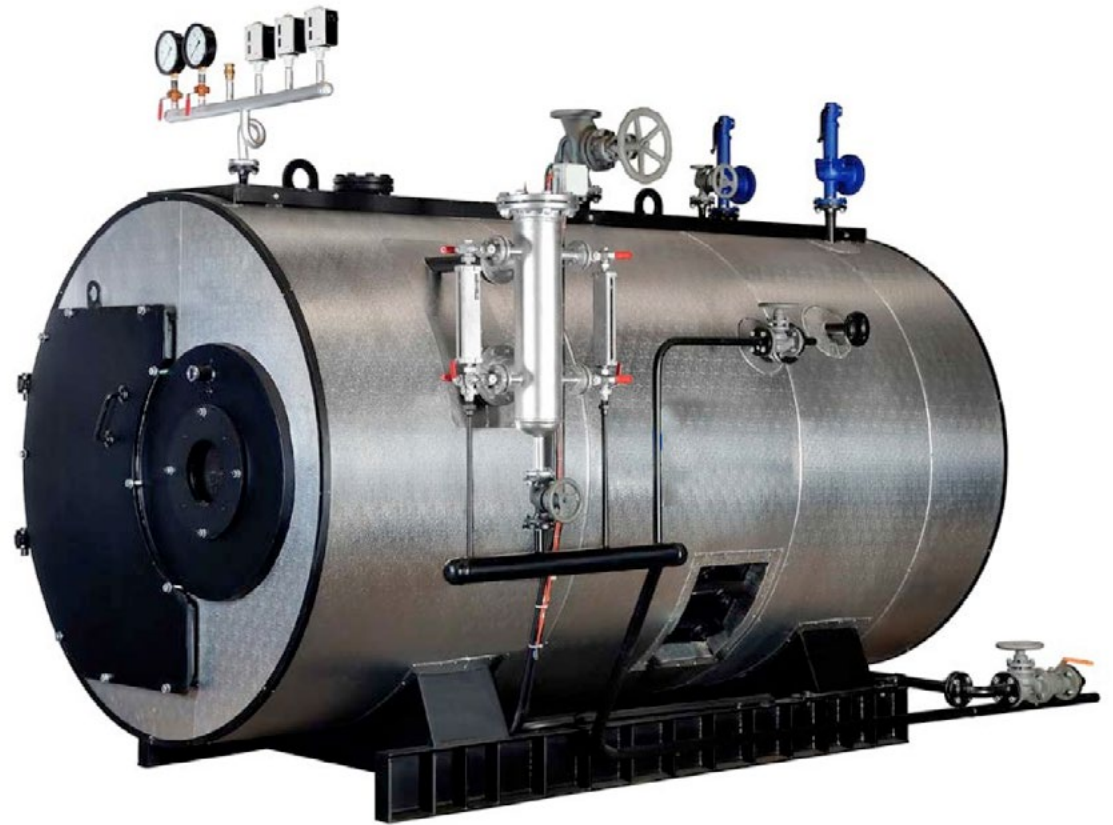


SERIES ESB MULTI-FUEL 3 PASS STEAM BOILERS

OPERATING AND MAINTENANCE INSTRUCTION MANUAL



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BOILERS**

HIGH EFFICIENCY CONDENSING BOILER-PLANT

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FEATURES OF *erensan*° BRAND BOILERS

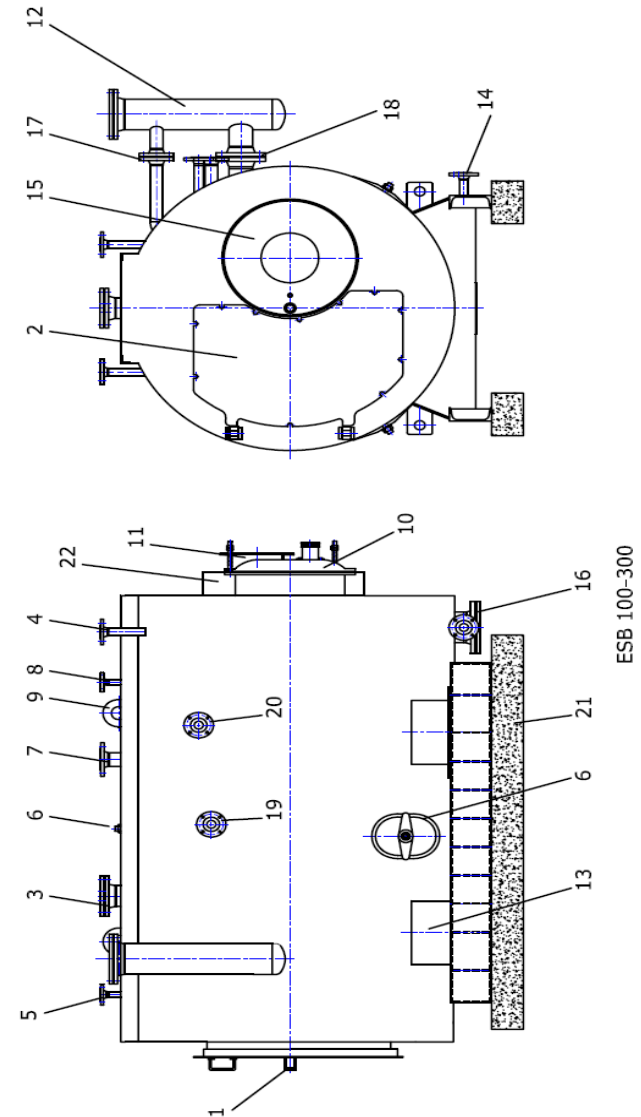
"the heating engineer"

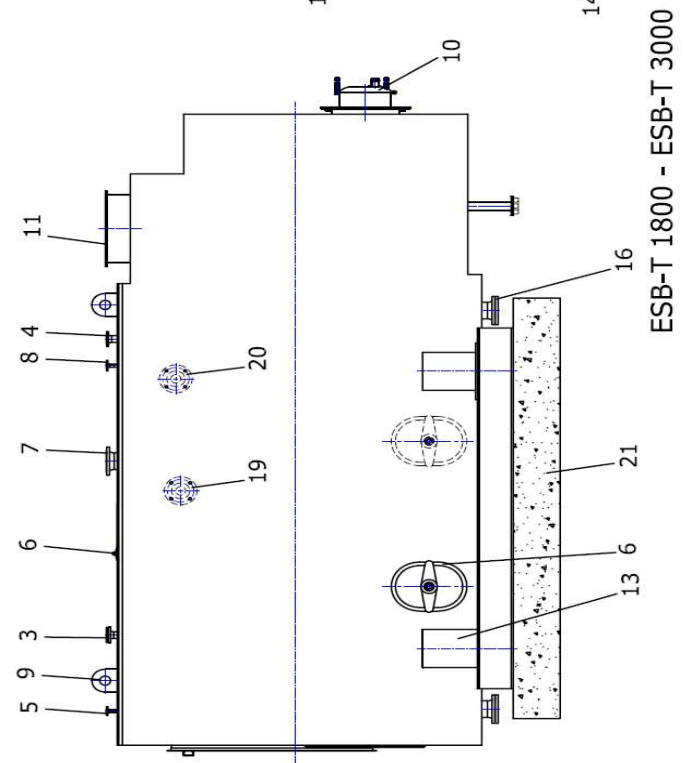
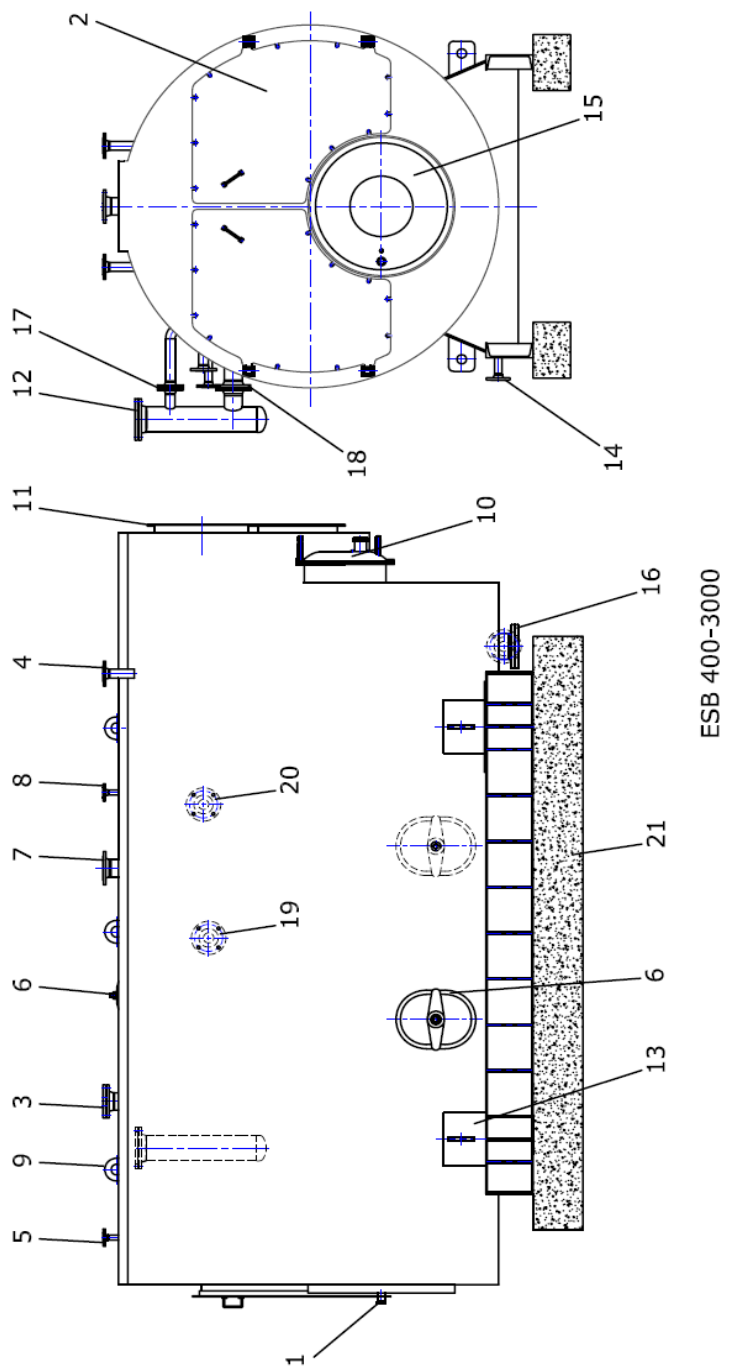
- ESB type boilers are 3-pass boilers. The radiation created by the 1st pass in the combustion room and the convection and conduction created by the 2nd and 3rd passes through the smoke pipes are transferred to water by heat transfer.
- ESB type boilers are convenient for large water and steam volumes and sudden steam needs under irregular working conditions.
- Because their "wet back" designs, ESB boilers provide maximum benefit from their heat transfer surfaces.
- Because of their low counter pressure, ESB boilers increase the combustion efficiency and decrease the electricity consumption of burners.
- erensan° brand liquid and gas fuelled ESB boilers that provide high efficiency with these features lower operational costs by working in a stable regime.

THE APPLIED DIRECTIVES AND STANDARDS

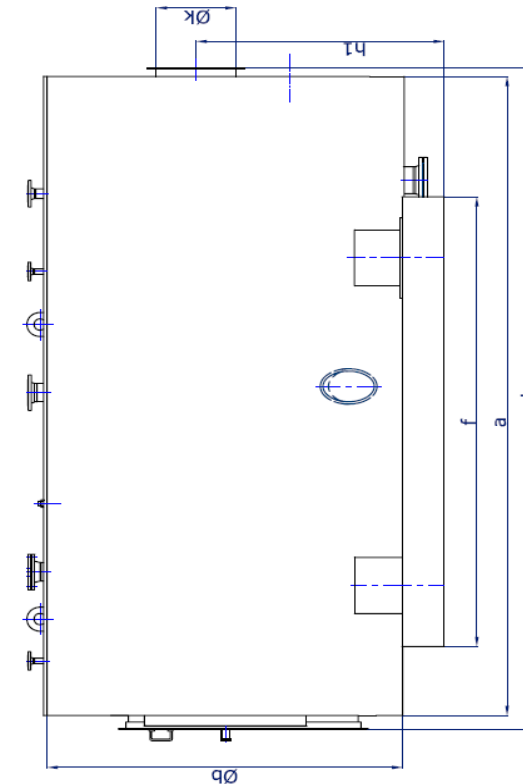
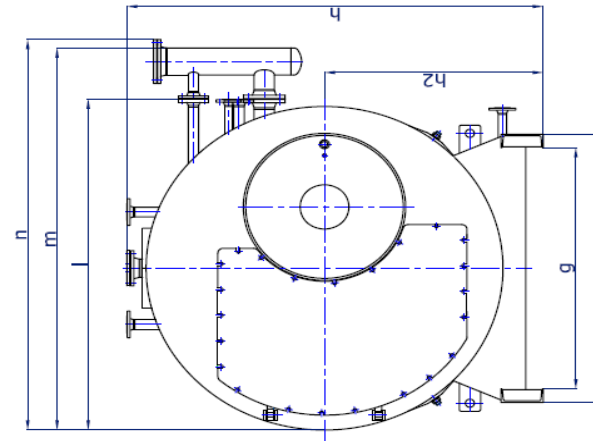
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- EN 12953-1.....8:2002
- pr EN 12953-9:1999
- pr EN 12953-10:1998
- pr EN 12953-11:2001

INTRODUCTION

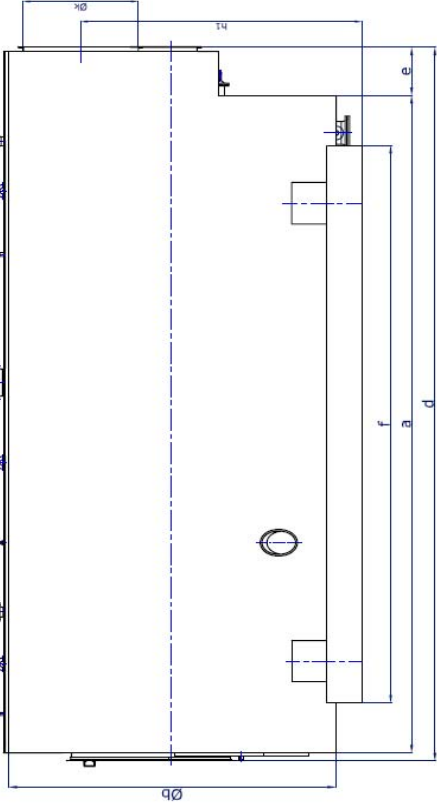
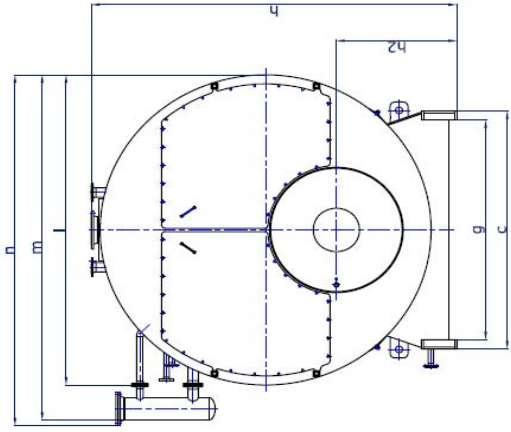




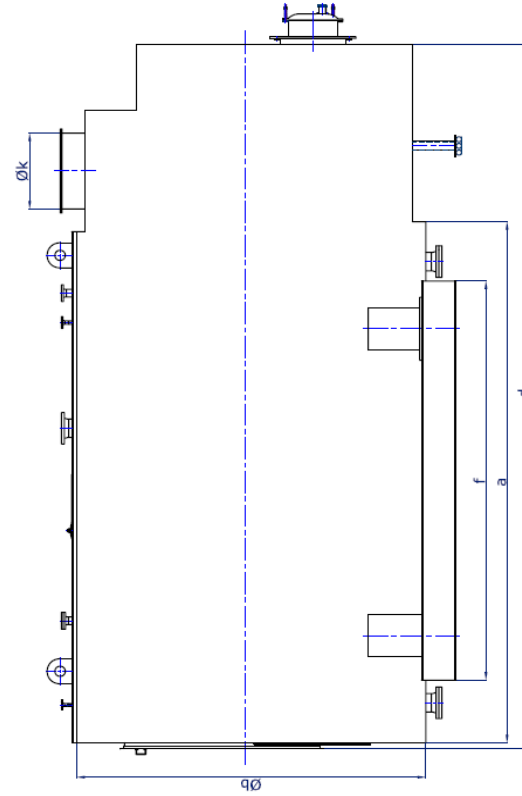
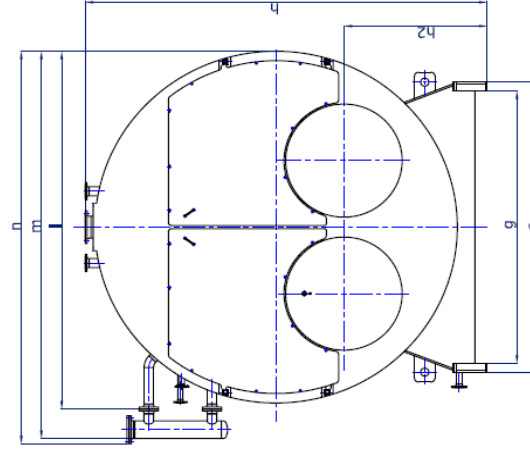
- 1 Flame inspection system
- 2 Front door
- 3 Water level electrode nozzle
- 4 Safety valve nozzle
- 5 Indicator nozzle
- 6 Manhole
- 7 Steam outlet nozzle
- 8 Air pipe
- 9 Eyebolt
- 10 Excess pressure lid
- 11 Chimney outlet
- 12 Water level bottle
- 13 Foot group
- 14 Bottom blowdown nozzle
- 15 Burner connection flange
- 16 Bottom mud blowdown nozzle
- 17 Water level upper connection nozzle
- 18 Water level lower connection nozzle
- 19 Surface conductivity electrode and surface
blowdown nozzle
- 20 Water feed inlet nozzle
- 21 Boiler supporters
- 22 Smoke chest



ESB 100 - ESB 300



ESB 400 - ESB 3000



ESB-T 1800 - ESB-T 3000

BOILER DIMENSIONS FOR DIFFERENT BOILER TYPES

ESB

TYPE	ESB	100	125	150	200	250	300
Capacity	kg/h	1000	1.250	1.500	2.000	2.500	3.000
Capacity	kW	655	818	982	1.309	1.637	1.964
Water volume	m ³	1,75	2,12	2,60	3,13	4,05	4,33
a	mm	2.730	2.885	3.240	3.390	3.830	3.830
b	mm	1.584	1.644	1.704	1.842	1.946	2.035
c	mm	1.500	1.500	1.500	1.500	1.570	1.670
d	mm	2.836	3.110	3.446	3.596	4.034	4.034
e	mm	1.870	2.125	2.270	2.370	2.810	2.810
g	mm	1.683	2.043	2.103	2.242	2.346	2.432
h	mm	1.840	1.897	1.992	2.102	2.245	2.352
h1	mm	1.120	1.162	1.248	1.290	1.380	1.400
h2	mm	956	986	1.040	1.090	1.160	1.236
Øk	mm	250	300	350	350	400	400
Pressure loss	mbar	5,5	7	8	8	8,5	9,0
Empty weight	ton	3,4	4,06	4,346	5,1	5,976	6,936

TYPE	ESB	400	500	600	700	850	1000	1200	1400	1500
Capacity	kg/h	4.000	5.000	6.000	7.000	8.500	10.000	12.000	14.000	14.000
Capacity	kW	2.619	3.273	3.928	4.583	5.565	6.547	7.856	9.165	9.820
Water volume	m ³	9,36	11,80	12,90	14,50	16,50	18,00	23,80	27,20	29,50
a	mm	4.635	5.000	5.072	5.411	5.479	5.833	6.483	6.633	6.874
b	mm	2.418	2.590	2.720	2.820	2.992	3.062	3.269	3.439	3.462
c	mm	1.970	1.970	2.050	2.050	2.360	2.400	2.400	2.500	2.700
d	mm	5.215	5.600	5.710	6.015	6.215	6.570	7.220	7.370	7.610
e	mm	500	500	550	550	650	650	650	650	650
f	mm	3.445	3.770	3.840	4.226	4.280	4.690	5.055	5.370	5.650
g	mm	2.742	2.909	3.040	3.139	3.047	3.477	3.684	3.852	3.875
h	mm	2.715	2.890	3.022	3.122	3.371	3.440	3.642	3.794	3.816
h1	mm	2.100	2.154	2.260	2.384	2.551	2.551	2.755	2.870	2.900
h2	mm	965	985	1.040	1.053	1.161	1.171	1.222	1.246	1.313
Øk	mm	600	600	700	700	800	800	900	1.000	1.000
Pressure loss	mbar	7,5	8,0	8,5	8,0	8,5	9,5	10	11	11
Empty weight	ton	8,663	9,94	12,425	13,7	15,3	17,507	20,04	22,585	24,476

TYPE	ESB	1600	1800	T-1800	2000	T-2000	2500	T-2500	3000	T-3000
Capacity	kg/h	16.000	18.000	18.000	20.000	20.000	25.000	25.000	30.000	30.000
Capacity	kW	10.474	11.784	11.784	13.093	13.093	16.366	16.366	19.640	19.640
Water volume	m ³	29,80	34,50	34,50	36,50	36,50	38,80	38,80	41,00	41,00
a	mm	7.102	7.732	5.575	7.810	5.660	8.602	6.235	8.602	6.235
b	mm	3.521	3.566	4.073	3.600	4.155	3.796	4.423	3.969	4.455
c	mm	2.700	2.860	2.900	3.000	3.000	3.500	3.500	3.500	3.500
d	mm	7.840	8.518	7.980	8.596	8.115	9.388	8.890	9.388	8.890
e	mm	650	700	1.300	700	1.300	700	1.400	700	1.500
f	mm	5.840	6.190	4.215	7.000	4.795	7.342	5.028	7.342	5.028
g	mm	3.934	4.033	4.466	4.063	4.552	4.210	4.876	4.381	4.956
h	mm	3.875	3.900	4.526	4.050	4.698	4.164	3.590	4.164	3.590
h1	mm	2.950	2.950	*	3.065	*	3.266	*	4.190	*
h2	mm	1.282	1.250	1.700	1.350	1.750	1.382	1.780	1.400	1.800

BOILER OPERATING PERSONNEL

The personnel to be charged with boiler operation are responsible for intervention in case of any emergency. For this purpose, they must be fully informed about the functions, operating characteristics, operating pressure and temperature and flow quantities; they should know the functions and operation of all control circuits and measurement devices and electrical safety hardware well.



MAKE SURE BOILER PERSONNEL HAVE BOILER CERTIFICATES!

TRANSPORTATION AND TEMPORARY STORAGE

The boiler should be transported using the lifting and transportation points and utilizing appropriate equipment. For horizontal movement, horizontal displacement is possible through controlled sliding on pipes when it is not possible to utilize a winch.

The boiler should be protected against mechanical blows and collisions during loading, transportation and unloading.

During temporary storage before transportation and installation, the boiler must be protected against damages that may result due to moisture and external mechanical agents.



USE THE BOILER IN COMPLIANCE WITH WARNINGS AND RECOMMENDATIONS IN THIS INSTRUCTION GUIDE !

INSTALLATION

Boiler installation site should comply with the related standards and procedures. Boiler room door should open outside and fresh air inlet at floor level and polluted air outlet at ceiling level should exist. More than one boiler should not be connected to the same chimney.

The boiler should be installed on a foundation elevated from the floor at the installation site. The back feet have been manufactured as a slider system to meet thermal expansion.

The slider system bolts should be loosened to enable system functioning.

The mechanical connections of the boiler should comply with Installation Circuit Diagram.

Purchase of the boiler as a package including armature is recommended. In case the steam boiler is purchased without armature, the armature choice should comply with boiler operating pressure and related standards and procedures; and the installation should be done by qualified technical personnel.

The following control devices should exist on the boiler:

- At least 2 manometers (min. Ø100mm)
- 1 pressurestat (Number of burner stages + 1)
- Thermometer (for chimney gas and feed water temperature)
- At least 2 level gauges
- Water level controller
- At least 2 safety valves

Alarm element that is recommended to exist in a boiler;

- Water level electrode and relay system.

In order to prevent battery corrosion, the boiler must be grounded with,

- a) 0.5m², 2mm thick copper sheet,
- b) 0.5m², 3mm thick hot dip galvanized sheet,
- c) Massive copper bar electrodes.

Automatic lockout and protection hardware

For their safe operation, boilers should be equipped with safety lockout systems and alarm circuits depending on their type, capacity and features. At least the following lockout elements are recommended to exist in a boiler:

- A main flame prevention system that will continuously monitor initial ignition flame and stop the ignition circuit if the flame goes out.
- A photo-electric monitor that checks main burner flame and shuts off fuel and puts the flame out if the flame goes out or combustion is excessively smoky.
- An adjustable pressure safety switch (pressurestat) that stops the burner when steam pressure is too high.

- A level control device that stops the burner when water level is excessively low.
- In kerosene burning boilers, adjustable pressure switch that stops fuel if fuel pump outlet pressure drops.
- In fuel oil burning boilers, an adjustable thermostat that cuts fuel if fuel temperature drops.
- A pressure switch that shuts the burner in case boiler combustion air pressure drops.
- If atomization is being applied during liquid fuel burning, hardware to cut fuel if atomization (steam or pressurized air) environment pressure drops.
- In gas burning boilers, an adjustable pressure switch that cuts fuel if gas pressure drops.
- Gage glasses, discharge valves, control valves, pressure and temperature gages, safety valves, measuring and control devices, locking and protecting hardware, air heaters, boiler feed pumps, blower should be inspected and maintenance, control and adjustment operations should be done.
- Electric panel, burner panel and fan, boiler feed pump propellers should be cleaned with dry pressurized air. They should be protected from dust and water.

Required protective elements, apart from these:

BURNER SELECTION AND INSTALLATION

To achieve efficient combustion, the burner to be attached to the boiler should be selected in compliance with the combustion chamber defined in the boiler technical specifications section.

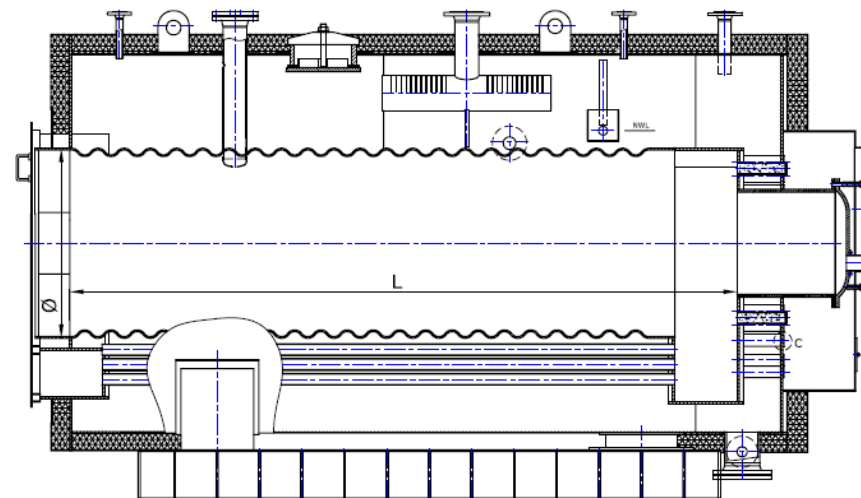
During the installation of the burner, care should be shown to match burner nozzle axis with combustion chamber axis.

To prevent entry of excess air into the combustion chamber from outside, the burner installation should be performed carefully to prevent leakage.

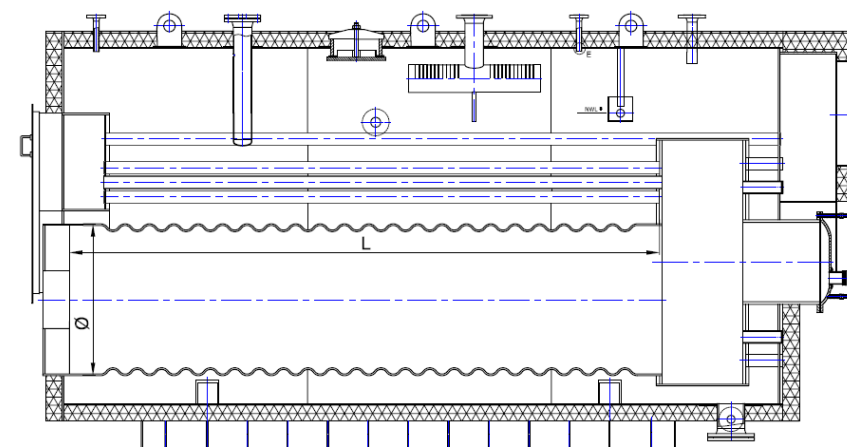
The fuel used for operating should comply with burner manufacturer recommendations.

A suitable burner should be selected, which conforms to the capacity and efficiency of the boiler and the counter pressure of the boiler. When ordering a boiler, the related sales personnel should be informed about the burner selected to enable the design of connection flange to suit the burner.

COMBUSTION CHAMBER DIMENSION

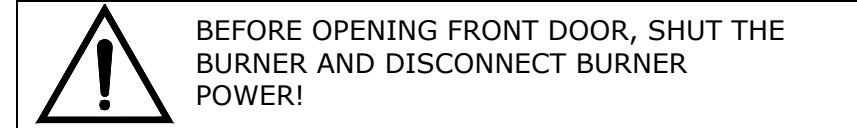


ESB 100-300



ESB 400-3000

ESB	Ø [mm]	L [mm]
100	646	2.115
125	678	2.370
150	710	2.725
200	805	2.875
250	843	3.200
300	916	3.200
400	933	3.675
500	1.030	3.870
600	1.076	4.080
700	1.124	4.350
850	1.220	4.450
1000	1.283	4.710
1200	1.350	5.370
1400	1.410	5.545
1500	1.420	5.725
1600	1.442	6.000
1800	1.448	6.600
T - 1800	1.220	4.710
2000	1.525	6.600
T - 2000	1.283	4.710
2500	1.600	7.500
T - 2500	1.330	5.545
3000	1.750	7.500
T - 3000	1.420	5.825



FUEL HARDWARE

In a boiler operation, fuel hardware is quite important. Different burner hardware exists for various fuels. Automatic systems are also used for fuel burning. Because the system may malfunction at any time for any reason during automatic fuel burning, the operating personnel for automatic burning controlled boilers should be trained to operate the boiler manually when necessary and automatic operation should be continuously monitored by the boiler men and the system should be transferred to manual mode immediately in emergencies.

The fuel hardware should be controlled before firing whatever the fuel type it runs with.

When the boiler is first fired or a burner, which was shut off for any reason, is restarted, the boiler should be ventilated for at least 2 minutes to enable purging of flammable gas mixtures that may have collected in the furnace and chimney gas channels.

Liquid fuel hardware

In liquid fuel burning boilers, before first firing, all the tank, heater, pump, valve and pipe system related to the fuel circuit should be reviewed and ensured that they are in good status and function normally.

If the liquid fuel tank is at a lower level than the fuel pump, parts such as valves, flanges, filters should be inspected and full leakage prevention should be provided in suction pipe; the pump should thus be prevented from drawing air. When fuel-oil is used as liquid fuel, all heaters operating with electricity or steam should be checked to be in good working order. In steam

FUEL SELECTION AND STORAGE

Fuel complying with the characteristics indicated in the burner user manual or burner vendor catalogues should be obtained.

Fuel transfer lines should comply with technical specifications, procedure guides and standards in effect. The fuel tank-burner axis levels should not exceed figures specified in the burner user manual.

Fuel tanks should conform to standards. A wall must exist between the fuel tank and the boiler.

If the fuel is oil, the necessary arrangements and heating system should be installed for fuel flow from tank to burner.

heaters, fuel oil leakage to steam side should be checked. To understand this, the oil pump should be run and by using the pump safety valve or the first valve after the heater outlet on fuel oil pipe, the highest pressure in the system should be applied for five minutes while the steam is closed on the heater fuel oil side. After this, the steam inlet should be fully opened and the condenser water should be checked for fuel oil existence.

In liquid fuel burning boilers, the most important reason for bad combustion is fuel not being fully atomized. To ensure full atomization, the type of atomization that will be recommended by the manufacturer should be applied.

The water collected at the bottom of the fuel tank should be discharged.

Fuel circulation should be provided running the pump after ensuring the fluidity of the fuel-oil in the pipes. All air in the fuel-oil hardware should have been bled.

The fuel residues collected in the burner, boiler front and especially at furnace bottom should be cleaned before firing.

When load needs to be reduced while the boiler is operating, the burners in operation should be shut off one by one and the required minimum fuel amount should never be dropped under, thus the continuity of the flame should never be jeopardized.

Gas fuel hardware

Before firing, all jointed points such as valves, flanges in the gas pipe should be checked for gas leaks; all burning hardware, hardware such as burners, control valves should be controlled, the leaks found should be urgently removed.

The burners should be fired after adjusting the gas and air amount to first firing values. A burner to be fired should never be ignited from the flame of another burner in operation.

In both the liquid and gas fuel burning hardware, the fuel valve or valves, coming after the last manometer in front of the burner or burner group, should always be kept fully open

during combustion. Otherwise, the real conditions in the burner (such as the real value of the fuel feed pressure) cannot be monitored.

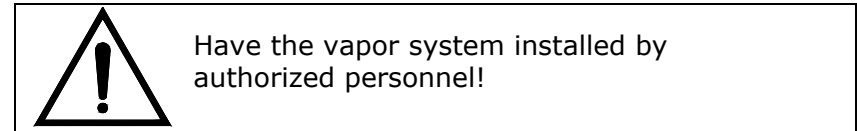
The first firing flame to be used in the first firing hardware in ESB type boilers should be great enough to overcome the counter pressure of the boiler.

SAFETY RULES

- The boiler should only be used for **steam production purposes**.
- The boiler should be used complying with warnings and recommendations in this procedure.
- Steam installation should be commissioned to authorized personnel.
- Electrical connections of the boiler should be commissioned to authorized personnel.
- The boiler should not be operated if boiler water level is below minimum.
- When opening the front door, the burner should be shut off and burner power should be disconnected.
- It should be ensured that the personnel to operate the boiler have boiler certification.
- The boiler chimney should be built in compliance with chimney building rules. Airbrick and briquette should not be used in boiler chimneys.
- 2 times a year, chimney cleaning should be procured. It should be ensured that the chimney has no any cracks, holes, the chimney cleaning door is closed and insulated properly.
- During first operation and subsequent firings, it should be checked that the boiler and condenser tank is filled with water and that the suction and discharge valves of the boiler feed pump, which is expected to run, are open, the pump air has been bled and pump rotation direction is correct.
- If abnormal noises are heard in the boiler or the installation when the boiler is operated, the burner should be immediately shut off and pressure should be relieved by the discharge lines. Then, the fault should be determined and removed.

- In cold climate regions, required measures should be taken to prevent boiler and condenser tank water temperature dropping to freezing temperature.
- Except before firing, the boiler should not be fed cold water. It is recommended not to drop below 70°C in any case. To be used in processes where condenser return is low or nil and at times when condenser water temperature is low; heating of the condenser tank should be ensured by connecting the condenser tank to steam heater line.
- The boiler water level should be checked continuously. If the water level cannot be seen properly or the gage is defective, the burner should immediately be stopped and the gage glass should be cleaned or the gage error should be investigated and corrected. It should be frequently checked that the gage valve and connection pipes are not blocked internally.
- Boiler feed devices should always be in working condition and at least once in each shift the device discharge valve should be opened to discharge possible deposits and pipe clearance should be inspected. Once a month, the feeding device body should be opened, checked, any existing deposits should be cleaned, the connection pipes and valves should be checked with a wire for blockage. Measures should be taken to prevent use of hard water that causes deposits or for more regular utilization of the Water Softener Device.
- In abnormal situations, for example when water level is rapidly dropping, steam pressure is rapidly rising, when redness/bending at some parts of the boiler is observed or any leakage or drain is seen, the burner should be stopped immediately. The steam should be let off from the discharge and the authorized services should be notified. During this time, the boiler should not be fed with fresh water.
- If the burner does not run, do not press the computer's reset button more than twice and call authorized burner service.
- If leaks and drains are observed on burner fuel connections and transfer lines, the burner should be immediately stopped and line valves should be closed. In the case of natural gas or LPG usage, utilize a

- leakage detector device in the boiler room and an automatic fuel cut-off system on the main inlet.
- In the case of LPG usage, when you observe icing and dew on fuel pipes due to liquidizing of residual gas in fuel pipes, especially on cold days, do not absolutely operate the burner. The LPG should be safely discharged from the drain tap. (Liquidizing may also form at normal times due to gasification level control or line regulator problem.)
- The boiler door should absolutely not be opened before the burner is stopped and electric power is cut.



PREPARATION OF THE BOILER FOR OPERATION AND FIRST FIRING

Initial preparations

Before a boiler that is to be newly put in operation or on which maintenance-repair work has been performed is fired, both the water side and the gas side (such as furnace inside, chamber, chimney gas channels, air channels, air heater, burner combustion chamber) should be inspected thoroughly; should be cleaned of tools sets, pieces of cloth, iron pieces, oakum etc. Residues such as dust, soot, slag should be removed by washing or sweeping.

Any existing loose places in boiler internal parts and all other loose places such as holders, clamps and similar, should be tightened. After this, all inlets should be closed and manholes should be tightened using appropriate gaskets.

It should be ensured that all hardware in the fuel equipment and chimney draught system function correctly, any existing flaps should be controlled for ease of opening and closing. If automatic combustion controls or other automatic controls exist, all adjustments, tests and all calibrations related to these should

have been made and faultless operation status of the system should have been provided.

After making sure all discharge and release valves, level indicator relief valves and control valves are in working condition and leak-proof, these should be closed.

Water with required chemical specifications (see: Boiler feedwater specifications, page 41) should be filled into the boiler up to the normal water level seen on page 28. During this operation, while water fills the boiler, air valves should be opened to prevent trapping of air at any part.

When the boiler is filled up to the desired level, water feeding should be stopped. Water level column and level indicator discharge valves should be opened fully and some discharge should be allowed to determine whether blockages exist in valves and pipes. Controls should be made by performing blowdowns from others discharge valves related to the boiler. It should be ensured that the main steam pressure gage shows the correct value (furthermore, the connections of the pressure gage with the boiler should be checked).

If the boiler is not attached to the main steam pipe with only one valve, the steam outlet valve should be checked by opening and closing it and ensured to function well. This valve should not be tightened too much to prevent getting stuck from heat expansion when steam is produced. When the boiler is heated and steam starts to come from the discharge pipe, the air in the boiler should be allowed to bleed off with steam waiting for some time and the discharge valve should be tightened fully. Because water level will rise as boiler water is heated, the water level should be kept constant by discharging from the bottom.

The nuts on boiler feet should be loosened to free the bolts.

Operating and first start

- Check system and boiler connections.
- Fill boiler with chemically suitable water up to the required level. The air discharge valve of boiler should be kept open to enable air discharge during water filling. (The air discharge valve should be kept open until steam is seen to come out.) When the water level is satisfactory, the boiler feed device will automatically stop the feeding pump. The bottom and surface discharge valves and boiler feeding device and level gage valves should be opened to check any blockage.
- During the first run of the boiler or during initial ignition of a cold boiler, the burner should be fired so that it will run for 10 minutes and wait for 10 minutes at 1st level small flame for at least 1 hour to let pressure and temperature rise gradually and to prevent thermal stress forming on boiler.
- When the boiler starts to build up pressure, the steam outlet valve should be opened a little to let steam into the system for gradual warm up. When steam pressure reaches ¼ operating pressure, the burner should be stopped and waited for 5-10 minutes for balanced heat distribution to system. Then firing should be resumed by restarting the burner and the operating pressure should be reached as slowly as possible. When the steam pressure reaches the adjusted pressurestat level, the burner will stop and further rising of pressure will be prevented.
- After the boiler operating pressure is reached, the surface discharge should be opened for 10 seconds and the lower discharge for 5 seconds to flush undesired substances from the boiler. In order to prevent human errors and negligence in the operation of your boiler, usage of automatic discharge systems is recommended.
- For boilers without automatic discharge systems, boiler water should be analyzed and surface discharging should be done more frequently when the conductivity coefficient is found to be high and bottom discharging should be done more frequently when hardness value is high.
- Boiler and feed water analyses should be repeated periodically. If any negative analysis results are

obtained, improvement procedures should be performed under control of expert water chemists. Our company should be consulted on these topics.

- When water analyses cannot be done, bottom and surface discharging should be performed at least 3 times a day. Bottom discharging should be performed several times with bottom discharge valve fully opened for at most 3 seconds; surface discharge should be done opening the surface discharge valve very little and keeping it open for long times.
- The operation of the boiler gages and control devices should be checked continuously every day and in case a condition out of normal operational behavior is observed, the boiler firing should be stopped under control and the necessary inspections and evaluations should be done. If needed, defective devices should be replaced.
- Condenser tank temperature should be continuously controlled and not let rise over 80°C. High water temperature may cause cavitation in boiler feed pumps, may result in pump failure in a short time and intermittent water pumping into boiler may disrupt normal operation. For this reason the condenser stops in condenser lines should be checked and cleaned one by one and should be replaced if steam leakage is still observed.
- During the firing of boiler and pressure build up, the boiler armatures and connections, manhole door gasket edges should be controlled and any leakages should be removed. The leakages detected after boiler operating-pressure is reached, should not be handled immediately, the required intervention should be performed after combustion is stopped, boiler depressurized and material temperature drops to enable handling.
- Steam valves should be opened and closed slowly. Otherwise, steam impacts may form.

ADJUSTMENTS AND CONTROLS TO BE PERFORMED

Purchase of a boiler as a package with all armatures included, is recommended. For steam boilers not purchased as a package, armatures that suit the nominal values of boiler and

comply with standards should be used and support may be requested from our company on armature selection.

Burner capacity adjustment should be made by the relevant burner firm and not exceeded boiler nominal value.

Pressurestat adjustments should be made not to exceed boiler operating pressure and in line with process requirements.

Boiler feedwater pump should turn in the direction indicated by arrow, if it is in reverse, phase connections should be reversed.

The boiler water level should be checked from the level gage and pressure from manometer and the boiler feed device

operation should be controlled continuously. Boiler safety valve opening pressure (see safety valve adjustment table, page 28)

should be tested once a month and if weighted safety valve is utilized, the weight positions should be constantly checked to stay at marked positions.

Control of safety valves

The nominal values of safety valves should be recorded at start and these records should be kept. In boilers that have more

than one safety valve, the valve that opens at the greatest pressure should be controlled first. For this purpose valves that

rate higher opening pressures should be locked with special mechanisms and the safety valve spring to be controlled should

be released. When the boiler reaches operating pressure the safety valve should be opened and closed manually several

times. This way the safety valve should be ensured to work properly and valve body should be allowed to warm up.

After this, the boiler pressure should be raised to valve discharge value and it should be checked whether the safety valve opens automatically at required pressure. As soon as the

safety valve opens, combustion should be stopped and the pressure should be dropped discharging steam to a level

enabling safe operation on valve.

Safety valves not rating desired nominal value are adjusted as recommended by manufacturer. While adjusting safety valves

(especially high pressure and capacity boiler valves), the boiler pressure should have been lowered to 20% under operating

pressure. The same inspection should be repeated after valve is adjusted.

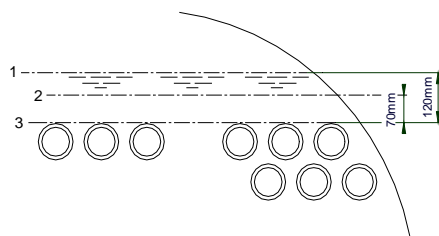
Water level control

During boiler operation, water level should be kept at desired value for as constantly as possible. For boilers of high capacity and with constant changes in steam draught, automatic control of water level should be provided. However, probability of malfunction in device should be kept under consideration and water level continuously be monitored by operators.

There must exist at least 2 level measuring tools in each boiler to inspect water level, one being the level gage glass. If differences are observed between gages, the reason should be found out and corrected.

At least once every shift, level control device should be discharged by opening its discharge valve and closed to see that the control device is filled with water again.

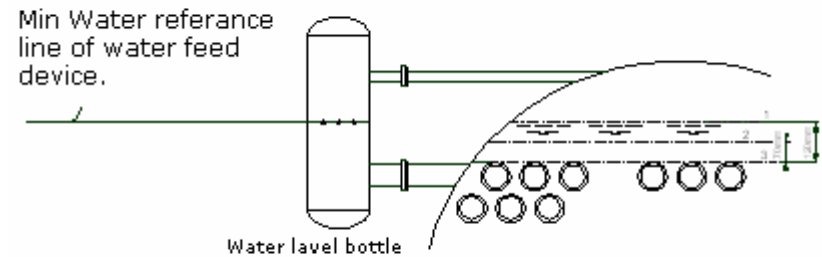
Minimum and maximum water levels should be marked off on the level gage glass. Level gage glass and surroundings should be lighted well and steam leaks should not be allowed. Level gage glasses should be kept clean. If water level is not seen in level gage glasses, discharging should be performed to make water level visible.



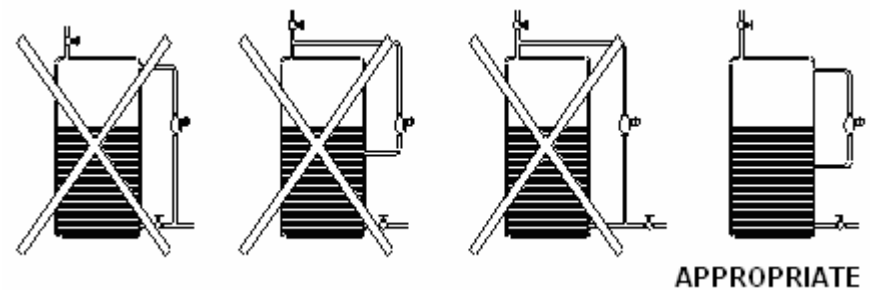
- 1 Normal water level
- 2 Lowest allowable water level
- 3 Highest point of heating level

Boiler water level

In boilers with automatic water level control, if water level drops or rises excessively, the system should be taken out of automatic control and water level should be put in manual mode. After this, the system should not be connected to automatic control before understanding and correcting the fault reason.



Obtain opinion from producer/vendor firms in case level electrode is being used.



Automatic boiler feed device installation

Foam control

When foam formation occurs manifesting itself with fluctuations in water level and unexplained drops in steam temperature, steam draught should be reduced to restore constant water level. To remove foam, water level should be returned to normal level and steam should be discharged at foam level continuously. The boiler should be fed with fresh water and foam discharge should be continued until foaming is prevented and if foaming cannot be prevented, the boiler should be taken out of operation and the reasons of the problem should be investigated.

Boiler feedwater control

Boiler feedwater should be sent to the boiler after passing through a water softener device and undesired conditions should be removed making constant analyses of the boiler water.

Boiler feedwater pumps should be kept under observation during operation and in case a fault arises, the spare pump should be operated immediately to prevent feedwater cut.

Blowdown

Maintaining the concentration of solids dispersed in the boiler water (TDS- Total Dissolved Solids) at an acceptable level can be provided by constantly analyzing the boiler feedwater and blowing down continuously from the blowdown pipe installed for this purpose. If water analyses that can determine the continuous blowdown quantity and duration are not being made, the boiler should be blown down by opening fully the lower blowdown valve once every shift. Blowdowns should be done when steam draught is at minimum.

While blowing down boiler in cases where there are double valves on the blowdown line, the valve first opened should be closed last. Blowdown valves must be opened carefully and slowly.

The blowdown system should be inspected frequently and leaking valves should be repaired or replaced. Leaks under high

pressure or temperature should be removed after burner is shut and pressure drops.

During high volume blowdowns, the shutting valve should be opened slowly to its end and then blowdown should be started turning the valve slowly ½ turn. In this case, blowdown should be done until the water level in level gage drops 1.5-2 cm. If more blowdown is required, blow down should be completed opening the blowdown valve fully after this stage and first the blowdown valve then the shutting valve should be closed.

THINGS TO BE DONE IN EMERGENCY CONDITIONS

Abnormally low water level

For whatever reason, if the water level in the level gage drops below minimum, the burner should be stopped immediately and steam outlet should be closed. Then the reasons for water level drop should be investigated.

It is very dangerous to feed water immediately and restore a closed boiler's water level to its previous state. Water should be fed under control after the boiler is cooled down to 50 °C for some time.

When the reason for the water level dropping is understood and the fault is removed, the water should be brought to normal level and then the boiler should be re-fired. In boilers that have electrical alarm and locking systems, which notify low water level, these systems should be always kept in good working order, providing safety against sudden level drops.



PERFORM THE INSPECTION AND
MAINTENANCE OF THE BOILER AND
BOILER ACCESSORIES FULLY

BOILER HARDWARE OPERATING, INSPECTION AND MAINTENANCE RULES

Inspection, maintenance and controls of boiler hardware should be done in compliance with hardware manufacturer's instructions.

Safety valves

Generally there should be two safety valves on boilers.

Safety valves should always be in good working order.

Safety valves should be passed through hot test at least once a year and compliance of opening and closing values with nominal values should be checked.

For new safety valves, nominal values should absolutely be controlled regardless of their values set by the manufacturer.

If a leak is seen in the safety valve during operation, the safety valve is manually opened to remove this leak and steam is blown down for a short time to enable discharge extraneous substances that may exist on valve seat. If the leak is still not removed, the safety valve is removed and repaired after the boiler is cooled. Spring pressure **should not be increased** in leaking safety valves to remove the leak.

During safety valve opening control, the following formula should be taken into consideration:

$$P_{\text{opening}} = 1.05 \times P_{\text{operating}}$$

EXAMPLE: Safety valve adjustment pressure for **6 bar** operating pressure:

is found to be: $P_{\text{opening}} = 1.05 \times 6 = 6.3$ bars

Feedwater pumps

Before boiler feed pumps are put in operation, the protective substances applied to shiny external surfaces by manufacturers for protection purposes should be cleaned off. Pump suction is checked and water feed provided.

Boiler feed pumps should be utilized in alternation to balance their operating lives. Bearing grease heads should be checked and depleted grease should be completed. Water drop leaks on their gaskets are normal for cooling the shaft. Over squeezing of gasket retainer to prevent water droplets may cause erosion of shaft and gasket due to overheating. In case of too much water leak gasket retainer must be tightened. If it fails to prevent leak, the gasket should be reinforced. In case, normal mechanical sounds are heard from pump bearings or pump internals or frequent thermal cuts happen, authorized pump service should be contacted.

BOILER INSPECTION AND MAINTENANCE RULES

General

Boiler periodical maintenance should be planned according to boiler operating conditions and how fast it gets dirty. In normal operating conditions, smoke side maintenance (turbulator and smoke pipe cleanup) should be performed at least once in a week for liquid fuels, at least once in 2 months for gas fuels and waterside maintenance at least once in 6 months. If the boiler gets dirty faster due to operating conditions, maintenance period should be shortened.

Furthermore, for the purpose of removing malfunctions seen in steam boilers, the boiler should be stopped at least once a year and the boiler and hardware should be passed from a general inspection and maintenance.

Taking the boiler out of operation

While steam output is reduced, feedwater should also be cut down and the flame be lowered. When the flame size goes down to the desired level, the fuel is cut and flame is put out. Airflow should be continued for some more time and flammable

gases collected in the furnace and chimney channels should be purged out.

Whether a check-valve exists or not in the boiler outlet, the shutting valve at the steam outlet should be tightly closed after the flame is put out. If there are two shutting valves at the outlet, the steam in the pipe between them should be blown down after both are closed.

After the fuel is cut, if an atomizing medium such as steam or pressurized air exists, the atomizing medium inlet should be closed.

If the boiler water level is normal, feedwater pump should be stopped. Feedwater inlet valve should be closed and if the water level is too high, blowdown should be performed to bring it to normal.

The cooling period of the boiler differs according to boiler type, capacity and features. To prevent formation of differential heat, fast cooling should be avoided. In very big boilers, additional (short time) firings may have to be performed in the boiler during cooling to provide equalized heat distribution.

Discharging

When the boiler is left to cool down, pressure drop is monitored. When pressure goes down to 2-2.5 bars (2-2.5 kgf/cm²), the air bleed pipe should be opened to prevent parts working under pressure. When boiler pressure becomes "0" and water temperature drops under 90°C, the boiler may be discharged.

If the boiler to be discharged operates in parallel with other boilers, care should be shown for the discharge valve that belongs to that boiler only. After the boiler is fully discharged, blowdown valves should be tightly closed and warning label should be hung on them stating that they should not be opened.

Inspection and maintenance preparation

- The boiler is stopped, cooled and discharged for inspection and maintenance.
 - Before entering the boiler for inspection, the main steam outlet valve or valves should be closed. The blowdown valve between the two valves is opened. Warning plates are tied on the valves. Boiler feedwater inlet valve, blowdown valves are closed and warning plates are tied on them. If the blowdown valve of the boiler is connected to blowdown valves of other boilers, stricter safety measures should be provided (for example, taking out fly wheels after blowdown valves are closed).
 - All fuel inlet valves are closed and warning plates are tied on them. To provide for the safety of the maintenance personnel, the burner ignition pipes are taken out and in gas fuel burning boilers, the gas line is plugged off or part of the gas pipe is removed.
 - Before entering the boiler, the combustion chamber and chimney channels are aired and gases inside are purged.
 - When personnel enter the boiler for inspection, etc. labels or warning plates are placed at visible places to indicate that people are working inside. Hinged doors are fully opened and tied back before entering.
 - Before stopping the boiler for inspection and maintenance purposes, soot blowing is performed to clean the heating surfaces. For inspection purposes, first the soot on the heat transfer surfaces of the boiler such as pipes, etc are swept and cleaned thoroughly.
 - The mobile lamps and lining to be used for lighting in the boiler should not be over 42 volts and the extension cables should be faultless and thickly isolated. The cables should be protected from crushes, cuts from possible damaging locations (such as sharp edges, door openings), all electrical devices to be used should be properly grounded and devices that work with the lowest

voltages should be preferred and electricity connection work should be done outside the boiler.

Inspection and maintenance of internal surfaces

- Internal surfaces of the pressurized boiler parts are inspected to control the suitability of the chemical specifications of the feedwater and the boiler water being used. Before entering the boiler for this purpose, the door must have been opened and the boiler should have been aired thoroughly.
- In boilers with flame pipes, pipes should be controlled, lighting their insides to ensure they are clean and free of blockage.
- Pipes should not be damaged any way during mechanical washing and cleaning.

Inspection of the outer surfaces and other parts

- The boiler should be inspected from outside to ensure that there are no breaks, welding tears at any part due to heating.
- All pipes must be cleaned with a suitable steel mop.
- All detected leaks and drains should be removed. Excessive force should not be applied while tightening for this purpose and if the leak does stop in spite of tightening, the leaky places should be opened and new gaskets should be placed after cleaning. While removing gaskets on shiny parts, care should be shown not to scratch these surfaces.
- The valves, pipes, pipe connection fittings and outer pipes on the boiler and boiler hardware should be inspected for leakage.
- Manholes known to leak should be passed from maintenance and existing leaks should be removed.
- If the chimney is directly above the boiler or boiler construction, measures taken to prevent rainwater from the chimney entering and corroding the boiler should be controlled.
- The steel construction, the steel platforms and stairs, boiler wall pipes, carrier supports, pipe suspension bars

should be controlled to see if dislocations and bends exist.

- Water level glass and position should be inspected to see if dislocations exist
- During maintenance and inspection, the boiler and its surroundings, air channels, chimney bottom, burners, boiler front, fuel hardware and control devices should always be kept clean. The tools and kits to be used during maintenance should not be scattered around in a disorderly manner.

Cleaning of internal surfaces

- Before starting to operate a boiler whose installation has been completed, rust, corrosive substances, grease leftovers, organic substance leftovers, protective paint, welding electrodes, and other extraneous materials leftover from installation should be cleaned as thoroughly as possible.
- Surfaces that are in contact with water and steam during boiler operation should be cleaned of substances such as oil, grease, oil acids, rust, and paint.
- Help must be obtained from expert institutions for chemical cleaning of the boiler.
- If the boiler will be kept out of operation for a period of time, it should be fully cleaned as in weekly cleaning and the surfaces should be cleaned with soda solution to remove acidity. If deposits have formed a layer, soda solution cleaning should be repeated as many times as required. Sufficient cleaning of sulphur may be tested with pH paper (pH value should be 7–9). Acid removal operation should be performed when the boiler is at a temperature of 50-60°C. When this process is completed, surfaces are left to dry and then linseed oil, turpentine and graphite are sprayed to prevent oxidation of metallic surfaces. The boiler doors should be closed to isolate it from air. In addition a container of half active lime is placed in the boiler to keep the air inside boiler dry.

Deposits

The solid deposits in the boiler are in the form of scales or mud in pipes and other surfaces.

Deposits in the form of scales

The reason for scaling is lack of a chemical medium that will turn deposits that form in many boilers into mud and such deposits, normally forming mud, harden and stick to surfaces under specific conditions.

Scaling leads to excessive heating in heating surfaces and thereby to pipe perforations. To ensure prevention of scaling, the boiler feedwater should be passed from processing to provide the desired chemical conditions before being given to the boiler. The water in the boiler should also be kept in suitable chemical conditions. The correctness of the chemical process to be applied should be checked with periodical boiler water and boiler feedwater analyses.

Mud

Formation of mud on boiler surfaces should be prevented as it will reduce heat transfer and lead to overheating of surfaces.

When the boiler is put out of operation, the water inside should not be discharged until it has cooled down thoroughly and the mud thus formed should be prevented from baking solid on hot surfaces.

Corrosion

Corrosion may happen when the boiler is in operation or when it is taken out of operation. If crusty deposits do not exist in the boiler, the life of the metal parts and pipes of the boiler depends on local blowholes or erosion of pipes or body due to corrosion.

If red or black iron oxide stains exist in locations with blowholes, these have formed due to neutral or alkaline character of the boiler water.

If there is excessive heat in regions, the boiler water is in contact with metal parts and water circulation is not sufficient, they develop blowholes or pitting. Corrosion may similarly form in water of neutral character, although more slowly. As a result of this type of corrosion, iron oxide and hydrogen gas formed. Sometimes, due to high metal temperatures that arise because of bad heat transfer on surfaces covered with excessive deposits, the deposited materials enter reaction with the metal leading to corrosion.

Therefore, the necessary hardware should be used to purge boiler feedwater from all kinds of gases, especially from oxygen. (For this purpose a gas remover called de-aerator should be utilized.) Furthermore, various gas removing chemicals should be added to the boiler water.

The CO₂ concentration in the steam condenser should be kept at minimum value.

Prevention of gas side corrosion

When liquid fuel and especially heavy fuel oil is used, sulphur content reaches approximately 3%. During combustion, sulphur collects on fire and smoke surfaces, especially in far corners. During start stop operations of the boiler, the water vapor in the chimney gas condenses and sulphur mixes with water to form sulphuric acid.

To prevent this:

- Liquid fuel with low sulphur content should be used.
- Soot and smut gathering on boiler heating surfaces (combustion chamber, smoke pipes, smoke chest) should not be allowed, cleaning process should be performed as frequently as possible.
- Panorin should be applied to heating surfaces. (The soot on surfaces will disappear and boiler smoke side cleaning will become easier).
- The burner should not be stopped very frequently.

- Burner combustion settings should be good. Burner adjustment should be performed by authorized burner services with Chimney Gas Analyzer.

Cracks and brittleness formed in steel parts

Cracks in the boiler and smoke pipes should be removed immediately, as they will lead to dangerous consequences. The assistance of the authorized service personnel and experts should be utilized to eliminate such consequences.

CHEMICAL SPECIFICATIONS OF BOILER FEEDWATER AND BOILER WATER

Water to be used in boilers must be conditioned. The chemical specifications that the feedwater and the water in the boiler must meet are shown in the tables and graphics below. To operate the boiler efficiently and economically, the boiler feedwater and boiler water should be continuously checked to ensure provision of the necessary chemical conditions for the water.

The degree of pureness of the steam and the degree of being polluted should be determined with samples taken from the steam condenser.

Deterioration of steam purity

All solid and liquid extraneous substances carried away with steam produced in the boiler are pollutants that impair steam purity. Liquid substances consist of water droplets that are dragged along without evaporating and solids consist of suspended or dissolved solid substances that are dragged along together with these water droplets or steam.

Water dragging is dragging along of large volumes of water together with steam due to increase in boiler level or a sudden increase in steam draught in a short time for any reason. Water dragging leads to water impacts in steam pipes.

Foaming is collection of boiler water around steam bubbles in membrane form due to pollutant solid or liquid substances

existing in the boiler water. The foam forming as a result of this may rise and be dragged along with steam.

Fog - little water droplets existing on boiler water surface in the form of spray or fog are thrown into the steam due to explosion of steam bubbles rising on the surfaces where steam is freed.

Priming is the event of water being moved along with steam with a sudden displacement of boiler water. (It can be compared to the event observed when an open cola or soda bottle is shaken.)

Silicate (SiO₂) - Solid substances suspended in boiler water collect in the film layer around steam bubbles and increase resistance of the bubble against breaking and cause foaming.

Effects of water dragging

- Dropping of boiler operating efficiency
- Erosion of devices that work with steam
- Deposits forming in steam and condenser circuits

Checking of steam purity

Foaming and water dragging in boiler are dangerous conditions that require taking measures and removing immediately.

Measures to prevent water dragging

- Performing controlled blowdowns continuously to keep the condensation in the boiler water at values foreseen by the application,
- Ensuring lack of foaming substances in the boiler water,
- Preventing sudden changes in steam draught,
- Keeping water level at limits shown on page 25.
- Reducing chemical substances input to the boiler.
- Establishing the feedwater conditioning system so as to provide the conditions in table-1,
- Adding special foam removing substances to boiler water,
- Checking the suitability of the boiler capacity selection,

- Checking the conformance of the selected burner and burner nozzle with boiler capacity,
- During initial operation in the morning, giving way to steam after all pipe lines reach operating pressure,
- Using steam water separator (especially after the main steam valve, before any existing pressure reliever, at steam using device inlets),
- Designing steam pipelines so as to prevent steam cooling and condensing.

Sampling boiler feedwater, boiler water and steam

The sampling dates and sample quantity of the samples taken for use in experiments to be performed for checking desired water conditions should be identified.

In conditions where boiler water composition changes slowly or generally stays constant, it is sufficient to take samples once in each shift or once a day. At places where water composition changes fast, more samples should be taken.

In a system where various boilers exist, a separate sample should be taken from each boiler. Samples should be taken just before blowdowns or during blowdowns and should be immediately analyzed after cooling under pressure.

The container for taking sample should be clean and the container should be rinsed with the water to be sampled before the last sample is taken in the container. Sample containers should be closed and the contact with dust or carbon dioxide in the air should be prevented. The results of the experiments made should be recorded daily with a record and kept.

BOILER WATER SPECIFICATION

FEEDWATER FOR STEAM BOILERS (EXCEPT ATTEMPERATOR SPRAY WATER) AND HOT WATER BOILERS			
Parameter	Unit	Feedwater for steam boilers	Make-up water for hot water boilers
Operation pressure	bar (= 0,1 MPa)	> 0,5 - 20	total range
Appearance	-	clear, free from suspended solids	
Direct conductivity 25 °C	µS/cm	not specified, only guide values relevant for boiler water see table 5-2	
pH value at 25 °C ^a	-	> 9,2 ^b	> 7
Total hardness (Ca + Mg)	mmol/l	< 0,01 ^c	< 0,05
Iron (Fe) concentration	mg/l	< 0,3	< 0,2
Copper (Cu) concentration	mg/l	< 0,05	< 0,1
Silica (SiO ₂) concentration	mg/l	not specified, only guide values for boiler water relevant, see table 5-2	-
Oxygen (O ₂) concentration	mg/l	< 0,05 ^d	-
Oil/grease concentration (see EN 12953-6)	mg/l	< 1	< 1
Organic substances (as TOC) concentration	-	see footnote ^e	

^a With copper alloys in the system the pH value shall be maintained in the range 8,7 to 9,2.

^b With softened water pH value > 7,0 the pH value of boiler water according to table 5-2 should be considered.

^c At operating pressure < 1 bar total hardness max. 0,05 mmol/l shall be acceptable.

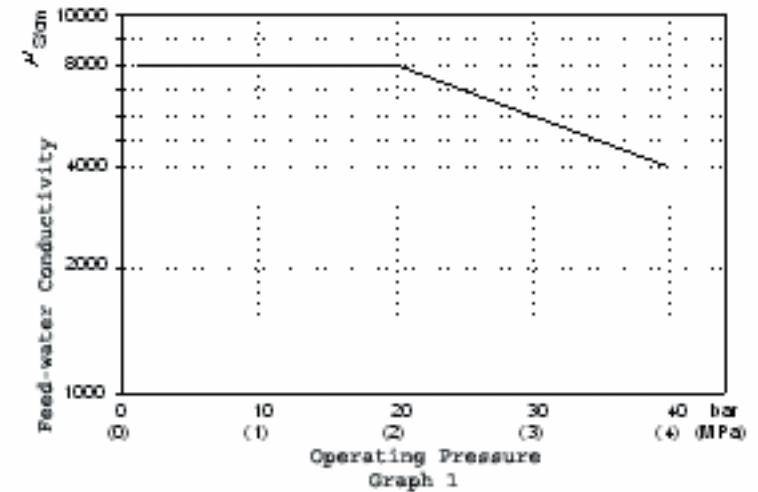
^d Instead of observing this value at intermittent operation or operation without deaerator if film forming agents and/or excess of oxygen scavenger shall be used.

^e Organic substances are generally a mixture of several different compounds. The composition of such mixtures and the behaviour of their individual components under the conditions of boiler operation are difficult to predict. Organic substances may be decomposed to form carbonic acid or other acidic decomposition products which increase the acid conductivity and cause corrosion or deposits. They also may lead to foaming and/or priming which shall be kept as low as possible.

Ref: EN 12953-10 : 2003 Table 5-1

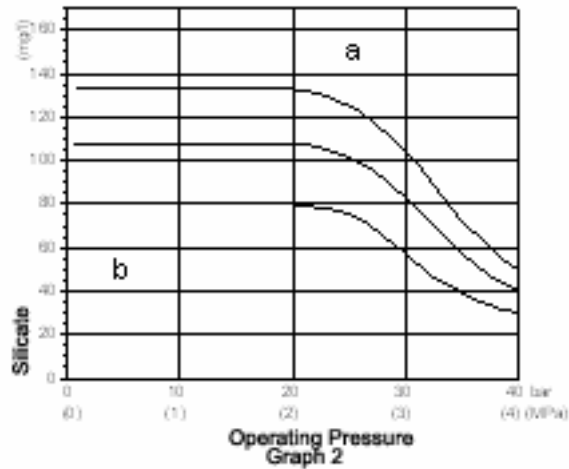
BOILER WATER FOR STEAM BOILERS					
Parameter	Unit	Boiler water for steam boilers using			Boiler water for hot water boilers
		Feedwater direct conductivity > 30 $\mu\text{S}/\text{cm}$	Feedwater direct conductivity ≤ 30		
Operation pressure	bar (= 0,1 MPa)	> 0,5 - 20	> 20	> 0,5	total range
Appearance	-	clear, no stable foam			
Direct conductivity 25 °C	$\mu\text{S}/\text{cm}$	< 6000 ^a	see Figure 5-1 ^a	< 1500	< 1500
pH value at 25 °C	-	10,5 - 12	10,5 - 11,8	10 - 11 ^{b,c}	9 - 11,5 ^d
Composite alkalinity	mmol/l	1 - 15 ^a	1 - 10 ^a	0,1 - 1 ^c	< 5
Silica (SiO ₂) concentration	mg/l	pressure dependent, according to figure 5-2			-
Phosphate (PO ₄) ^e	mg/l	10 - 30	10 - 30	6 - 15	-
Organic substances	-	see footnote ^f			-
^a With superheater consider 50 % of the indicated upper value as maximum value.					
^b Basic pH adjustment by injecting Na ₃ PO ₄ , additional NaOH injection only if the pH value is < 10.					
^c If the acid conductivity of the boiler feedwater is < 0,2 $\mu\text{S}/\text{cm}$, and Na + K concentration is < 0,010 mg/l, phosphate injection is not necessary.					
Under the conditions AVT (all volatile treatment, feedwater pH $\geq 9,2$ and boiler water pH $\geq 8,0$) can be applied, in this case the acid conductivity of the boiler water is < 5 $\mu\text{S}/\text{cm}$.					
^d If non-ferrous materials are present in the system, e.g. aluminium, they may require lower pH value and direct conductivity, however, the protection of the boiler has priority.					
^e If coordinated phosphate treatment is used; considering all other values higher PO ₄ concentrations are acceptable (see also clause 4).					
^f See ^e in table 5-1.					
Ref: EN 12953-10 : 2003 Table 5-2					

Maximum acceptable boiler water conductivity depending on the pressure



Boiler feedwater conductivity should be > 30 $\mu\text{S}/\text{cm}$.

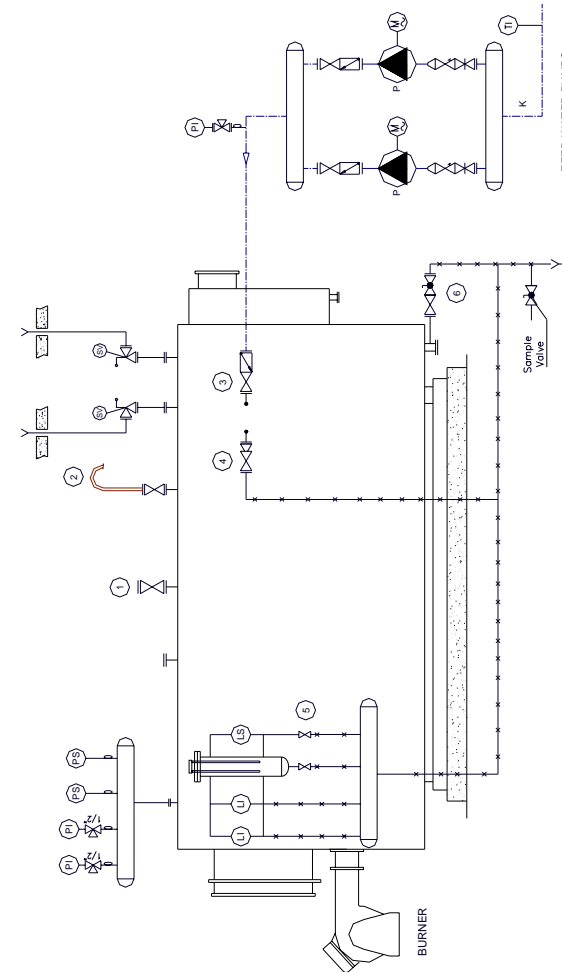
Maximum silicate (SiO₂) quantity acceptable in boiler water depending on the pressure



- If operating pressure is >20 bars it is not appropriate to work in region (a).
- Max. acid quantity in (b) region should be pH= 8.2

INSTALLATION CIRCUIT DIAGRAM

A boiler installation diagram is given as an example. An installation according to the needs of the operation and the characteristics of the process where the steam is utilized should be setup.



Piping and Instrumentation diagram

PS	Pressure switch
PI	Manometer
SV	Safety valve
LI	Water level gage
LS	Water feed device
LE	Level electrode
K	Water coming from the condenser tank
TI	Thermometer
M	Motor
P	Pump
1	Steam Outlet
2	Air pipe
3	Feed water Inlet
4	Surface blowdown
5	Level bottle discharge valves
6	Bottom blowdown

BOILER LIFE SPAN

Hot water boilers' economic life span has been set by the Ministry of Industry to be 10 years. If erensan° brand boilers are utilized in compliance with operating and maintenance instructions, it is possible to go well over the ministry stated life span. Therefore, **make sure that this operating and maintenance procedure is read and fully applied by operating personnel.**

When the boiler has reached unusable state, remove the junk from usage area in compliance with environmental procedures.

WISHING HAPPY USE OF YOUR BOILER... ..
