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Water-tube boilers and auxiliary installations - Part 7: Requirements for equipment for the boiler

Wasserrohrkessel und Anlagenkomponenten - Teil 7: Anforderungen an die Ausrüstung für den Kessel

Chaudières à tubes d'eau et installations auxiliaires - Partie 7: Exigences pour l'équipement de la chaudière

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Water-tube boilers and auxiliary installations - Part 7: Requirements for equipment for the boiler

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This document (prEN 12952-7:2010) has been prepared by Technical Committee CEN/TC 269 “Shell and water-tube boilers”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 12952-7:2002.

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.

The European Standard EN 12952 concerning water-tube boilers and auxiliary installations 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: In-service boiler life expectancy calculations.

Part 5: Workmanship and construction of pressure parts of the boiler.

Part 6: Inspection during construction; documentation and marking of pressure parts of the boiler.

Part 7: Requirements for equipment for the boiler.

Part 8: Requirements for firing systems for liquid and gaseous fuels for the boiler.

Part 9: Requirements for firing systems for pulverized solid fuels for the boiler.

Part 10: Requirements for safeguards against excessive pressure.

Part 11: Requirements for limiting devices of the boiler and accessories.

Part 12: Requirements for boiler feedwater and boiler water quality.

Part 13: Requirements for flue gas cleaning systems.

Part 14: Requirements for flue gas DENOX-systems using liquified pressurized ammonia and ammonia water solution.

Part 15: Acceptance tests.

Part 16: Requirements for grate and fluidized bed firing systems for solid fuels for the boiler.

CR 12952-17: *Guideline 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 water-tube boilers requires the application of more than one Part in order for the requirements of the standard to be satisfactorily fulfilled.

NOTE Parts 4 and 15 are not applicable during the design, construction and installation stages.

1 Scope

This Part of this European Standard specifies the minimum requirements for suitable protective devices for water-tube boilers as defined in EN 12952-1, to ensure the boiler operates safely within the allowable limits (pressure, temperature, etc.).

2 Normative references

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

EN 837-1:1996, *Pressure gauges — Part 1: Bourdon tube pressure gauges — Dimensions, metrology, requirements and testing.*

EN 12952-1:2001, *Water-tube boilers and auxiliary installations — Part 1: General.*

prEN 12952-6:2008, *Water-tube boilers and auxiliary installations — Part 6: Inspection during construction; documentation and marking of pressure parts of the boiler.*

EN 12952-8:2002, *Water-tube boilers and auxiliary installations — Part 8: Requirements for firing systems for liquid and gaseous fuels for the boiler.*

EN 12952-9:2002, *Water-tube boilers and auxiliary installations — Part 9: Requirements for firing systems for pulverized solid fuels for the boiler.*

EN 12952-10:2002, *Water-tube boilers and auxiliary installations — Part 10: Requirements for safeguards against excessive pressure.*

EN 12952-11:2007, *Water-tube boilers and auxiliary installations — Part 11: Requirements for limiting devices of the boiler and accessories.*

EN 12952-12:2003, *Water-tube boilers and auxiliary installations — Part 12: Requirements for feedwater and boiler water quality.*

EN 12952-13:2003, *Water-tube boilers and auxiliary installations — Part 13: Requirements for flue gas cleaning systems.*

EN 12952-14:2004, *Water-tube boilers and auxiliary installations — Part 14: Requirements for flue gas DE-NOX-systems.*

EN 12952-16:2002, *Water-tube boilers and auxiliary installations — Part 16:Requirements for fluidized bed and 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 Part of this European Standard, the following terms and definitions apply in addition to those given in EN 12952-1, EN 12952-8, EN 12952-9 and EN 12952-11.

3.1
Types of steam boilers and hot water generators
3.1.1
natural circulation steam boilers and hot water generators
steam boilers and hot water generators in which the water to be evaporated/heated circulates due to the differences in density (see Figure B.3-1)

3.1.2
forced or assisted circulation steam boilers and hot water generators
steam boilers and hot water generators in which the water to be evaporated/heated is circulated by means of pumps (see Figure B.3-2)

3.1.3
once-through steam boilers and hot water generators
steam boilers, with or without separating vessels, where the water flow is determined by the feed pump, and the water is evaporated completely or in a major portion during one single passage

Hot water generators, where the water flow is effected by the circulating pump of the heating system and is heated during one single passage, e.g. once-through hot water generator where there is no contact between hot and cold water in the drum (two-way drum) see Figure B.3-3 once-through hot water generator with header distributing water from below, see Figures B.3-4 and B.4-9

3.1.4
waste heat steam boilers and hot water generators
generators utilizing heat recovered from outside sources, e.g. gas turbines, blast furnaces

3.2
limits of steam boilers and hot water generators
boundaries of the steam and water spaces located between the shut-off devices of the steam boilers and hot water generators in the inlet, outlet, pressure retaining, overflow, and drain lines. The bodies of the shut-off devices are considered to be within these limits

3.3
steam boilers and hot water generating plant
plant consists of the water-tube boiler and its equipment as defined in EN 12952-1

3.4
heat supply system
assembly of components in which the energy of the fuel (including electrical and waste-heat energy) is supplied to the steam boilers and hot water generator

3.5
Classification of pressure generation systems (Hot water generators)

3.5.1
internally pressurised systems
systems where the pressure is generated by the saturation pressure corresponding to the flow temperature (see Figures B.3-1, B.3-2, B.3-3, B.3-4, and Figure B.4-9)

3.5.2
externally pressurised systems
systems where the pressure is generated by such methods as gas cushion or pressure pumps (see Figures B.4-1 to B.4-8, B.4-10 to B.4-13)

3.6
expansion vessels
containers to compensate for temperature related changes in volume dependent

— closed expansion vessels are pressurised

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

3.7
sinking time
time during which the water level will sink from the lowest permissible water level (LWL) to the highest point of the heated surface (HHS) (see 4.5.2)

NOTE For hot water generators applicable only in the case of internal pressure generation; see Figures B.3-1, B.3-2, B.3-3, B.3-4, and B.3-9.

3.8
maximum continuous rating (MCR)
maximum continuous steam output that can be generated during continuous operation taking the specified steam condition into consideration

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 generators may be operated

3.10
maximum allowable pressure
maximum pressure for which equipment is designed, as specified by the manufacturer, and at a location specified by the manufacturer

NOTE This may be the location of connection of protective and/or limiting devices or the top of equipment or, if not applicable, any point specified.

3.11
allowable flow temperature
maximum allowable temperature at which the hot water generator may be operated

3.12
controls
devices used for holding the variable to be controlled (e.g. water level, pressure, temperature) at a specified value (set point)

3.13
limiter
limiting 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 requires manual unlocking before restart

limiting device requires:

— a measuring or detection function, and

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

and which is used to carry out safety related functions as defined in the PED 97/23/EC, either on its own or as part of a protective system (e.g. sensors, limiters, etc.) (see also Figure 3.13). If this is achieved by multi channel systems, then all items or limiters for safety purposes are included within the protective system.

NOTE 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.

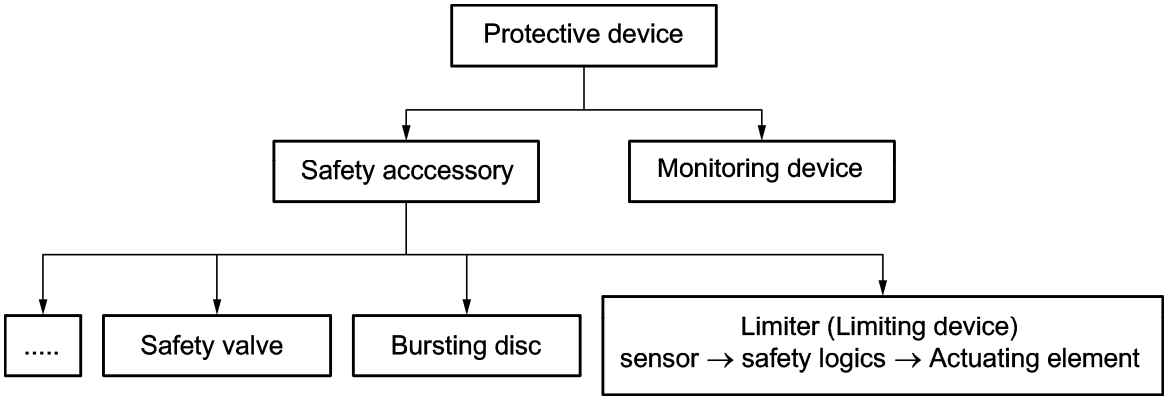

Figure 3.13 — Protective devices and safety accessories according to Directive PED 97/23/EC

3.14
independent
ability to function as required without interference from other equipment

3.15
reliability
ability to perform a required function under specified conditions and for a given period of time without failing

3.16
Functional check
testing of the safety device to ensure it performs its intended function

3.17
boiler attendant
boiler operator
skilled person appointed for operating the boiler plant

3.18
normal shut down
controlled switch off of the boiler either operated manually or automatically

3.19
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).

3.20
lock-out
safety shut-down condition of the protective system, such that a restart can only be accomplished by a manual re-set of the limiter or by a manual reset of the safety logic and by no other means

4 General requirements for steam boilers and hot water generators

4.1 Hazard consideration

All service conditions shall be considered to select the most appropriate safety concept to ensure safe operation.

This requires an identification of the hazards by means of a hazard analysis in accordance with EN 50156-1.

Hazard analysis involves:

- Determination of the boundaries of the pressure equipment including intended use and reasonably foreseeable misuse;
- Identification of potential hazards.

On the basis of the hazard analysis, a judgement shall be made on how to achieve a high degree of health and safety protection on the basis of:

- elimination or reduction of the hazards where this is possible,
- applying appropriate measures to protect the boiler against exceeding the allowable limits, where it is not possible to eliminate or reduce the hazards, and/or
- give information about all residual hazards and details of the appropriate measures that shall be taken at the time of installation and/or use.

4.2 Safeguards against excessive pressure

Each steam boiler, hot water generator and each isolatable heated compartment shall be equipped with safeguards against excessive pressure in accordance with EN 12952-10 and the hazard analysis.

4.3 Heat supply system

4.3.1 The requirements for heat supply to steam boilers and hot water generators shall be in accordance with:

- EN 12952-8 for firing systems for liquid and gaseous fuels;
- EN 12952-9 or EN 12952-16 for solid fuels.

4.3.2 The heat supply shall be adapted to the allowable heat output as well as to the intended mode of operation.

The heat supply shall be controlled and in all operating stages adapted to the variation of the heat demand.

4.3.3 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 generator.

This requirement is deemed to be fulfilled e.g.

— 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); or

— if a reliable feedwater supply is installed to ensure adequate cooling of the heating surfaces in case of a sudden loss of essential operational parameters (see e.g. 5.1.1.2); or

— in case of oil-, gas- or pulverized fuel firing systems (except slag-tap firing).

4.4 Ash removal plants

Ash removal plant shall be in accordance with EN 12952-9 or EN 12952-16.

4.5 Flue-gas cleaning plants

Flue-gas cleaning plants shall be in accordance with EN 12952-13 and EN 12952-14.

4.6 Requirements for limiting devices and safety circuits

4.6.1 The protective systems shall be in accordance with EN 50156-1.

Binary limiters and their installation shall be in accordance with EN 12952-11.

Limiters with analogue transmitters shall be in accordance with EN 50156-1 and Annex E.

4.6.2 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.

The appropriate levels of functional safety identified in the hazard analysis for the limiters shall be 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.

4.6.3 Functional check of all limiters shall be possible at any time during operation.

Where appropriate and if justified by the hazard analysis the functional check can be performed by simulation.

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

4.7 Feed lines and protection against feedwater backflow

4.7.1 Each feed line leading to the steam boiler or hot water generator shall be equipped with a protection device against backflow and a shut-off device. If the shut-off device and the protection device against backflow are not installed in direct connection to each other, pressure relieving shall be possible for the intermediate piping section.

A single once-through steam boiler in which the heat supply is cut off automatically in the case of feedwater failure, requires neither a shut-off device nor protection device against backflow if the feed pump is of the positive displacement type where it can be ensured that no dangerous backflow can occur.

4.7.2 Except for once-through boilers, the feed line shall be connected to the steam boiler or hot water generator in such a way that, in the case of leakage of the protection device against backflow, the steam boiler cannot be drained to below the highest point of the downcomers.

4.7.3 Feed pumps shall be capable of isolation from common suction or pressure lines.

4.7.4 If there is a possibility of backflow through a feed pump, the suction line between the valve and the pump shall be designed for full pressure or appropriate devices shall be installed to exclude the danger from closing the isolating valve in the suction line.

4.8 Connection of steam boilers or hot water generators

Where a steam boiler or hot water generating plant has several steam boilers or hot water generators connected by common lines and the shut-off devices in the steam or hot water and feed lines remain permanently connected with these lines during inspection of the steam boilers or hot water generators, two shut-off devices with intermediate venting shall be installed in each line. The shut-off devices shall be lockable in the closed position and be protected against unintentional actuation.

4.9 Water quality

The water quality shall be at least in accordance with EN 12952-12 and the manufacturer's operating instructions.

4.9.1 Condensate in steam boiler plants

An assessment 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.

If it is assessed 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.

4.9.2 Water circulating system in hot water generator plants

An assessment 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.

If it is assessed that harmful matter can enter the water circulating system, adequate monitoring shall be installed which is able to detect the contamination.

5 Special requirements for steam boilers

5.1 Requirements for pumps

5.1.1 Number of feed-water pumps

5.1.1.1 One feed pump shall suffice if the requirements of 4.3.3-1st or 3rd indent(s), are met. In the case of failure of the feed pump e.g power source the heat supply shall be cut off automatically.

5.1.1.2 Steam boilers that do not meet the requirements of 4.3.3-1st or 3rd indent(s) shall be equipped with at least two feed pumps.

5.1.2 Capacity of feed-water pumps

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

The feed pumps shall be capable of supplying the feedwater to the steam boiler at 1,1 times the maximum allowable pressure, considering to geodetic high, dynamic pressure losses in the feedline and the boiler.

5.1.2.2 If more than one feed-water pump is required according to 5.1.1.2, the following shall apply:

a) In the case of failure of the feed pump with the highest capacity, the remaining feed pumps shall meet the requirements of 5.1.2;

b) Two independent power sources shall be available. By exception, steam operation of all feed pumps from only one steam main shall be permissible. The feed pumps shall be connected to the power sources in such a way that in the case of failure of one power source the remaining feed pumps shall meet the requirements of 5.1.2.1. Where the pumps are electrically driven, one line per feed pump drive can suffice if the line can be switched over to a separate independent electrical supply;

c) In the case of steam boiler plant of a unitized arrangement, it shall be permitted to rate the second feed pump for reduced capacity if it is ensured that in the case of failure of the feed pumps rated for the allowable steam output, the heat supply system is, at the same time, automatically adjusted to the reduced steam output. If water is blown down, the quantity of blow down water shall be fully considered when rating the second feed pump;

d) For natural and assisted circulation steam boilers, the stand-by pump shall have been put into operation if the operating pump fails, before the water level has sunk below the lowest water level;

e) In the case of once-through steam generators, the stand-by pump shall have been put into operation, within a time interval to be specified by the manufacturer, if the operating pump fails, or if the flow through the steam boiler has fallen to below the minimum flow required, thusensuring that an inadmissible excess of the temperature is avoided.

The feed pumps shall be capable of supplying to the steam boiler both the feedwater quantities at maximum allowable pressure as specified in 5.1.2.1 and the feedwater quantity corresponding to the allowable steam output at 1,1 times the allowable working pressure.

If it is proved that the pressure relief devices are capable of discharging the steam generated in the case of excess of the allowable working pressure by less than 10 %, a correspondingly lower factor than 1,1 can be used in the calculation.

5.1.3 Circulating pumps

5.1.3.1 For forced circulation steam boilers one circulating pump shall suffice if in the case of failure of the circulating pump e.g. power source, the heat supply is cut off and:

a) the requirements of 4.2.3-1st indent are met and there is no risk of local overheating of the circulation system; or

b) the requirements of 4.2.3-3rd indent are met; or

c) the steam boiler is only heated with gases not exceeding a temperature of 400 °C.

5.1.3.2 Forced circulation steam boilers not corresponding to 5.1.3.1 shall be equipped with at least two circulating pumps. A common standby circulating pump can suffice for several forced circulation steam boilers of one steam boiler plant, if it can be connected to each steam boiler.

5.1.3.3 An alarm system shall become effective in the case of failure of one circulating pump and whenever the flow rate in the circulation system has fallen to a specified minimum value.

5.1.3.4 For the power sources of the circulating pumps 5.1.2.3 b) shall apply.

5.2 Isolating and drain devices

5.2.1 Each steam boiler shall be provided with sufficient devices by which it can be positively isolated from the system. Except in the case of unitized arrangements such devices shall be located as close as possible to the steam boiler.

Where duplicate isolating devices are installed in series, but not adjacent to each other, the intervening tubework shall be provided with means for venting and condensate removal.

5.2.2 Steam boilers shall be equipped with drains. Such drains and the nozzles thereof shall be protected against the effects of combustion gases. Self-closing blowdown devices shall be capable of being locked manually in the closed position unless a further shut-off device is installed in the line.

5.2.3 Automatic devices by which the water level may be lowered to below LWL (see 5.3) shall only be used if the following requirements are met.

The steam boiler shall comply with 4.2.3-3rd indent or the design of the heat supply system shall ensure that no unacceptable evaporation of the water inside the steam boiler occurs due to the heat accumulated in the boiler passes upon cut-off of the heat supply.

5.3 Lowest permissible water level (LWL)

5.3.1 For all steam boilers except once-through steam boilers, the lowest permissible water level (LWL) shall be determined and shall be permanently marked on the boiler.

5.3.2 The lowest permissible water level (LWL) shall be at least 150 mm above:

— the uppermost heated point of the drum and;

— the highest connection of the downcomers (top edge) to the boiler drums.

In the case of two-drum boilers with an evaporator tube bundle between them, the outer tubes shall not be considered as downcomers.

5.4 Water level and flow indicators

5.4.1 All steam boilers, except once-through steam boilers, shall have at least two devices for indicating the boiler water level:

— one device shall be a gauge, with an indicating column made of transparent material (the gauge glass); and

— two electronic or electrical devices for water level indication; or

— a water level controller indicating the water level; or

— a water level limiter indicating the water level.

During operation the boiler water level shall always be clearly indicated to the boiler attendant.

NOTE A water gauge glass that is not used to indicate the water level to the boiler attendant during operation, may be isolated from the boiler.

5.4.2 The connecting tubes between the steam boiler and the water level indicators shall have an inside diameter of at least 20 mm. If the water level indicators are connected by means of common connecting lines these shall have an inside diameter of at least 40 mm. Connecting tubes on the steam side shall be designed so that condensate does not accumulate. The water connection shall be horizontal or slope down towards the boiler.

However, when reverse measuring method is used, impulse tubes to transmitters on the steam and water side shall be full of condensate and the transmitters shall be below the water level. Impulse tubes to transmitters can have a smaller inside diameter.

5.4.3 Water level indicators shall permit isolation from the steam boiler for blowdown. Where cocks are used, the open position shall be indicated.

5.4.4 On each glass gauge the lowest permissible water level (LWL) shall be permanently and clearly marked by the letters LWL at the height of the level mark in accordance with to 5.3.1. The lower limit of the indicating range of a glass gauge shall be at least 30 mm below the lowest permissible water level (LWL).

If 4.2.3-1st indent applies a water level indicating device shall be so arranged to clearly indicate to the boiler attendant the water level until the temperature of the highest point of the heating surface (HHS) falls below 400°C or the value “50mm above HHS”, which ever is the greater. This may be an additional device.

5.4.5 During operation the water level shall always be within the range of the water level indicator.

5.4.6 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.

5.4.7 Blowdown systems on water level indicators, controllers and limiters shall be so installed as to prevent accidents. Any blowdown operation shall be detectable.

5.4.8 Once-through steam boilers shall be equipped with at least one low-flow indicator device which will indicate water shortage to the coil. Indirect measuring methods may be used.

5.4.9 Forced circulation steam boilers shall be equipped with at least one low-flow indicator device in the circulating line.