TECHNICAL MANUAL

EN

The above picture is only for reference.

GX

STEAM GENERATOR

1 TECHNICAL CHARACTERISTICS

1.1 GENERAL

The GX series steam boilers are type semi-fixed, horizontal smoke-tube type, complete with accessories. The boilers are suitable for operation with pressurised burners for gas, fuel oil or heavy oil.
Safety, reliability, high efficiency and high quality saturated steam are the characteristics of our boilers. Please consult the instructions with attention.

This high-pressure steam (12-15 kgf/cm^2) generator uses a combustion chamber with three-gas-passes, wet floor-externally-fired boiler. For operation at up to 3000 kg/h of steam generated there is partial exoneration (in Italy) in the employment of specialist boiler operators. Local requirements as to personnel qualification MUST be taken into account for the country where the unit is installed.

1.2 CHARACTERISTICS

- **Working pressure switches** for operation (controlling the 1st and 2nd burner flame).
- **Locking pressure switches** (stops the burner on reaching the maximum steam pressure; the boiler is manually reset from the control panel).
- **Automatic level regulator** (2 probes connected to an electronic conductivity relay maintain the water level between the set levels).
- **Water level limits** (2 probes connected to two independent electronic conductivity relays stop the burner if the water level falls below the safe minimum; reset is manual on the control panel).

1.3 TECHNICAL DATA

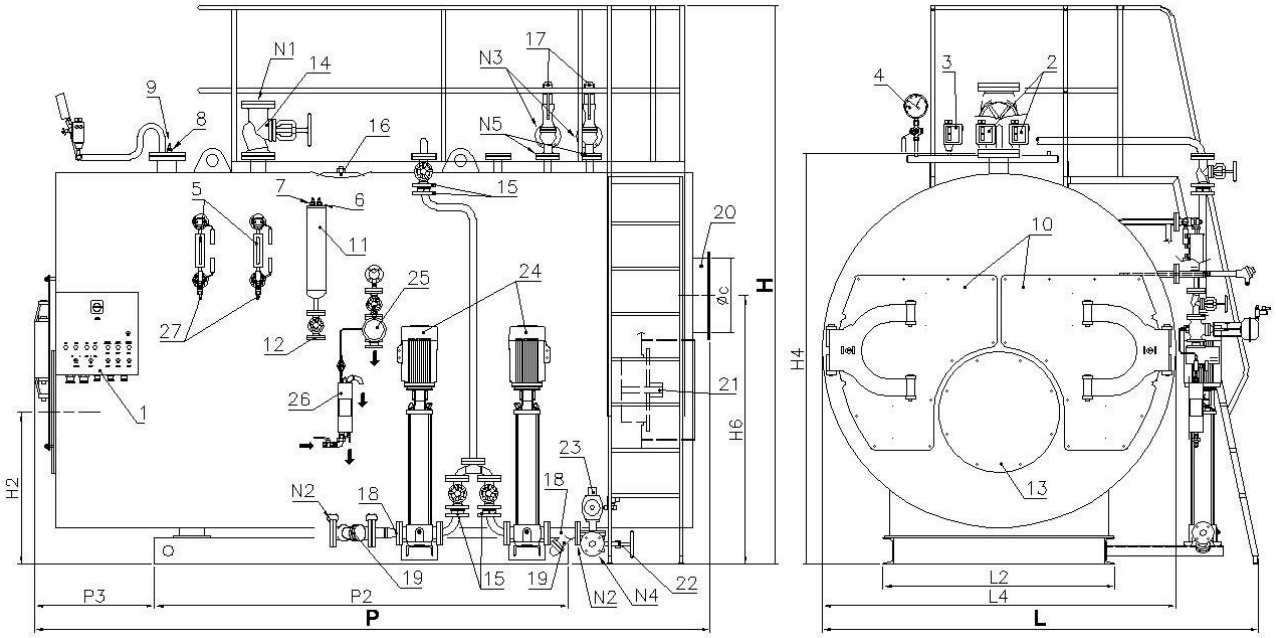


Fig. 1

LEGEND

1	Switchboard	12	Barrel drain	24	Feed water pumps
2	Control pressure switches	13	Burner plate	25	Salinity check
3	Locking pressure switch	14	Steam take-off	26	Chill
4	Pressure gauge	15	Non return valve	27	Level gauges drain
5	Level gauges	16	Inspection door		
6	Pump stop probes	17	Safety valves	N1	Steam take-off fitting
7	Pump start probes	18	Feed water	N2	Feed water fitting
8	1st safety level probe	19	Suction pumps filters	N3	Safety valve drain fittings
9	2nd safety level probe	20	Smokestack connection	N4	Boiler drain fitting
10	Front plates	21	Flame inspection hole	N5	Safety valves fittings
11	Probes holder barrel	22	Boiler drain		
		23	Pneumatic drain valve		

NOTE: drawing, legend and data refer to standard models. For specific models, please refer to the provided accessory drawing.

Characteristics	Heat output		Pressure losses flue gas side	Design Pressure	Total capacity	Steam capacity*	Total weight	Electric supply	Frequency	Insulation class	Fuel		
	kW	kcal/h	mbar	bar	l	kg/h	kg	Volt ~	Hz	IP			
											Nat gas	Gas	Gas
GX 1000	**1163**	1.000.000	5,5	12	5940	1700	6500	3/N~ 400	50	IP55	X	X	X
GX 1200	**1395**	1.200.000	7,0	12	5840	2050	7100	3/N~ 400	50	IP55	X	X	X
GX 1500	**1744**	1.500.000	7,0	12	6960	2560	8500	3/N~ 400	50	IP55	X	X	X
GX 1750	**2035**	1.750.000	7,0	12	6860	3000	9600	3/N~ 400	50	IP55	X	X	X
GX 2000	**2326**	2.000.000	8,5	12	8435	3410	10500	3/N~ 400	50	IP55	X	X	X
GX 2500	**2907**	2.500.000	8,0	12	9610	4260	11500	3/N~ 400	50	IP55	X	X	X
GX 3000	**3488**	3.000.000	9,0	12	9865	5100	13100	3/N~ 400	50	IP55	X	X	X
GX 3500	**4070**	3.500.000	10,5	12	11940	6000	14500	3/N~ 400	50	IP55	X	X	X
GX 4000	**4651**	4.000.000	10,0	12	12670	6800	16000	3/N~ 400	50	IP55	X	X	X
GX 5000	**5814**	5.000.000	10,5	12	13750	8520	18500	3/N~ 400	50	IP55	X	X	X
GX 6000	**6977**	6.000.000	12,0	12	16530	10240	21000	3/N~ 400	50	IP55	X	X	X
GX 7000	**8140**	7.000.000	12,0	12	20030	12000	24000	3/N~ 400	50	IP55	X	X	X
GX 8000	**9302**	8.000.000	14,0	12	24700	13600	28000	3/N~ 400	50	IP55	X	X	X
GX 9000	**10465**	9.000.000	14,0	12	28140	15300	30000	3/N~ 400	50	IP55	X	X	X
GX 10000	**11628**	10.000.000	15,0	12	32000	17000	36600	3/N~ 400	50	IP55	X	X	X
GX 12000	**13953**	12.000.000	19,0	12	37500	20000	38000	3/N~ 400	50	IP55	X	X	X
GX 13000	**15116**	13.000.000	20,0	12	39000	22170	40000	3/N~ 400	50	IP55	X	X	X
GX 15000	**17441**	15.000.000	25,0	12	39000	25000	45500	3/N~ 400	50	IP55	X	X	X

Dimensions	H	H2	H4	H6	L	L2	L4	P	P2	P3	øc	N1	N2	N1/N2	N3	N4	N5
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	DN/in	DN/in	PN	DN/in	DN/in	DN/in
GX 1000	**3200**	865	2280	1500	**2450**	1200	2000	**4100**	2400	750	400	65	40	16	40	40	25
GX 1200	**3200**	865	2280	1500	**2450**	1200	2000	**4100**	2400	750	400	65	50	16	40	40	25
GX 1500	**3300**	915	2460	1620	**2550**	1400	2180	**4100**	2500	750	450	80	50	16	50	40	32
GX 1750	**3350**	915	2460	1620	**2650**	1400	2180	**4100**	2500	750	450	80	50	16	50	40	32
GX 2000	**3350**	915	2460	1620	**2650**	1400	2180	**4600**	3000	750	500	80	50	16	50	40	32
GX 2500	**3500**	990	2620	1745	**2760**	1500	2300	**4900**	3200	800	550	100	50	16	50	40	32
GX 3000	**3600**	1030	2690	1830	**2900**	1500	2340	**5100**	3200	880	600	100	50	16	50	40	32
GX 3500	**3600**	1020	2720	1750	**2900**	1500	2400	**5600**	3500	1025	600	125	65	16	50	40	32
GX 4000	**3780**	1115	2920	1950	**3000**	1600	2500	**5700**	3700	1070	650	125	65	16	65	40	40
GX 5000	**3954**	1150	3020	2020	**3260**	1600	2640	**5700**	3500	1100	650	125	65	16	65	40	40
GX 6000	**4110**	1250	3200	2050	**3390**	1700	2740	**6300**	4000	1100	700	150	80	16	80	40	50
GX 7000	**4250**	1300	3350	2070	**3460**	1800	2880	**6750**	4500	1100	700	150	80	16	80	40	50
GX 8000	**4400**	1345	3500	2150	**3620**	1900	3040	**7250**	5000	1100	800	150	80	16	100	40	65
GX 9000	**4550**	1320	3600	2200	**3750**	2000	3200	**7650**	5100	1200	900	200	80	16	100	40	65
GX 10000	**4550**	1400	3685	2350	**3750**	1900	3280	**8050**	5500	1200	900	200	80	16	100	40	65
GX 12000	**4650**	1400	3770	2240	**4000**	2300	3350	**8700**	6000	1150	1100	200	100	16	100	40	65
GX 13000	**4870**	1470	3970	2240	**4500**	2300	3500	**9030**	6200	1160	1100	200	100	16	100	40	65
GX 15000	**4870**	1477	3892	2500	**4500**	2300	3500	**9300**	6500	1200	1100	250	100	16	100	40	65

* 80°C feeding water

2 ACCESSORIES

GX steam boilers are fitted with a series of accessories that can be subdivided as follows:
- Safety accessories (safety valves, water level limits, safety pressure switches).
- Observation accessories (level gauges, pressure gauge, flame inspection).
- Control accessories (level ad pressure switches).
- Feed water accessories: centrifugal pump, stop valves.
- Manual operation accessories (stop valves, purge valve).

In the following description the accessories are subdivided as to the physical parameter they control (pressure and level).

2.1 PRESSURE

2.1.1 Pressure gauge (Fig. 2)

The pressure gauge is Bourdon type consisting of a flat elliptical section metal tube, bent to an arc. One end of the tube is open and communicates with the boiler where the pressure is to be measured; the other end, closed and free to move is connected by a lever system to a toothed arc and to the gauge indicator hand.
The gauge shows in red the design pressure.

The gauge is carried on a three-way valve to allow the following operations:
- Communication between boiler and gauge (normal operation position).
- Communication between gauge and the atmosphere (position necessary to purge the siphon).
- Communication between the boiler, the gauge and a test gauge (position necessary to verify the gauge).

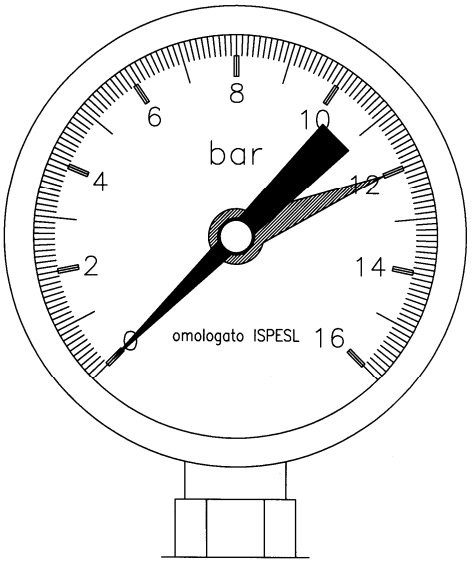


Fig. 2

2.1.2 Operation pressure switch

Device that controls the boiler pressure and holds the pressure between the set maximum and minimum values.

Instructions for adjustment.
The electric switch has three screws (2-1-3 from right to left).
On reaching the set pressure, the contact 2-1 switches to 2-3.

Adjustment of the pressure switch (Fig. 3):

a) Turn the knob (1) until the scale indicator (2) reaches the pressure at which the burner shall restart.
b) Remove the cover of the pressure switch and position the drum (3) at the value selected for the pressure differential (stopping the burner) as to the diagram Fig. 4.

Example:
* Type of pressure switch: RT 5
* Scale indicator 9 bar
* Drum indicator: 4 corresponding to 2,1 bar
* Burner start: 9 bar
* Burner stop: 11,1 bar

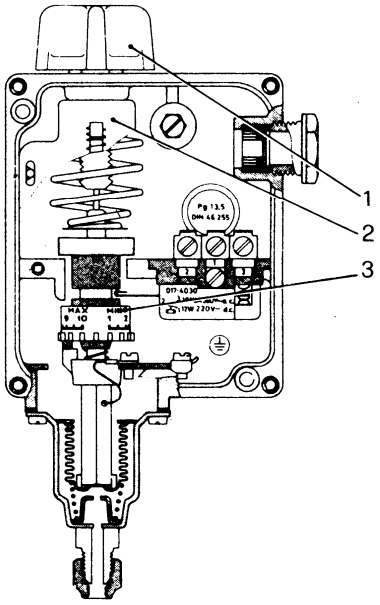


Fig. 3

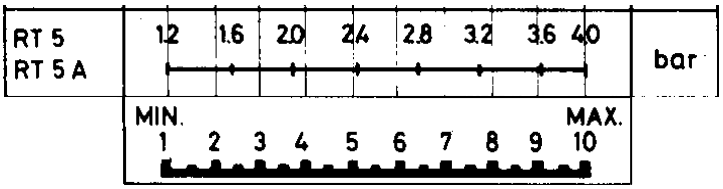


Fig. 4

2.1.3 Safety pressure switch

This switch is set at a higher pressure than the maximum of the control pressure switch, but always lower than the opening pressure of the safety valves.

The safety pressure switch acts in the case of a fault to the control pressure switch and stops the burner permanently. Restarting the burner can only occur after the steam pressure has fallen and after a manual reset on the switchboard.
This pressure switch is adjusted in a similar manner to that of the control pressure switch, with the only precaution that the drum indicator is set to 1 so that the differential is effectively nil.

2.1.4 Safety valves

These valves have the function of discharging steam when the maximum design pressure of the boiler is reached.
The valves used on boilers are of the type **Spring** (Fig. 5).
The boiler operator must pay much attention to the safety valves and carry out careful and diligent maintenance. The safety valve is the most important and sensitive accessory on the boiler and represents the best guarantee that the internal pressure of the boiler does not exceed the design pressure.
As during normal operation of a boiler, the safety valve never acts, it is **good practice to check that the valve is free, i.e. that the valve plug is not stuck to the seat,** by acting on the side lever until the valve starts to discharge steam.

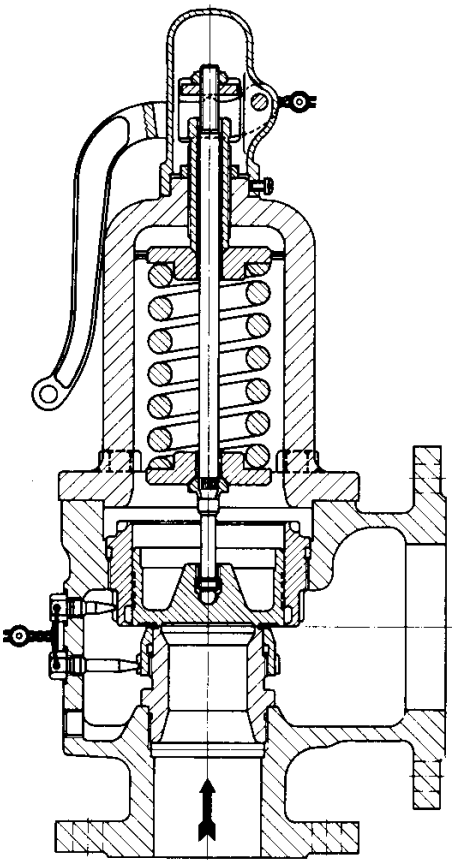


Fig. 5

WARNING
The safety valve installed on steam boilers must have the discharge piped to outside the boiler room. Particular care must be taken in designing the discharge line; we show some here.

- The discharge line should e of diameter at least equal to that of the discharge flange on the safety valve.
- Only wide radius curves must be used in the discharge line.
- The entire discharge line must be built to avoid the formation of condensation locks. There must be therefore adequate slopes to ensure complete drainage.

Particular care must be taken if the valve seat and plug are to be ground; if this operation becomes necessary due to leaks, use abrasives based on silicon carbide or oil based carborundum. Carry out the first grinding operation using fine grain abrasive, finishing with a very fine grain abrasive.

2.2 LEVEL

2.2.1 Level indicator gauge

The level indicator consists of a pair of valves connected to a sight glass box containing a prismatic glass. This device is connected to the boiler both above and below the normal water level, while the lower part is fitted with a purge valve so that any sludge can be removed, to keep the glass clean. Using these valves, the efficiency of the level control system can be verified periodically by carrying out the following operations:

- Open for a few seconds and then close the purge valve. If the water disappears from the sight glass and then appears again with ample level oscillation, then it can be considered that the level operates correctly. If on the other hand the water returns slowly or stops at a level differing form the preceding level, then on of the communications may be obstructed. To make sure which of the two is obstructed, and to attempt a purge, close the steam valve leaving the water valve open, then open the purge valve. This valve must release water taking with it any sludge formed in the pipes. Then close the water valve and open the steam valve: steam should be released from the purge valve. Closing the purge valve and leaving the two water and steam valves open, the water should return to the initial level. If this does not occur, the communication pipes between the level and the boiler must be cleaned.

2.2.2 Automatic level regulator and water level limits (Fig. 6)

The physical principle employed to detect and control the water level is based on the electrical conductivity of the water. The control device consists of a part sited in the control panel (electronic relays) and of probes of differing lengths immersed in the barrel and boiler shell.
Operation of the system provides for:

- **Automatic pump start and stop**: Two probes inserted in the barrel, of which the longer starts, and the shorter stops the pump, connected to a single control relay in the control panel.
- **Burner stop at low water level**: two probes, inserted in the boiler and connected to two distinct control relays in the control panel, stop the burner permanently if the water level drops below the admissible level.

Barrel probes:
6 Pump stop
7 Pump start

Boiler probe:
8 2nd safety burner stop and alarm on.
9 1st safety burner stop and alarm on.

N.B.: we suggest that as well as the acoustic alarm in the boiler room, a further acoustic alarm be provided in an area where personnel is normally present.

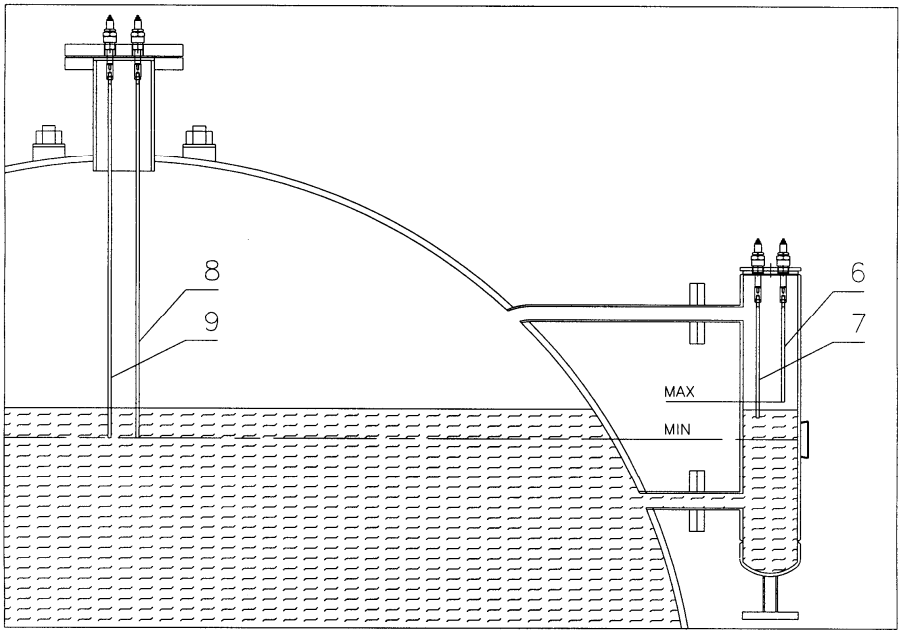


Fig. 6

2.3 FEED WATER

An electric centrifugal pump supplies the water. The inlet side of the pump must never be under suction pressure, but always under positive pressure due to the difference in height between the pump itself and the feed water tank. While a pump can operate under suction head from a cold water tank (up to 5-6 m), if the water is hot the pump cannot operate and indeed needs the water to be delivered under a certain pressure.
The height of the feed water tank varies with the temperature, as shown in the following table:

WARNING

- **Oxygen dissolved in water causes corrosion in the boiler. Reference should be the maximum permissible values indicated in the relevant section of the technical manual.**
- **To avoid pump cavitation problems, you must perform the following table.**

DEAERATOR TYPE	**Feed water temperature** (°C)	**Positive water head** (meters)
ATMOSPHERIC DEAERATOR	60	1
	70	2
	80	3
	90	4,5
DEAERATOR THERMOPHYSICAL PRESSURISED 0,5 barg	105	6
DEAERATOR THERMOPHYSICAL PRESSURISED 3 barg	120*	7

*** NOTE: the maximum of the pump inlet temperature is 120 ° C**

3 INSTALLATION

3.1 SITING

Our generators must be placed on a horizontal support base able to support the weight of the boiler when completely full of water for the possible on-site hydraulic test.

3.2 WATER CONNECTIONS

The steam boilers once positioned are connected to the system as follows (Fig. 7):

Water

From the condensate collection tank (10) (if existing; otherwise from the treated water tank) to the suction side of the feed water pump (9).

Steam

From the main steam take-off valve (3) to the user services (distributor or others), from the safety valve outlets (6) to outside the boiler room in a safe position.

Drains

From the level indicator drains (16) and the boiler drain (17) to the drainage network.

Fuel

Connection to the burner foreseen for fuel oil or natural gas.

Compressed air

Air pressure should range from 4 to 10 bar.

Important: the air should be filtered through a mesh of 25 µm.

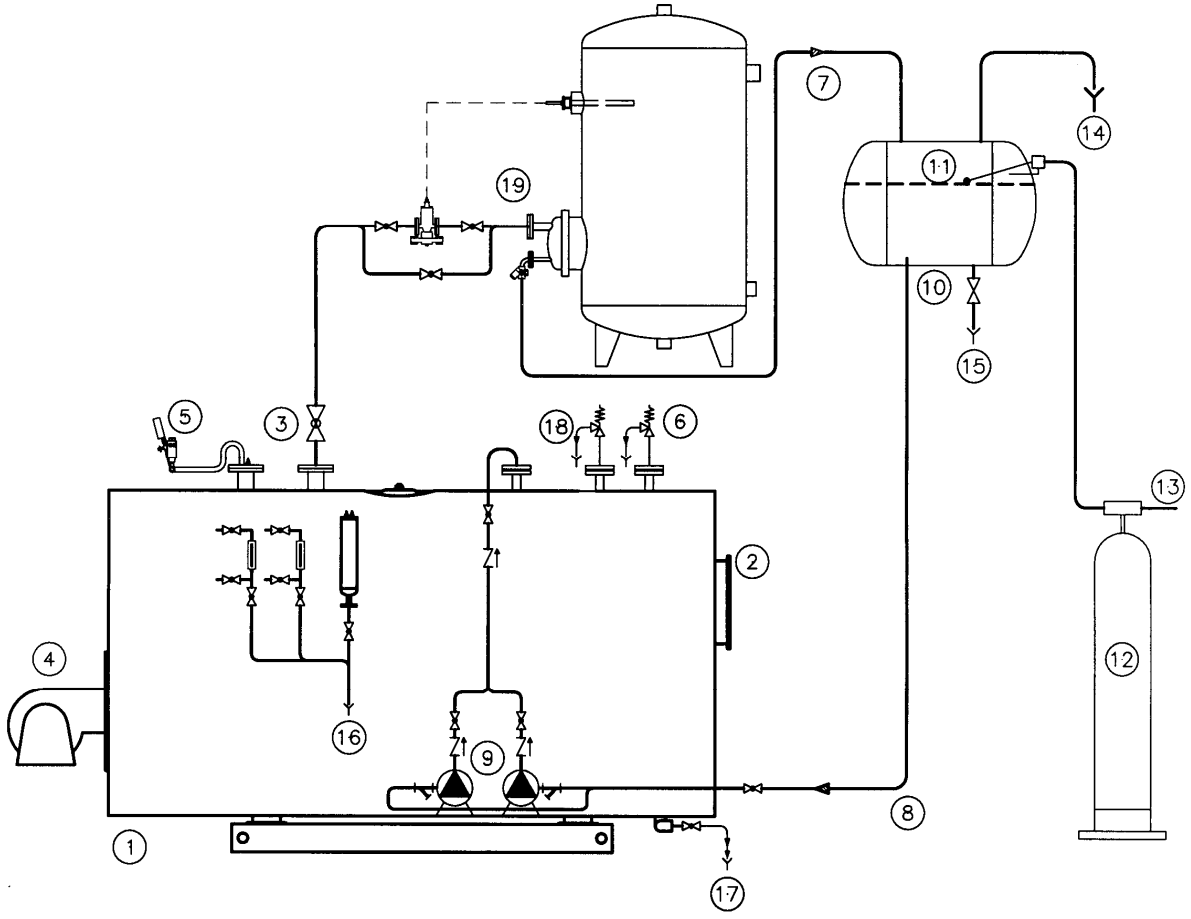


Fig. 7 – System diagram

LEGEND

1. Boiler
2. Smokestack
3. Steam take-off
4. Burner
5. Pressure switches
6. Safety valves
7. Condensate return
8. Electric pump supply
9. Feed water pump
10. Condensate collection tank
11. Water level
12. Water treatment
13. Water supply
14. Breather
15. Condensate tank drain
16. Level indicator drain
17. Boiler drain
18. Safety valve drain
19. Example of user service

3.3 ELECTRIC CONNECTIONS

The boilers are provided with a switchboard (protection level IP 55) completely assembled to the various boiler accessories.
Before connecting the switchboard, make sure that the electric system has been correctly installed, checking in particular the efficiency of the earthing system.

Wiring diagram
Refer to the diagram supplied with the specific switchboard.

3.4 SMOKESTACK

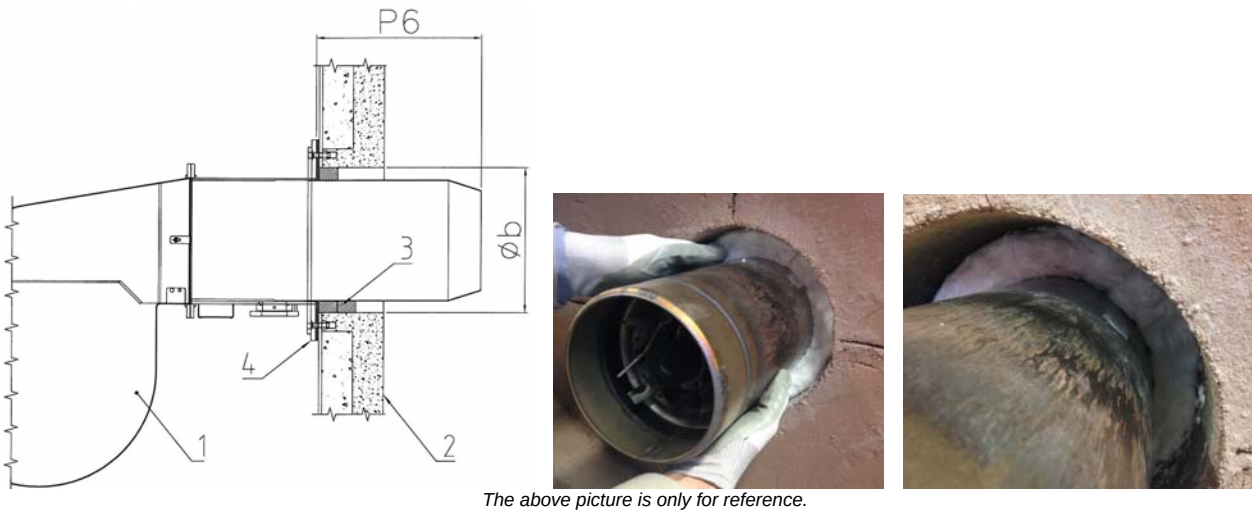
The smokestack must be dimensioned as to applicable regulations.

3.5 BURNER

The suitable burner shall be a **two-stage burner** or **a modulating burner;** this avoids large pressure variations consequent on sudden stream demands.
Further, and above all with natural gas, every burner start-up is preceded by a long period of preventilation of the combustion chamber, with consequent loss of heat to the smokestack.

3.5.1 Boiler - Burner coupling

Verify that the spaces between the burner sleeve and the boiler door are suitable filled with flame-resistant ceramic insulation (Fig. 8).
The thermoinsulating strip provided with the boiler must be wrapped around the mouthpiece for at least an entire circumference of the flame radiation to protect the flange of the burner. Not that the ceramic insulation is necessary to fill the gap until the insulation inside surface of the door.



The above picture is only for reference.
Fig. 8

KEY:
1. Burner
2. Manhole
3. Thermoinsulating material
4. Flange

4 BOILER OPERATION

4.1 FIRST START-UP

- Verify that all fittings are tight.
- Verify that the feed water pipes are clean, carrying out a series of washing operations with drainage to waste before final boiler filling.
- Close the drain valves, the steam take-off valve and the level drains.
- **Verify that the lifting lever of the safety valves is free of moving in order to ensure the steam discharge at the set pressure, which is marked on the valve.**
- Open the level control valves and the feed water valve (upstream of the feed water pump).
- Check that the upper man-way is correctly closed.

WARNING!

- Loosen the anti vibration bolts which are fitted on the front doors hinges (1 Fig. 9) before opening the doors.
- **Remove the holding bolts from the rear leg of the boiler base (2 Fig. 9) after positioning the boiler and in any case before first start-up, in order to allow boiler expansion during operation.**

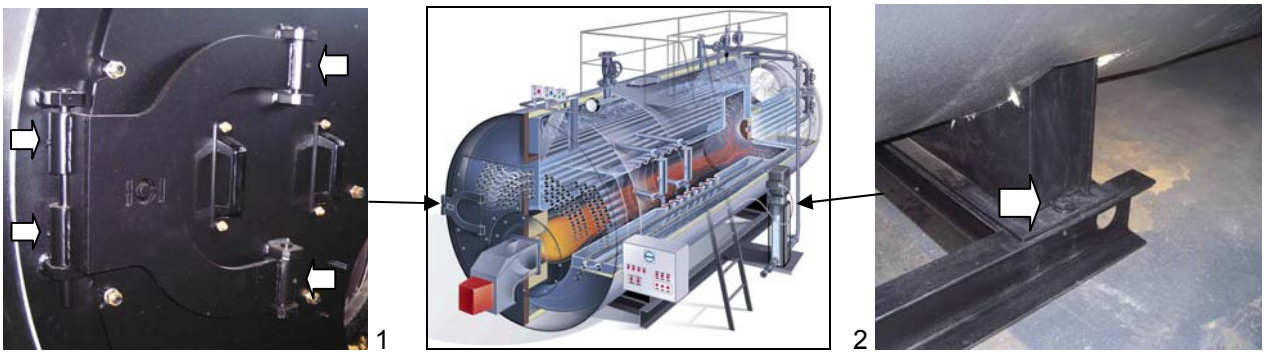


Fig. 9

Start the boiler as follows:

1) Switch on the control panel by turning the main switch.
2) Check that the drive shaft of the feed water pump is free to turn. By starting the pump manually for an instant, check that the shaft turns in the correct direction.
3) Set the pump switch to AUT and verify that burner cannot start before the attainment of the minimum level;
4) Check that the pump stops when the maximum level is reached by observing the level indicators and checking the positions of the indicator valves.
5) Press and keep pressed the safety water level reset button for at least 10 seconds, the conductivity relay being of the delayed type.
6) Open the boiler drain and check on the level indicator at what level the pump-start probe acts.
7) Set the pump switch to “0” leaving the drain open and check the actuation level of the safety probes with respect to the minimum level reference plate.
8) Close the drain and set the pump switch to AUT
9) Switch on the burner and bring the boiler up to pressure adjusting the operation pressure.

WARNING: On boilers with a man-way and head-way, during the first start-up it is important to tighten progressively the nuts on the man-way cover as the pressure increase. Otherwise a hazardous situation is created due to steam leaks that quickly deteriorate the gasket creating a dangerous situation for the boiler room personnel.

4.2 NORMAL OPERATION

With cold start-ups, verify that:

- The boiler is full of water to the minimum level;
- The increase of the water volume due to heating does not raise the water level too far: if necessary drain the boiler at regular intervals to bring the visible level back to the centre of the water level sight glasses;
- On reaching the set pressure, the steam take-off valve can be opened very gradually in order to heat the steam delivery lines eliminating any condensate that may be present in the pipework;
- The man-way gasket does not leak.

5 MAINTENANCE

5.1 ORDINARY

- Periodically purge the level gauges, probe holder if fitted and the boiler, to avoid the accumulation of sludge.
- Check the efficiency of the control and regulation instruments, examining carefully the electrical parts (connections included) and the mechanical parts (pressure switches); it is advisable to replace every year the ceramic probe-holders.
- Carry out burner maintenance (as to the specific instructions);
- Check the tightness of flange bolts and the state of the gaskets;
- Check the conditions of the boiler door internal covering after loosening the anti vibration bolts on the hinges, in order to allow door opening;
- Clean the flue-gas tube bundle;
- Carry out correct maintenance to the pump (bearings, mechanical seal);
- Check for wear to the discharge valves; these tend to wear more quickly, due to the abrasive effect of the sludge during blow-down;

5.2 PERIODIC

5.2.1 Periodic control (every 6 hours of use)

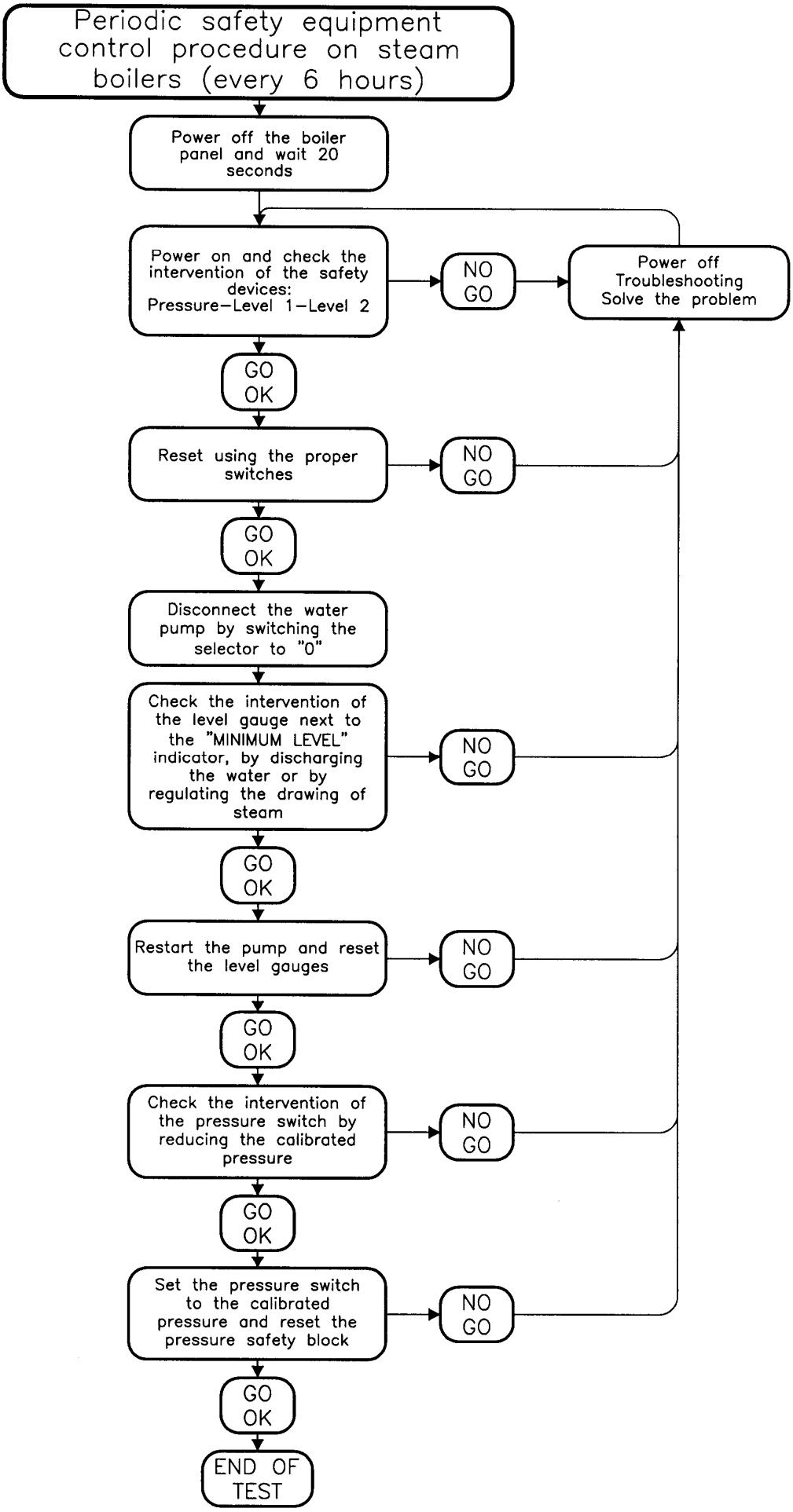
From time to time (every 6 hours of use) the thermal plant must be inspected by qualified personnel to check the efficiency of all safety accessories:

- Safety pressure switch

- Water level limits

The system can be reset if no anomalies have been encountered: power off the panel for approx. 20 seconds, power on the main switch and press the reset buttons.

For further details follow the flow chart below:


Periodic safety equipment control procedure on steam boilers (every 6 hours)
Power off the boiler panel and wait 20 seconds
Power on and check the intervention of the safety devices: Pressure–Level 1–Level 2
NO GO
Power off Troubleshooting Solve the problem
GO OK
Reset using the proper switches
NO GO
GO OK
Disconnect the water pump by switching the selector to "0"
Check the intervention of the level gauge next to the "MINIMUM LEVEL" indicator, by discharging the water or by regulating the drawing of steam
NO GO
GO OK
Restart the pump and reset the level gauges
NO GO
GO OK
Check the intervention of the pressure switch by reducing the calibrated pressure
NO GO
GO OK
Set the pressure switch to the calibrated pressure and reset the pressure safety block
NO GO
GO OK
END OF TEST

5.3 SCHEDULED

All boilers must be periodically stopped for careful inspection and maintenance: the time interval between stops is established by experience, by the operating conditions, by the quality of the feed water and by the type of fuel used.
Before entering the boiler shell for inspection or for cleaning, check carefully that there is no possibility of entry of water or steam via the pipework to which the boiler is connected. Every valve must be locked and if necessary isolated by removing a piece of pipework or by inserting a blind flange.
The parts under pressure must be carefully examined internally to identify any encrustation, **corrosion** and other potential **sources of danger linked to the feed water**.
All deposits must be removed mechanically or chemically and **the effective thickness of the structures must be verified using suitable instruments to determine that they are equal to or greater than the design values**. All pustules or other types of corrosion must be scraped and cleaned with a steel wire brush to white metal. Leaks between fire tubes and tube plates must be carefully examined: any welding must be done in all cases observing legal obligations, without forgetting that a steam boiler is a pressure vessel with danger of explosion and subject to control by competent authorities.
During inspection also verify all the accessories, with priority to safety valves, level probes and pressure switches.

5.4 CONSERVATION DURING WHEN OUT OF SERVICE

Often during periods of disuse the worst cases of corrosion appear. The operations to be carried out to guarantee correct conservation of the boiler depend essentially on the duration of the stop.
The boiler can be subjected to dry conservation if the period of disuse is long, or to a wet conservation for short stops or if the boiler has a back-up function and must be ready to come on-line in a short time.
In both cases, the necessary operations tend to eliminate the causes of possible corrosion.

5.4.1 Dry conservation

The boiler must be drained and dried carefully, then placing in the boiler shell a hygroscopic substance (for example lime or silica gel etc)

5.4.2 Wet conservation

Drain the water and clean the generator completely. Fill the body up to the normal operation level and after a brief evaporation period it is essential to purge into the atmosphere to eliminate all dissolved gases. Then fill the generator completely, dosing a sufficient amount of DEHA (diethyl hydroxyl amine) to develop a residue concentration of more than 100 ppm that prevents attacks of oxygen dissolved in the water. Also add trisodium phosphate, until the total alkalinity reaches over 400 ppm. Now close all the connections.
Control all the connections to make sure that there are no leaks and take water specimens at regular intervals noticing that the alkalinity value has not had alterations.
A “wet” conservation” is always advisable because there are greater guarantees of perfect conservation and a smaller interval to reach operation conditions.

6 WATER CHARACTERISTICS

All the values listed as follow are taken by tables 5.1 and 5.2, figure 5.1 and 5.2 contained in the EN 12953-10 (rules related to quality features of feeding and working of boiler water).
For steam generators **there are some regulations that require limit values for water characteristics.** However, limits should be adopted for all generators as stated by qualified companies that recommend the type of treatment to be carried out basing on careful analysis of the available water. **Many faults and sometimes serious accidents are caused by the use of water with non-conforming features.**

FEEDWATER - LIMIT VALUES (entering the boiler)
Tab. 1

Specifications	**Measurement unit**	**Feedwater for steam boilers with pressure ≤ 20 bar**	**Integrating water for hot water boilers** (total operating range)
Appearance	Transparent, void of suspended solids		
Direct conductivity at 25 °C	µS/cm	See values in chart 2	
pH at 25°C [a)]	---	> 9.2 [b)]	> 7
Total hardness (Ca+Mg)	mmol/l	< 0.01 [b)]	< 0.05
Iron (Fe)	mg/l	< 0.3	< 0.2
Copper (Cu)	mg/l	< 0.05	< 0.1
Silica (SiO_2)	mg/l	See chart 1.1	
Oxygen (O_2)	mg/l	< 0.05 [d)]	-
Oil-based substances	mg/l	< 1	< 1
Concentration of organic substances	------	See footnote [e)]	

a) With copper alloys in the system, the value of the PH must be maintained in the interval between 8.7 and 9.2.
b) With a PH value of the water softened to > 7.0, the PH value of the boiler water should be foreseen as per prospect 5-2.
c) With an operating pressure <1 bar, a total maximum hardness of 0.05 mmol/l should be acceptable.
d) Instead of complying with this value with an intermittent operation or operation without deaerator, in case of agents which form the film and/or excess of oxygen, the additive must be used.
e) The organic substances are usually a mixture of numerous different compounds. The composition of these mixtures and the behavior of their single components to the operating conditions of the boiler are difficult to predict. The organic substances can be decomposed to form carbonic acid or other acidic decomposition products, which increase the acidic conductivity and cause rust and deposits. They can also lead to the formation of foam and/or to the production of steam with suspended water, which must be maintained as low as possible.

Chart 1.1 maximum acceptable content of silica in the boiler water up to pressures of 20 bar

Alkalinity	**Silicate**
0,5 mmol/l	**80** mg/l
5 mmol/l	**105** mg/l
10 mmol/l	**135** mg/l
15 mmol/l	**160** mg/l

Note: these values are to be accepted when a thermal deaerator is installed. If not so, it is good practice to heat the water in the tank at least to 80°C to reduce the content of dissolved gasses (O_2 e CO_2). Be sure to use chemical conditioners to deoxygenate feed water and to reduce CO_2 corrosion.

OPERATING WATER - LIMITING VALUES

Chart. 2

Specifications	**Measurement unit**	**Water for steam boilers with pressure ≤ 20 bar**		**Boiler water for hot water boilers** (total operating range)
		Direct conductivity of the feedwater > 30 µS/cm	Direct conductivity of the feedwater ≤30 µS/cm	
Appearance	Transparent, without the formation of permanent foam			
Direct conductivity at 25 °C	µS/cm	< 6000 [a)]	< 1500	< 1500
pH at 25 °C	------	10,5 ÷ 12	10 ÷ 11 [b) c)]	9 ÷ 11.5 [d)]
Composite alkalinity	mmol/l	1 ÷ 15 [a)]	0.1 ÷ 1 [c)]	< 5
Silica (SiO_2)	mg/l	See chart 1.1		
Phosphates (PO_4) [e)]	mg/l	10 ÷ 30	6 ÷ 15	-
Organic substances	------	See footnote [f)]		

a) With a super-heater, consider 50% of the value normally indicated as the maximum to be the maximum value.
b) Adjustment of the basic pH by means of an injection of $NaPO_4$, further injection of NaOH only if the pH value is < 10.
c) If the acidic conductivity of the feedwater of the boiler is < 0.2 µS/cm, and its concentration of Na + K is <0.01 mg/l, the injection of phosphate is not necessary . It can be applied in AVT conditions (All-volatile treatment with volatile chemical agents, feedwater pH ≥ 9.2 and boiler water pH ≥ 8), in such case, the conductivity of the boiler water is < 5 µS/cm.
d) If there are non-iron materials in the system, i.e. aluminum, these may require a lower pH value and a direct conductivity, however, the priority is to protect the boiler.
e) If a coordinated phosphate treatment is used, considering all the other values, higher concentrations of PO_4 are acceptable.
f) The organic substances are usually a mixture of numerous different compounds. The composition of these mixtures and the behavior of their single components to the operating conditions of the boiler are difficult to predict. The organic substances can be decomposed to form carbonic acid or other acidic decomposition products, which increase the acidic conductivity and cause rust and deposits. They can also lead to the formation of foam and/or to the production of steam with suspended water, which must be maintained as low as possible.

FREQUENCY OF THE ANALYSES

The frequency of analysis is determined evidently as a function of the use of the boiler and of the quality of the water used; it is advisable in any case to check the pH, the total hardness and the alkalinity of the feed and boiler waters at least every two days. Once a month, especially under conditions of variable operation, it is advisable to subject meaningful samples of the boiler and feed waters to complete analysis.
It is also advisable to inspect the return condensate for traces of any highly contaminating oily substances (reduction of evaporation from the water surface in the boiler caused by a layer of oil).

7 TROUBLESHOOTING

FAULT	PROBABLE CAUSE	SUGGESTED REMEDY
Safety valve/s opening	Maximum pressure exceeded, as set on the valve. Must be equal to the boiler design pressure.	Adjust the safety pressure switches and / or limit switches.
	Loss of the adjustment of the safety valve	Check and then adjust the valve using a reference gauge
Small leaks from the safety valve/s	Dirt on the valve seat	Clean the seat by opening the valve manually a few times
	Marks on the valve seat	Dismantle the valve and regrind the valve seat with very fine abrasive.
Pump stopped	Pump overload relay has acted	Check the motor current
		Check the relay setting
	Pump shaft seized	Maintenance to the pump
Pressure safety switch operates	Pressure limit switch set too high	Adjust the pressure limit switch
	Pressure limit switch faulty	Replace the pressure limit switch
	Pressure switch pipe coil blocked	Clean or replace the pipe coil
Safety level 1 or 2 operates	Water level detection interrupted	Steel probe encrusted Connection cable interrupted
	Safety level relay faulty	Temporary replacement of the safety electronic relay with one of the two relays in the panel. If the problem disappears, replace the faulty relay.
	No water feed	See faults "feed water"
Feed water insufficient	Pump seized	See faults "Pump stopped"
	Pump suction filter blocked	Clean the filter
	Level control faulty	Temporary replacement of the electronic control relay with one of those present in the panel. If the problem disappears, replace the faulty relay.
	Level probes short circuited	Dismantle the control probes for inspection of the ceramic insulation
	Pump cavitation	Suction head (difference in height between supply tank and pump) insufficient in relation to the water temperature
		Clean the pump suction filter
		Reduce the head loss in the pipe between collector tank and the pump by increasing the pipe section
	Pump rotation direction	Invert two phases (three-phase pump)
Burner always ON	Erroneous electrical connection to the panel	Consult the wiring diagram
	Safety level relays faulty	See “Intervention safety level 1 or 2”
	Control and/or safety pressure switches inactive	Check the adjustment of the pressure switches
		Check the pressure switch connections to the control panel
Burner always OFF	Problems with the burner	See the specific burner Manual
	Burner fuses interrupted	Replace the fuses
	No consent to the burner from the control pressure switch	Replace the control pressure switch
	No consent to the burner from the safety level relay	See “Intervention safety level 1 or 2”
	Erroneous connection to the control panel	Consult the wiring diagram

8 WATER LEVEL LIMITS

8.1 GENERAL

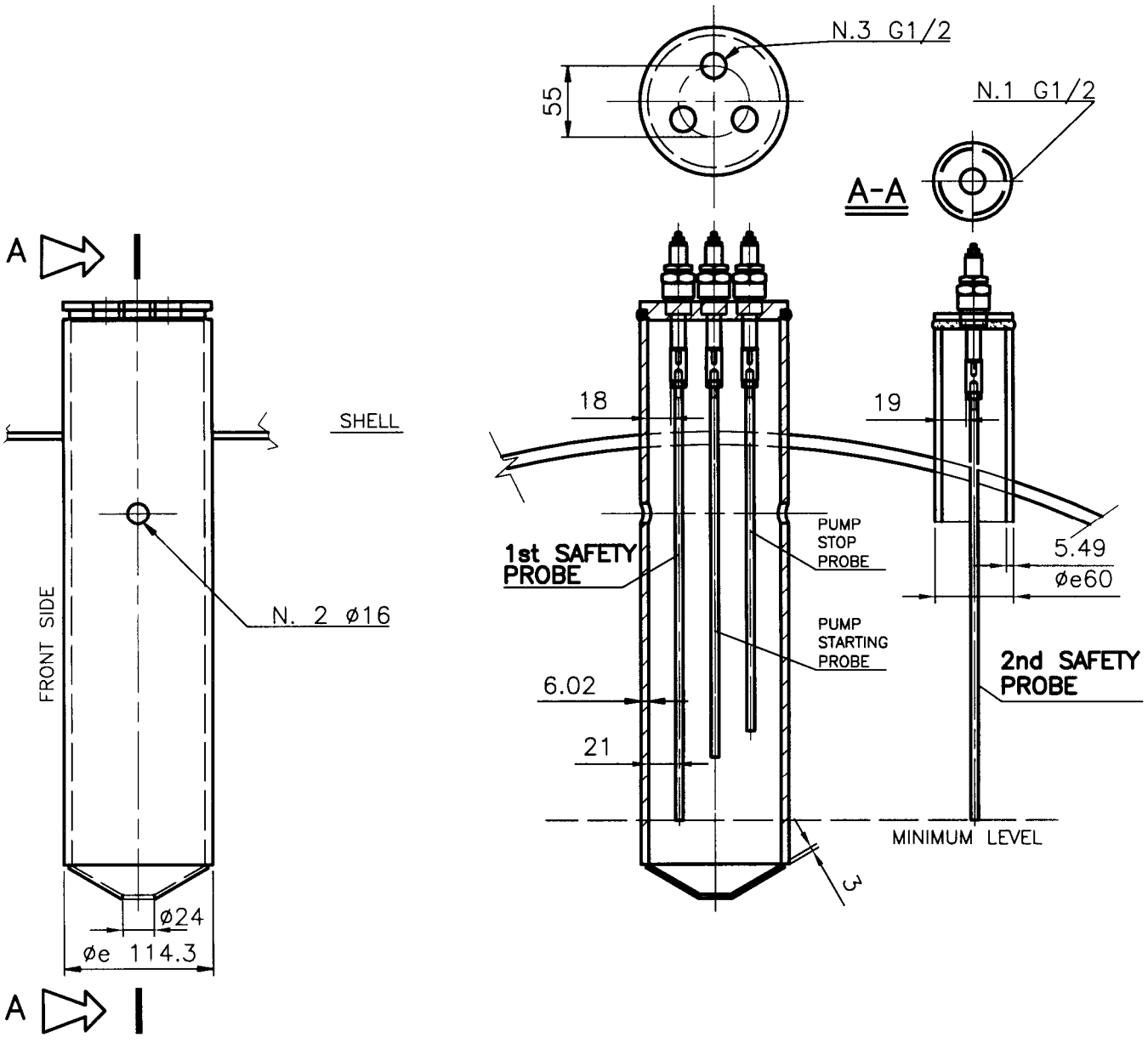
The water level limits consists in: n. 2 level rods, n. 2 probes, electrical cables, n. 2 electronic relays. The device prevents the lowering of the level of water in the steam generators and the consequent overheating of the membrature.

The principle of survey and control of the level is based on water conductivity. In order to guarantee the correct operation of the device, following conditions must be fulfilled:

- **Water conductivity > 250 μS/cm**
- **Water temperature < 210°C**
- **Pressure < 20 bar**

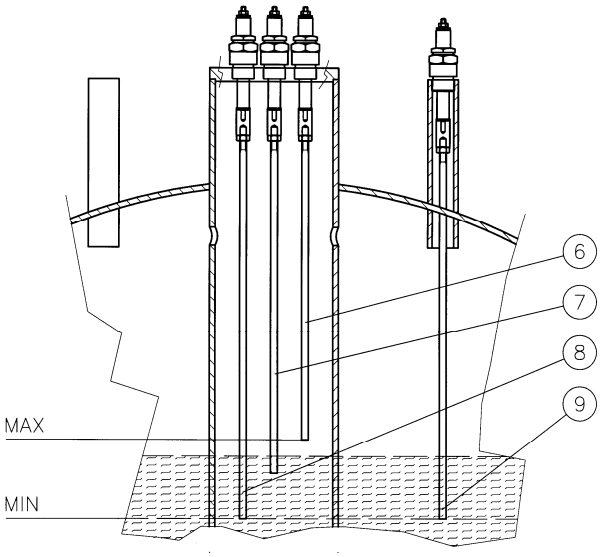
(See. " Operating water " - Tab. 2).

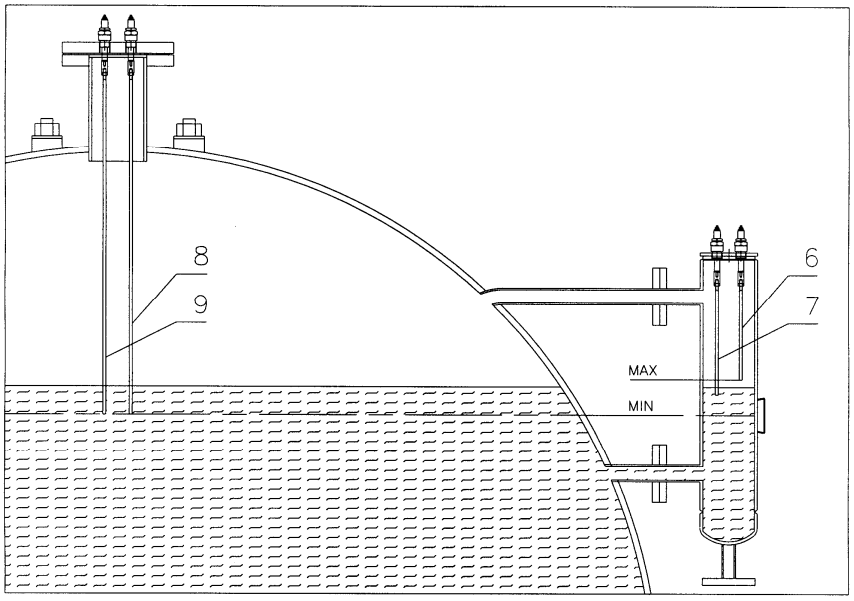
EXAMPLE: PROBES TANK FOR SAFETY AND REGULATION



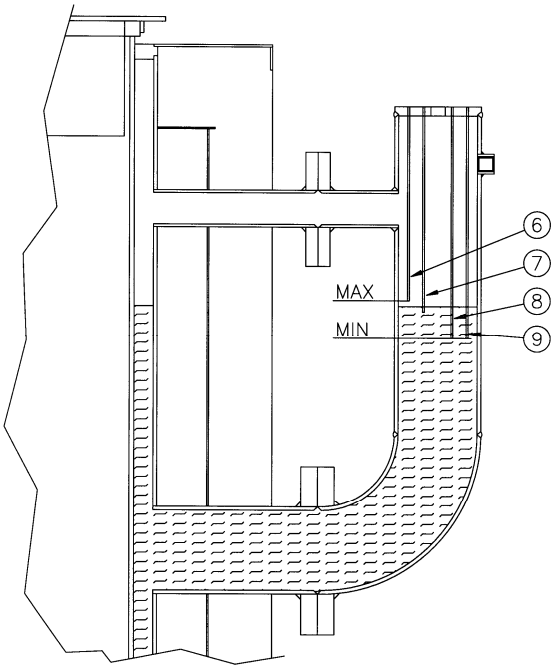
8.2 TYPICAL APPLICATIONS

Boiler probes:
6 Pump stop
7 Pump starting
8 1st burner cut-out safety device and alarm ON.
9 2nd burner cut-out safety device and alarm ON





NOTE: it is recommended that an alarm bell is installed in the boiler room as well as a sound or visual alarm in highly visited rooms.



8.3 ELECTRICAL CONNECTIONS

Refer to the diagram supplied with the specific switchboard.

8.4 STEAM GENERATOR OPERATION
(Water level limits)

8.5 FIRST START-UP

- Start the boiler, as follows:

1 Power up the boiler control panel
2 Make sure that the motor-driven pump drive shaft is free to rotate and that rotation direction is correct.
3 Set the pump selector switch on AUT and verify that burner cannot start before the attainment of the minimum level;
4 Make sure that the pump stops when the maximum level is reached, observing level indicators and checking the position of their cocks;
5 Maintain safety level reset pressed for 10 sec because it is employed an electronic delayed relay
6 Open the boiler discharge and check on the level indicator the intervention point of probe pump start
7 Set the pump selector switch on "0", leaving the discharge open, and check the intervention level of safety probes, referring to the minimum level information plate;
8 Close the discharge, place pump selector switch to AUT;

8.6 MAINTENANCE

8.6.1 Ordinary

- Bleed periodically (level indicators, probe-holder barrel if any, boiler) to avoid mud deposits.
- Check the efficiency of the regulation and control instruments by inspecting carefully the electrical (also connections); it is also recommended that the probe-holder ceramic plugs are replaced every year

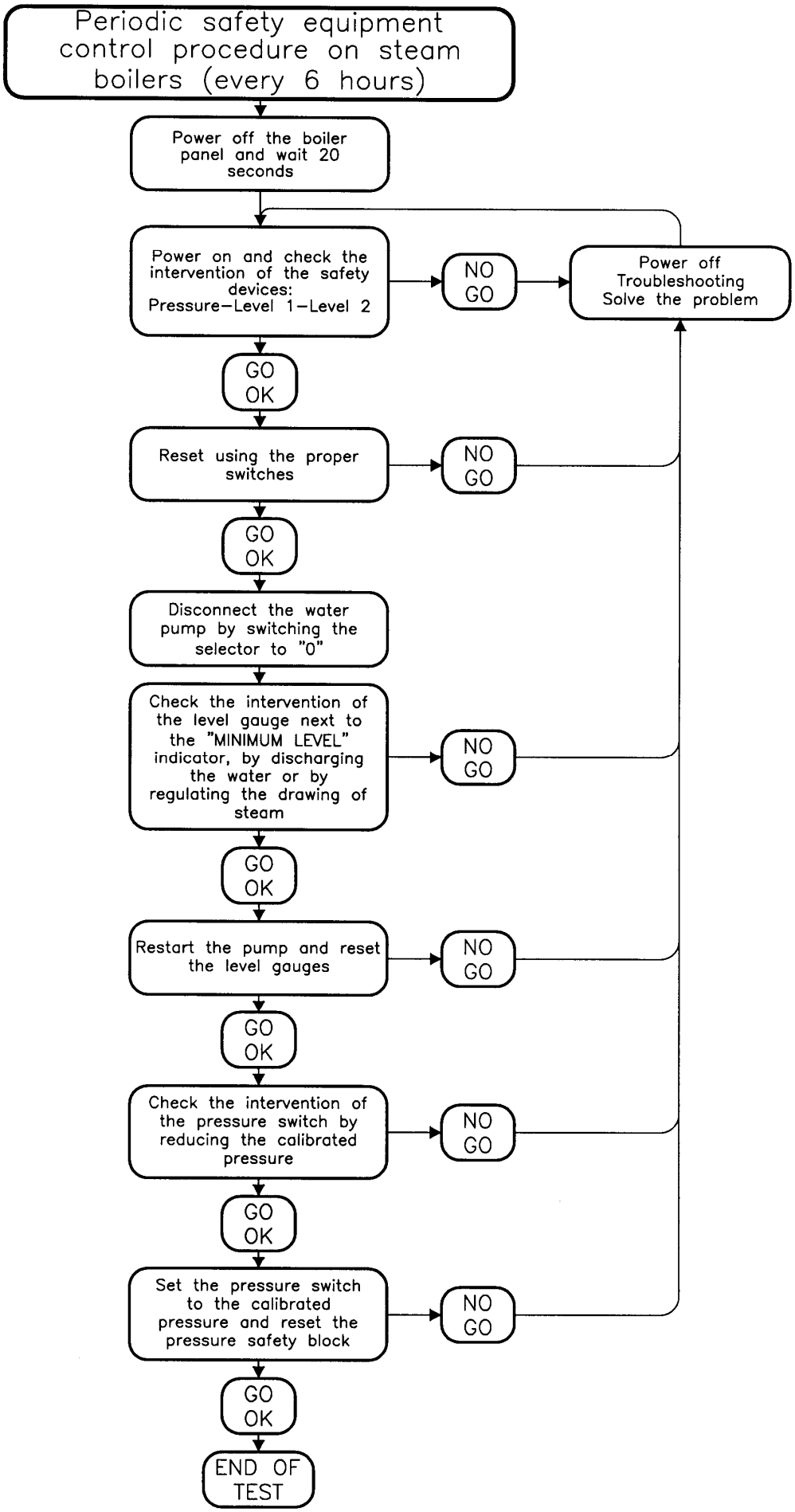
8.6.2 Periodic control (every 6 hours of use)

From time to time (every 6 hours of use) the thermal plant must be inspected by qualified personnel to check the efficiency of all safety accessories:

- Water level limits
- Safety valve

The system can be reset if no anomalies have been encountered: power off the panel for approx. 20 seconds, power on the main switch and press the reset buttons.

For further details follow the flow chart below:


Periodic safety equipment control procedure on steam boilers (every 6 hours)
Power off the boiler panel and wait 20 seconds
Power on and check the intervention of the safety devices: Pressure–Level 1–Level 2
NO GO
Power off Troubleshooting Solve the problem
GO OK
Reset using the proper switches
NO GO
GO OK
Disconnect the water pump by switching the selector to "0"
Check the intervention of the level gauge next to the "MINIMUM LEVEL" indicator, by discharging the water or by regulating the drawing of steam
NO GO
GO OK
Restart the pump and reset the level gauges
NO GO
GO OK
Check the intervention of the pressure switch by reducing the calibrated pressure
NO GO
GO OK
Set the pressure switch to the calibrated pressure and reset the pressure safety block
NO GO
GO OK
END OF TEST

8.6.3 Extraordinary maintenance (water level limits substitution)

To replace the water level limits or parts of it, follow strictly the instructions below:
1. Ensure that the new ceramic plug is intact
2. Check the length of the rod
3. Ensure that the rod is coaxial to the plug axis
4. Inspect the electrical system and, in particular, ensure that the resistance of the electric circuit linking the ceramic plug to the electrical panel is intact (resistance must be over 10 MOhm)
5. Ensure that the automatic level control consisting of the two ceramic plugs and their conductivity-relays, work well

8.7 TROUBLESHOOTING

FAULT	POSSIBLE CAUSE	RECOMMENDED REMEDY
Safety intervention level 1 or 2	Interrupted water level monitoring	Scaled stainless steel bar Broken connection cable
	Faulty safety level relay	Temporary replace the safety electronic relay with one of the two relays in the panel. If this is the problem, replace definitively the faulty relay.
	Water does not load	See "Loading" inconv.
Insufficient water load	Blocked pump	See. "Blocked pump" inconv.
	Dirty pump sucking filter	Clean the filter
	Level regulation anomaly	Temporary replace the safety electronic relay with one of the two relays in the panel. If this is the problem, replace definitively the faulty relay.
	Level regulation probes short circuit	Dismantle the adjustment probes to inspect visually the ceramic insulation
	Pump cavitatation	Insufficient head (=different height between the collecting vessel and the pump levels) in comparison with water temperature
		Clean the pump sucking filter
		Decrease the pipe resistance between the collecting vessel and the pump by increasing the passage section
	Pump sense of rotation	Invert one of the two phases (three-phase pump)
Burner always on	Incorrect electrical panel connection	Consult the electric diagram
	Faulty level safety relays	See "Safety intervention level 1 or 2"
	Regulation pressure and/or safety switches OFF	Check the pressure switches regulation
		Check the pressure switches connection to the electrical panel
Burner always off	Burner problems	See burner manual
	Interrupted burner fuses	Replace fuses
	Lack of burner consent from the regulation pressure switch	Replace regulation pressure switch
	Lack of burner consent from the level safety relays	See "Safety intervention level 1 or 2"
	Incorrect electrical panel connection	Consult the electric diagram

8.8 DATA LABEL

ICI CALDAIE S.p.A.
Via G. Pascoli, 38 - S.S. 434 km 9
37059 ZEVIO/Fraz. Campagnola
VERONA - ITALIA
Tel. 045/8738511 -fax 045/8731148

LIVELLOSTATO DI SICUREZZA
WATER LEVEL LIMITS

Modello / *Model*	**GP1**
N.fabb. / *Serial number*	
Conducibilità dell'acqua *Water conductivity*	> 250 μS/cm
PS max	20 bar
TS max	210°C
Fluido / *Fluid*	Acqua / *Water*
Data/*Date*	
Volt / Freq. / Pot. - *Power*	24 VAC / 50-60 Hz / 3 VA
Omologazione/*Approval*	CE 1370

Boiler serial number

Boiler final test date

IL LIVELLOSTATO DI SICUREZZA
DEVE ESSERE VERIFICATO OGNI
6 ORE DI FUNZIONAMENTO
WATER LEVEL LIMIT SHALL BE TESTED
PERIODICALLY FOR A MAX OF 6 HOURS
(ved. MANUALE TECNICO/*see TECHNICAL MANUAL*)

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