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