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# INSTRUCTIONS BOOKLET

ISTRUZIONI FOR: INSTALLATION, USE, MAINTENANCE

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**BHP**

STEAM GENERATORS

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Dear Customer,

Thank you for choosing an IVAR boiler.

In your interest and to maintain the highest level of performance and duration of your appliance, we recommend that you follow the instructions contained in this booklet and have regular maintenance checks performed by qualified personnel. We would like to remind you that failure to follow the instructions contained in this booklet may invalidate the guarantee.



The boiler identified below is in conformance with Regulation 97/23/CE (PED), regarding the instruments and pressure.

Boiler identification details:

series: BHP

model: \_\_\_\_\_

designed pressure: \_\_\_\_\_ MPa (\_\_\_\_\_ bar)

construction n°: \_\_\_\_\_

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## **CONTENTS**

- pag. 4 - GENERAL WARNINGS
- pag. 5 - GENERAL SAFETY RULES
- pag. 6 – APPLIANCE DESCRIPTION
- pag.10 – INSTALLATION SITE
- pag.11 - ELECTRICAL SYSTEM
- pag.12 - DISCHARGE OF COMBUSTION PRODUCTS
- pag.12 - FUEL SUPPLY
- pag.13 - BURNER CONNECTION
- pag.14 - OPENING AND ADJUSTMENT OF THE DOOR
- pag.15 - HYDRAULIC CONNECTION
- pag.16 – FEED WATER – FEEDING DEVICES
- pag.18 – FEED WATER – THE CONDENSATE BASIN
- pag.20 – FEED WATER – SPECIFICATIONS
- pag.21 - WATER-CAUSED TROUBLES IN STEAM GENERATORS
- pag.23 - PRELIMINARY OPERATIONS PRIOR TO STARTING UP FOR THE FIRST TIME
- pag.24 - FIRST START UP AND FURTHER CHECKS
- pag.25 - ALKALINE WASHING OR BOILING
- pag.26 - DRAINING AND CHECKING
- pag.27 - TURNING OFF THE GENERATOR
- pag.28 – MAINTENANCE
- pag.29 - RECOMMENDED SPARE PARTS
- pag.29 - TROUBLESHOOTING

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## **GENERAL WARNINGS**

This instruction booklet is an integral and essential part of the product.

Should the appliance be sold or transferred to another owner, or if you move and leave the appliance behind, always ensure that this booklet accompanies the appliance so that the new owner and/or installation technician can consult it.

This appliance must be used for the purpose for which it was specifically intended.

All contractual or non-contractual responsibility of the manufacturer is excluded in the event of damages to persons, animals or things caused by errors in installation, adjustment, maintenance and improper use.

The manufacturer's responsibility is excluded for all damage to persons and/or things resulting from a clear risk for the user which he could have avoided by taking suitable safety measures.

After having removed the packaging, check the contents for breakages. If you are in doubt, do not use the appliance and contact your supplier.

Do not leave the packaging materials (wooden cage, nails, staples, plastic bags, polystyrene foam, etc.) within the reach of children, as they are potential sources of risk.

The installation must be performed in compliance with the regulations in force, following the manufacturer's instructions, by professionally qualified personnel.

The term "professionally qualified personnel" means persons with specific technical skills in the sector of steam systems.

To guarantee the efficiency of the appliance and ensure correct operation, it is indispensable to have regular maintenance performed by professionally qualified personnel, following the manufacturer's instructions.

Any repairs to the appliance must be carried out using only original spare parts.

If you decide not to use the appliance for a long period, ensure you have professionally qualified personnel to carry out the necessary operations to preserve the generator (see chapter "Turning Off the Generator ", page 27).

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## **GENERAL SAFETY RULES**

The use of any component utilising energy power, fuels and water requires that certain fundamental rules be respected, such as:

Do not allow children or unskilled people to use the appliance;

If you notice smell of gas, do not turn on electric switches, household appliances, telephone or any other objects that could cause sparks. In this case:

- open doors and windows immediately to clear the air in the room;
- turn off the fuel taps;
- contact professional qualified personnel.

Do not touch the appliance with wet or damp parts of the body and/or with bare feet.

Do not perform any maintenance and cleaning operations without having disconnected the electric power and turned off the fuel supply tap(s).

Do not pull, disconnect, unwind electric cables coming from the boiler, even if they are disconnected from the mains supply.

Do not block or reduce the ventilation openings in the room to prevent the formation of toxic and explosive mixtures caused by gas leakage; it is also uneconomic and harmful to the environment because it causes bad combustion.

Do not expose the appliance to atmospheric agents.

The generator has not been designed to work outdoors and is not provided with automatic anti-freezing systems. Keep the boiler turned on in freezing conditions.

Other important warnings to be respected:

- If the power cable of the appliance is damaged, have it replaced by professionally qualified personnel;
- do not fix (and do not allow other persons to fix) electric cables on the system pipes or near sources of heat;
- do not touch the hot parts of the system (in particular the door and the smoke box) as they normally remain hot even for some time after the appliance has been turned off.

In the event of a water leak, turn off the system and contact exclusively professionally qualified personnel.

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## **APPLIANCE DESCRIPTION**

The BHP steam generators are enbloc pressurised combustion steam generators: the flame produced by the burner develops in the furnace and, since this is closed at the bottom, smokes return towards the front and enter the tube nest through the hollow in the door insulation.

Here smoke is forced by turbulatr to follow a whirling path which increases the heat transfer due to convection. In this way maximum heat absorption is obtained without harmful thermal stress.

On leaving the tube nest, smokes are collected in the rear box and conveyed to the flue.

Any burner fired by traditional liquid and gaseous fuel can be installed. The burner is installed on a hinged door in order to facilitate adjustment and maintenance operations of both boiler and burner without having to dismantle the latter.

The thermal insulation of the boiler body is obtained by applying a pad of highly insulating mineral wall.

Elegant aluminium panels complete the outside finish.

The operation is completely automatic: the maximum steam pressure is 11.8 bar (diverse pressures can by proportioned by request).

BHP steam generators are constructed and tested in accordance with Regulation 97/23/CE (PED): in addition to this booklet, the generator is supplied with the Certificate of Conformity and documentation of the accessories installed.

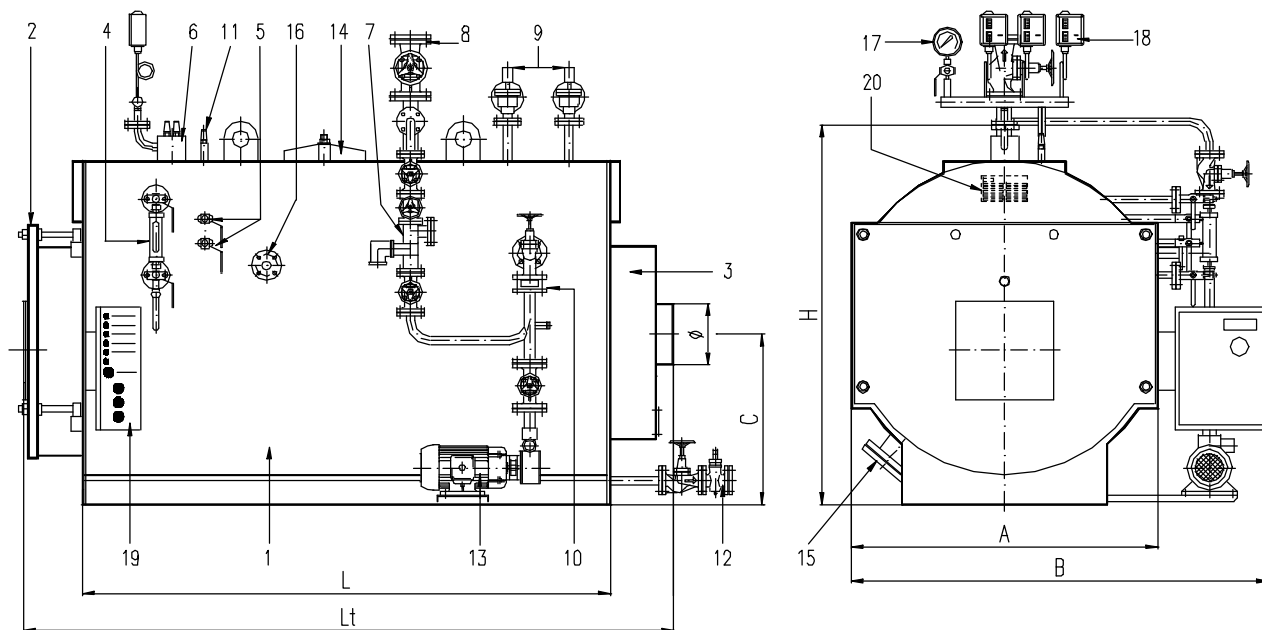
The test plate can be found in the front upper section of the generator, to the left.

For any servicing operations and spare parts it is indispensable to identify correctly the generator through its test plate.

The technical sheets of the BHP generators are included in the following pages.

# BHP

## GENERATORE DI VAPORE (Media Pressione) - STEAM BOILER (Medium pressure)



- |  |   |  |
|--|---|--|
| 1 - Corpo caldaia / Boiler   | 9 - Valvole di sicurezza / Safety valves          | 16 - Predisposizione regolazione conducibilità acqua (TDS) / Connection automatic control of the TDS in the boiler |
| 2 - Portellone / Front door  | 10 - Gruppo di alimentazione / Feeding unit       | 17 - Manometro con flangia di prova / Manometer  |
| 3 - Camera fumi / Smoke chamber  | 11 - Sonda di sicurezza / Safety probe            | 18 - Pressostati di servizio e sicurezza / Safety and service pressure switch                                      |
| 4 - Indicatore di livello visivo / Level gauge   | 12 - Gruppo di scarico / Discharged unit          | 19 - Quadro elettrico / Panel  |
| 5 - Rubinetti prova livello / Level check cocks  | 13 - Elettropompa di alimentazione / Feeding pump | 20 - Targa dati / Datas plat   |
| 6 - Regolatore di livello automatico e sonda di sicurezza / Level regulator and safety probe | 14 - Passo uomo / Manhole                         |  |
| 7 - Iniettore di vapore / Steam injector   | 15 - Passa mano / Handhole                        |  |
| 8 - Valvola di presa vapore / Steam outlet   |   |  |

MODELLO - TYPE		BHP 140	BHP 200	BHP 300	BHP 400	BHP 500	BHP 700	BHP 800	BHP 1000	BHP 1250	BHP 1500	BHP 1750	BHP 2000	BHP 2500	BHP 3000	BHP 3500	BHP 4000
Potenza nominale	kW	97	138	208	277	346	485	554	692	865	1038	1212	1385	1731	2077	2423	2769
Nominal capacity	kcal/h x1000	83,4	118,7	178,9	238,2	297,6	417,1	476,4	595,1	743,9	892,7	1042,3	1191,1	1488,7	1787,2	2083,8	2381,3
Potenza focolare	kW	108	153	231	308	384	539	616	769	961	1154	1347	1539	1923	2308	2692	3077
Furnace capacity	kcal/h x1000	92,9	131,6	198,7	264,9	330,2	463,5	529,8	661,3	826,5	992,4	1158,4	1323,5	1653,8	1984,9	2315,1	2646,2
Produzione vapore	kg/h	140	200	300	400	500	700	800	1000	1250	1500	1750	2000	2500	3000	3500	4000
Steam production	(1)																
Press. camera combust.	mbar	1,5	2,5	3	3,5	4,2	4,5	5	6	6,5	6,8	7	7	8	8,2	9	10
Combust.chamber press.																	
Contenuto acqua totale	dm <sup>3</sup>	475	475	670	670	1020	1020	1280	1410	1900	2120	2330	2650	3540	3960	4340	6050
- full																	
Water content	dm <sup>3</sup>	320	320	440	440	685	685	870	960	1280	1440	1580	1860	2550	2680	2830	4150
- at level																	
Dimensioni	A mm	954	954	1046	1046	1190	1190	1310	1310	1500	1500	1500	1620	1750	1860	1860	2100
	B mm	1450	1450	1540	1540	1690	1690	1810	1810	2000	2000	2000	2120	2270	2380	2380	2620
	H mm	1294	1294	1386	1386	1530	1530	1650	1650	1840	1840	1840	1960	2110	2230	2230	2456
	L mm	1274	1274	1524	1524	1828	1828	1831	2031	2033	2283	2533	2534	2832	2835	3035	3286
	Lt mm	1782	1782	2032	2032	2336	2336	2339	2539	2541	2791	3041	3042	3348	3350	3550	3841
	c mm	597	597	578	578	650	650	700	700	750	750	750	805	1205	1260	1260	1400
Attacchi	Camino Ø mm	200	200	250	250	250	250	250	250	300	300	300	350	350	400	400	450
	- Stack																
	Vapore DN - Steam	25	25	32	32	40	40	50	50	65	65	80	80	80	80	100	100
Scarico DN - Discharge	25	25	25	25	25	25	25	25	25	25	25	25	40	40	40	40	40
Peso a vuoto / Empty weight	kg	1150	1150	1450	1450	2200	2200	2550	2800	3300	3650	3900	4650	5500	6400	6850	8600

(1) acqua di alimento 70°C - pressione 11,8 bar / feedwater 70°C - pressure 11,8 bar

La I.VAR. INDUSTRY si riserva di apportare quelle modifiche che giudicherà necessarie per migliorare la produzione  
I.VAR. INDUSTRY reserves the right to make any modifications considered necessary for improving production

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For control and safety purposes the generator is delivered with a standard supply which includes:

- 1 manometer with three-way cut-off cock
- 1 regulation pressure switch (2 on request )
- 1 safety pressure switch
- 1 level gauge with cut-off cock and drain cock
- 2 level cocks
- 1 straightway valve on the steam intake
- 2 safety valves – weight and lever
- 1 motor-driven water feeding with cut-off and check valves
- 1 drain valve + 1 plug cock
- 4 electronic probes for checking the level in the boiler
- 1 electric control panel

BHP generators are provided with 1 steam injector with cut-off valve. According to ISPESEL regulations, steam generators with pressure exceeding 1 kg/cm<sup>2</sup>. cm must be supplied with an additional water feeding device powered by a source of energy different from that of the first feeding device (motor-driven pump).

The main regulation devices of the generators are:

- hydrostats with electronic probes
- regulation and safety pressure switches.

Hydrostats for conductive liquids are used to regulate the level of water: by exploiting the conductivity of water recorded by the probes of different lengths plunged in the generator body, in case of emergency due to lack of water, the feeding pump and the burner unit can be ignited and turned off through the hydrostats.

The positioning of the electronic probes is found on the following page.

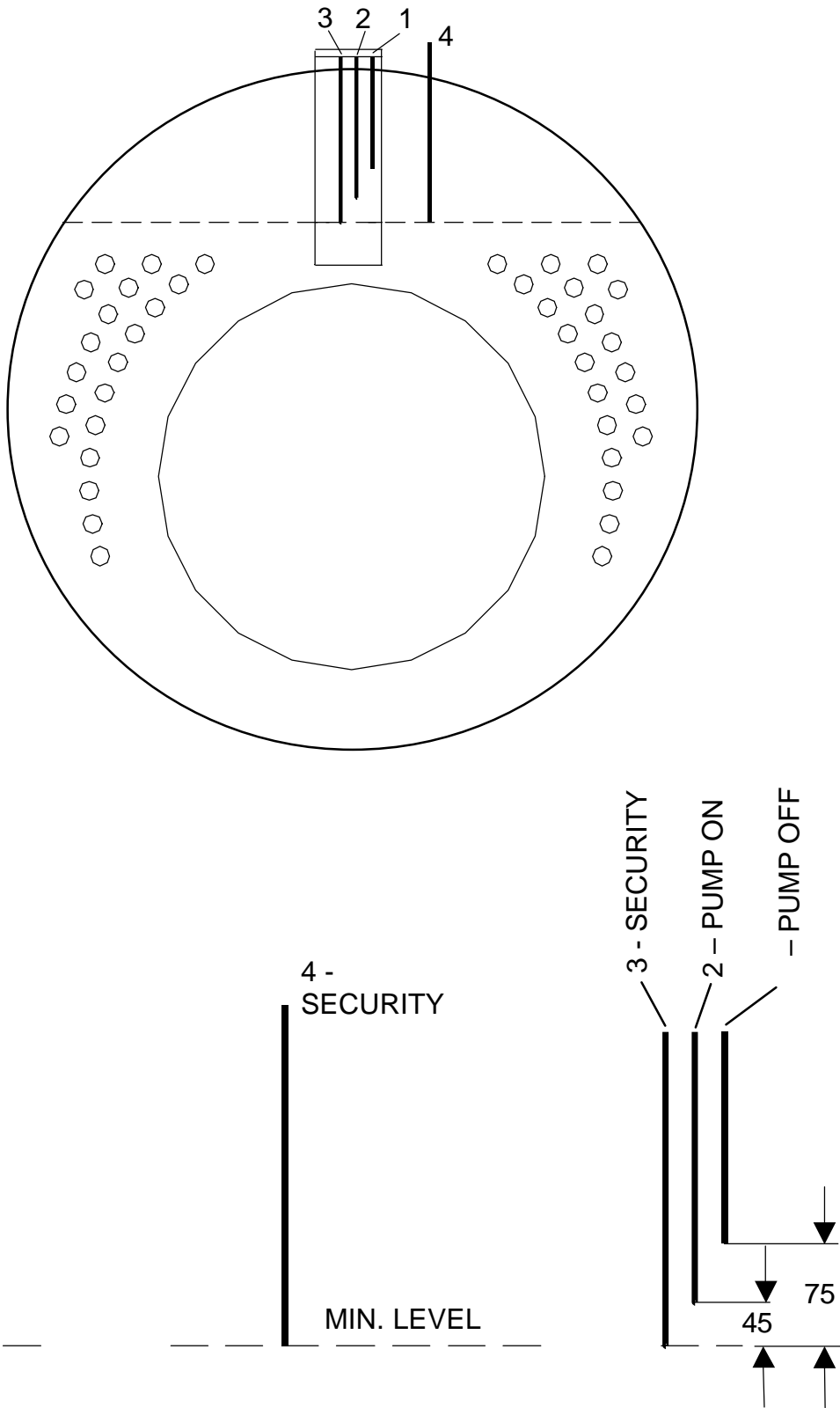
The burner can be ignited and turned off using the regulation pressure switch to reach the pressure set on the instrument.

If the burner has a two or three-stage firing system, a second or a third regulation pressure switch should be added to set decreasing values. This will improve the generator performance in periods of limited use.

If the burner is modular, a modulating pressure switch must be installed to control its activity. Here the boiler regulation pressure switch is only as a limited regulation pressure switch (regulated at maximum pressure use).

The safety pressure switch on the contrary is set to the maximum pressure allowed by the generator and, in case of intervention, it blocks the burner.

# ELECTRONIC PROBE POSITIONING



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## **INSTALLATION SITE**

The steam generator must be installed in a room that complies with current security regulations in the country where the device is to be installed with suitably sized air vents.

The following indications should be respected in the case that the country where the generator is to be installed does not have specific provisions:

- 1) The premises should be used exclusively as a heating plant: access is prohibited to unauthorised personnel. This notice must be clearly visible.
- 2) Ample space must be provided so as to allow for the manuvre and maintenance of all of the system's components (pumps, valves, filter, heat exchangers, etc.).
- 3) The flat surface of the boiler must be positioned horizontally and capable of uniformly supporting the base section bars.
- 4) The space must be large enough to allow the minimum and obstacle-free distances to be respected:
  - a) Generator front section (or operating area): a minimum distance of 1.5 m is required to read easily level gauges. A distance as long as the generator tube nest is recommended for cleaning the tubes and, if needed, to have them repaired.
  - b) On both sides of the generator: 0.80 m, that can be reduced to 0.60 m if the generator is near a wall or another generator with no other device or control system in the passage.
  - c) Generator rear section: 0.80 m.
  - d) From the upper section of the generator: 1.80 m between the highest passageway and the lowest obstacle of the generator ceiling, and 1 meter between the highest generator point and the lowest obstacle between the generator and its ceiling.
  - e) The pipes and transmission systems above the generator must be arranged in such a way that they do not interfere with the work carried out by the machine operator nor hinder his access to this area when checking, servicing accessories, etc. is required.

The generator draining system must be conveyed and installed in such a way as to prevent any damages to people and allow for inspections of the draining area.

The discharge of safety valves must be conveyed to the outside as to prevent any damages to people.

**CAUTION:** if the burner is supplied with combustible gas with specific weight higher than the specific weight of air, the electric parts must be positioned above 0.5 meters from ground level.

The boiler must not be installed outside as it has not been designed for outdoor installation and is not provided with automatic anti-freezing systems.

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In view of the frequent changes in legal regulations and their interpretation, the company recommends that the user keeps himself informed and updated in the matter.

## **ELECTRICAL SYSTEM**

The electrical system must comply with the current regulations and be installed by professionally qualified personnel.

Electrical safety of the equipment is ensured only when it is correctly connected to an efficient ground system in compliance with the current safety regulations. The manufacturer will not be liable for any damage caused by failure to ground the system.

Call professionally qualified personnel to check that the electrical system is suitable for the maximum power absorbed by the equipment, ensuring in particular that the system cable sections are suitable for the power absorbed by the equipment.

Adapters, multiple sockets and extension leads must not be used for general power supply of the equipment from the mains.

For connection to the mains, a double-pole switch must be provided in compliance with the current regulations.

The electrical panel is installed on the generator and the operating voltage of the auxiliary circuit is 24 V: different voltages are available on request only.

The electrical board includes different parts manufactured by the leading domestic and foreign companies.

Cutting-edge technology used to assemble parts guarantees the highest operating safety and easy control of each appliance.

The following appliances are included in the electrical board:

- main switch with door block system
- selector switch to operate the motor-driven pump automatically and manually
- warning and operation pilot lights
- guided overload cut-out of the motor pump
- valve triads for circuit protection
- electronic regulators for safety probes
- electronic regulators for level control
- alarm systems release push-button.

The electrical board also includes the electric diagram and the certification of conformity.

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## **DISCHARGE OF COMBUSTION PRODUCTS**

Correct burner/boiler/flue coupling drastically reduces consumption and optimises combustion with low emission of contaminants.

The FLUE must be resistant to heat and condensation, thermally insulated, hermetically sealed, without bottlenecks or obstructions, as vertical as possible and sized according to current regulations.

The CONNECTION BETWEEN THE BOILER AND THE FLUE must comply with the current regulations and legislation and consist of rigid hermetically sealed pipes resistant to high temperatures, condensation and mechanical stress.

For sealing the joints, use materials that can withstand at least 300°C.

Wrongly sized and shaped flues and couplings between the boiler and flue can amplify the combustion noise, negatively affect the combustion parameters and cause condensation problems.

CAUTION: non-insulated outlet pipes are a potential source of danger.

## **FUEL SUPPLY**

The fuel supply line must comply with current regulations and be laid by professionally qualified personnel.

Before installation, you are advised to thoroughly clean the inside of all the fuel supply pipes in order to remove any debris that may affect correct operation of the boiler.

Check the internal and external seal of the fuel supply system.  
If using gas, the connections must be perfectly sealed.

Check that the fuel supply system is provided with the safety and control devices prescribed by the current regulations.

Do not use the fuel system pipes to ground electrical or telephone systems.

Check that the boiler is pre-set for operation with the type of fuel available.

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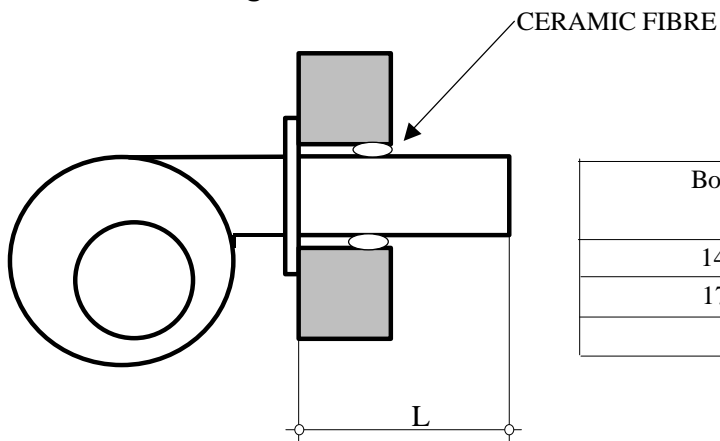
## **BURNER CONNECTION**

For installation of the burner, the electrical connections and the necessary settings, consult the burner instruction manual.

Ascertain that the correct type of burner has been chosen for the boiler, checking the technical specifications of both.

Secure the burner to the door by means of the fixing plate so that the flame is parallel and centred in the furnace; if not, combustion problems can occur with the risk of seriously damaging the boiler.

The burner draught tube must be sized as shown below:



Boiler model BHP	Burner draught tube min./max L mm
140÷1500	320 / 400
1750÷3500	350 / 450
4000	370 / 470

**IMPORTANT:** after installing the burner, fill any crack between the draught tube and the hole of the door with the material provided, resistant to 1000°C (ceramic fibre mat).

This operation prevents overheating of the door which would otherwise be permanently deformed.

If the burner is provided with an air intake, connect it by means of a rubber tube to the intake located on the flame inspection window: in this way the glass will remain clear.

If the burner is not provided with air intake, remove the intake on the flame inspection window and close the hole with a  $\varnothing$  1/8" GAS plug.

The fuel connections to the burner must be positioned in order to permit complete opening of the boiler door with the burner fitted.

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## **OPENING AND ADJUSTMENT OF THE DOOR**

The door can be opened from one side only, from right to left.  
To open the door, loosen the tightening screws on the right side.

For the BHP series to mod.2000, it is possible to invert the door opening: for the other models, it is possible to change the opening only by request, before the construction of the generator.

To modify the door opening direction, with the help of a lift:

- using a lift, hook the door by the two provided holes in the upper part;
- remove the four tightening screws
- remove the door;
- unscrew the two remaining nuts and screw them on the tie rod on the other side;
- replace the door, being sure to insert nuts in the door bearing;
- screw in the four fixing screws.

To regulate the tightening:

- screw the nuts without removing them from the door bearing;
- screw the fixing nuts crosswise, as much as is required to guarantee a hermetic and uniform closure;
- replace the fixing nuts until they lock.

Normally all maintenance operations require checking of the door adjustment.

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## HYDRAULIC CONNECTION

The choice and installation of the system components is the responsibility of the installer who must operate in accordance with correct working practice and the current legislation.

Prior to assembly all pipes must be thoroughly cleaned by using a strong vapour jet. In no way the pipe section must be reduced by seals.

The boiler fittings and the safety valves must not be strained by the weight of the system connection pipes as this can be dangerous and the latter must therefore be sustained and appropriately positioned.

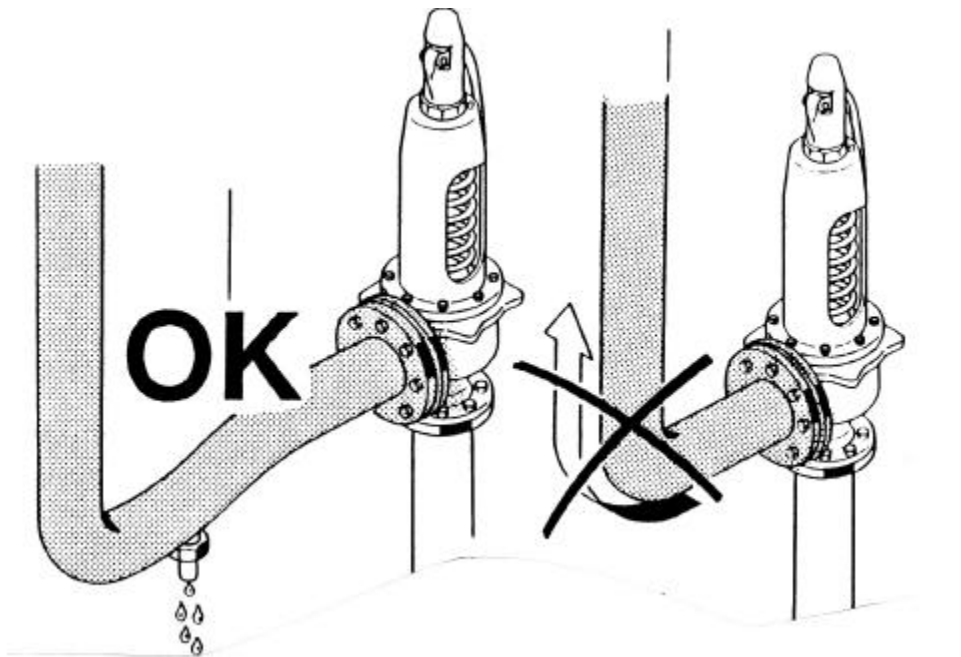
Safety valves must be installed only in upright position over the generator.

Ensure that no obstacle lies between the safety valves and the generator (on-off valve, etc.). At installation ensure that the valve inlet and the connecting pipe have been thoroughly cleaned.

Ensure that the safety valve outlets are conveyed to the outside in order to prevent any damages to people.

The exhaust pipe must guarantee the ventilation of the total flow rate of the safety valve; its diameter must be always larger than the valve outlet.

The valve ventilation pipe must be connected to the condensate draining system as it is illustrated in the following diagram.



In this way the valve shutter will not be damaged and blocked by stagnant condensate.

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Ensure that the hydraulic pipes are not used as earth connections for the electrical or telephone system. They are not suitable for this use and can rapidly deteriorate leading to serious damage.

It is recommended that the heating system pipes be insulated to avoid heat dispersion resulting in increased fuel consumption and environmental pollution.

## **FEED WATER – FEEDING DEVICES**

The water to the steam generator is fed through:

- No.1 centrifugal motor-driven pump with suitable head and delivery
- No. 1 steam injector representing the second emergency feeding device to be operated manually.

NOTE: The emergency feeding device is not operated automatically and, in case of emergency, the ongoing presence of personnel servicing the generator is required in order to check the level gauges in full view. It goes without saying that any emergency must be cleared as fast as possible (remove immediately the electric and/or mechanical troubles that caused the failure of the motor pump).

## THE WATER PUMP

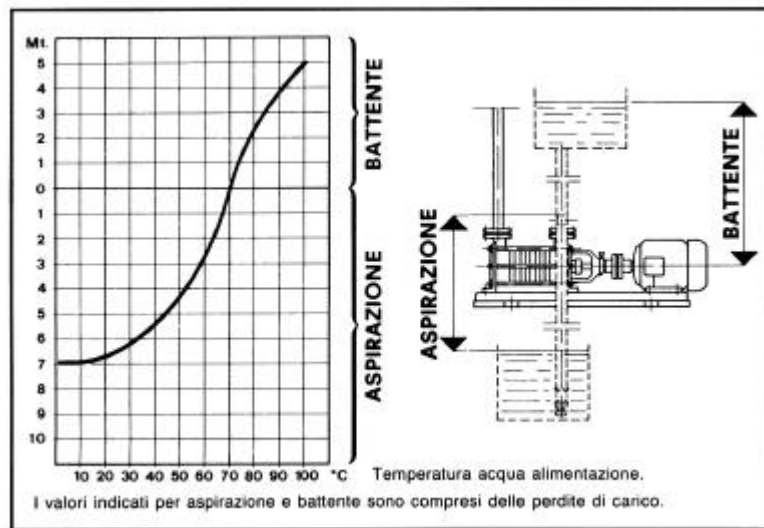
The water pump is an enbloc, single or multi-rotor pump.

To ensure that the pump is correctly operated, two parameters should be kept under control: temperature and water head at the pump inlet (head).

The cold water contained in the tank can be easily sucked by the pump, but if the water is hot pump suction is inhibited and water inlet pressure must be increased.

For this reason, any resistance ahead of the suction either accidental or all along the pipe, will reduce the pumping efficiency.

These conditions are acknowledged as a point of reference: speed inside the suction pipe between 0.3 and 0.5 m/sec., and the head height as a function of the temperature, according to the following table.



Aspirazione – pumping  
 Battente – head

Temperature of feed water.

The pumping and head values indicated include load loss.

It can be clearly noticed that a minimum head is required for pumping water when the temperature of water raises.

Do not forget that feed water temperature should be high as this will reduce considerably the O<sub>2</sub> and CO<sub>2</sub> content which otherwise would be conveyed and discharged in the generator causing damages that cannot be always duly ascertained and remedied.

The feed water temperature should not be below 60°C.

STEAM INJECTORS

Injectors are steam-jet static pumps manually operated.

Fed water must drop from above at a maximum temperature of 40°C and must not be connected to the condensate recovery basin.

The handwheel of the injector is usually set on OFF and the injector on-off valves are closed.

When in use, carry out the operations listed in sequence:

- a) power off the motor-driven pump and turn off the pump delivery valve;
- b) turn on the injector on-off valves (be careful with the steam inlet valve): now the water dropped and coming from the tank will be entirely discharged.
- c) Slowly turn on clockwise the injector handwheel: reduce the water flow from the tank in order to start mixing and feeding the boiler. This operation is accompanied by a special noise.
- d) Actuate again the handwheel until the flow has come to an end and the highest output can be obtained.

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Use the level gauges to check the regular increase of the level in the generator and stop the injector (set the handwheel on OFF and turn off the valve positioned at the injector water inlet) after the highest level is reached. If the level decreases to a minimum, start again the operations described above.

After using the injector – i.e. the feeding device is now efficiently working, close all the valves positioned at the inlets and outlets of the injector, open the pump delivery valve and power on the pump.

Suitable personnel should be present and check carefully when using the injector.

### **FEED WATER – THE CONDENSATE COLLECTING BASIN**

The basin size depends on the steam production per hour.

The condensate basin is connected to the pipes letting in the softened water by means of a float valve and an on-off valve.

The basin must be fitted with a vent pipe and overflow pipe that must be connected to the discharge.

If no condensate is collected, the water in the tank should be heated to about 60°C to prevent corrosion in the generator due to the presence of oxygen.

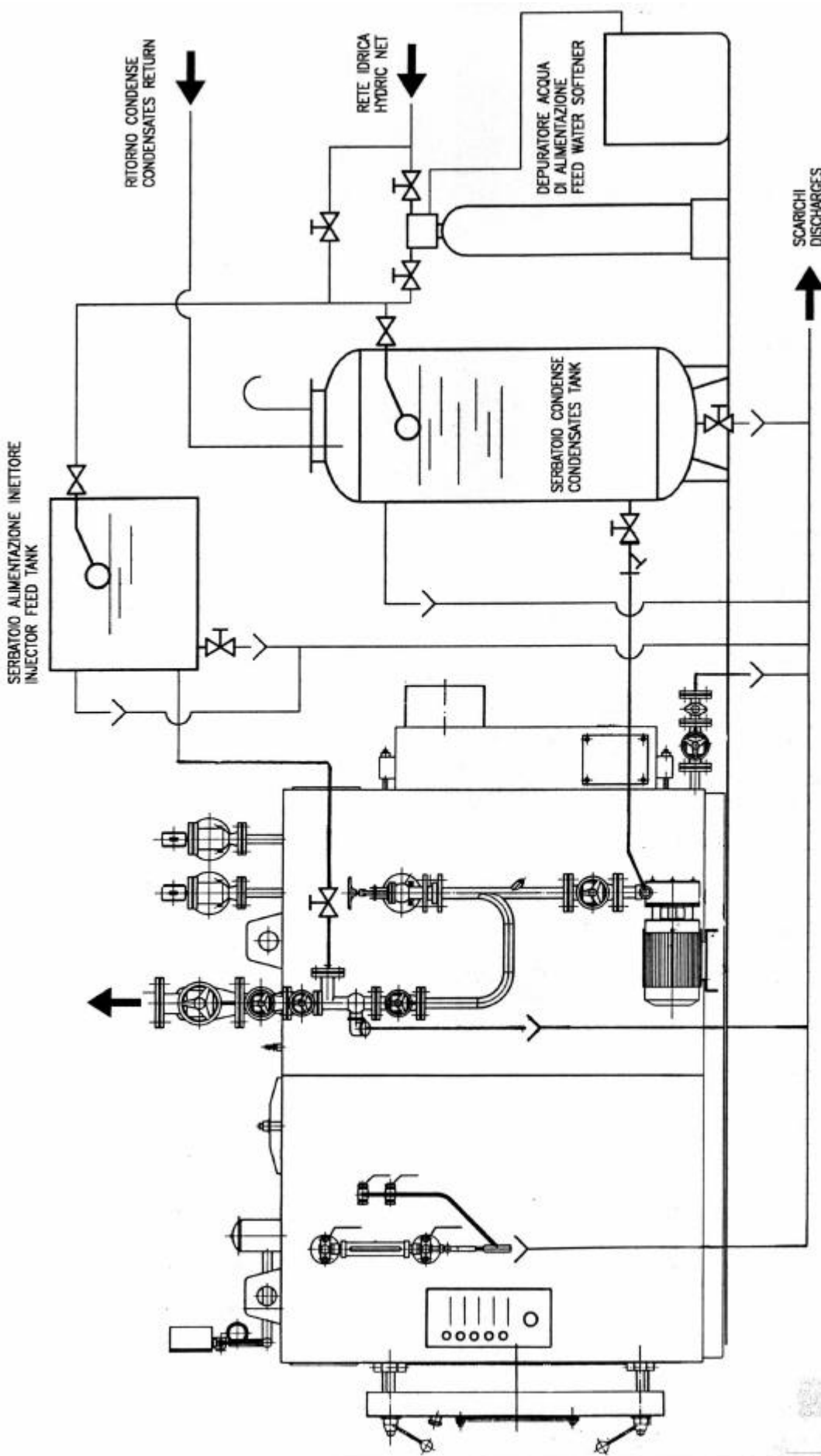
If all the condensate is recovered, check the head for the water pump as the temperature inside the basin will be extremely high: if it exceeds 70°C you can add cold water or raise the basin in order to ensure that the minimum head required is reached. If not, the pump cannot load the boiler.

There is another way to solve the head requirement: install a small circulator for heating systems with the same delivery as the pump and 0.5 head (5 cu m w.) that comes on together with the pump.

If the water level in the tank is higher than the water level in the boiler, when the system is off and without pressure, the boiler can be filled.

To avoid this inconvenience, a solenoid valve must be fitted on the tank suction area. The valve is controlled by the auxiliary contactor of the pump.

Installation diagrams for BHP steam generators are contained in the following pages:



SCHEMA DI INSTALLAZIONE PER GENERATORI DI VAPORE "BHP"  
 "BHP" STEAM BOILER PLANT DIAGRAM



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## **FEED WATER - SPECIFICATIONS**

It is known that the generator water and feed water must comply with certain specifications in order to prevent corrosion, lime, muds, etc.

### Limit values for steam generators up to 25 bar (UNI 7550/86)

<u>Feed Water</u>		<u>Periodical Inspections</u>
pH:	7.5÷9.5	weekly
total hardness:	5mg CaCO <sub>3</sub> /kg	at each shift
oxygen:	100 µg O <sub>2</sub> /kg (up to 15 bar)	weekly
oxygen:	50 µg O <sub>2</sub> /kg (16 - 25 bar)	weekly
free carbon dioxide :	200 µg CO <sub>2</sub> /kg	weekly
iron:	100 µg Fe/kg	weekly
copper:	100 µg Cu/kg	weekly
oily substances:	1 mg/kg	at each shift
chlorides:	200 mg/kg	weekly

### Generator water

pH:	9÷11.7	weekly
total alkalinity:	1000 mg CaCO <sub>3</sub> /kg (up to 15 bar)	at each shift
total alkalinity:	750 mg CaCO <sub>3</sub> /kg (16 - 25 bar)	at each shift
total hardness:	5 mg CaCO <sub>3</sub> /kg	at each shift
total conductivity:	7000 µS/cm (up to 15 bar)	daily
total conductivity:	6000 µS/cm(16 - 25 bar)	daily
total dissolved salts:	3500 mg/kg(up to 15 bar)	weekly
total dissolved salts:	3000 mg/k(16 - 25 bar)	weekly
silica:	150 mg SiO <sub>2</sub> /kg	weekly
phosphates:	30 mg PO <sub>4</sub> /kg	weekly

Furthermore, water must be clear and colourless, free from solid matters in suspension and persistent foam.

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## **WATER CAUSED TROUBLES IN STEAM GENERATORS**

### Scaling

Scaling is mainly caused by the precipitation of calcium and magnesium salts, a phenomenon which increases when temperature is high.

When water is at 60°C there is heavy precipitation of almost exclusively calcium carbonate. With temperature exceeding 100°C, magnesium carbonate as well as calcium and magnesium sulphates precipitate heavily.

Precipitates are collected in form of muds partially from the mass of water and partially from the walls where they adhere in form of scaling.

Another element make things even more difficult: the solubility of silica decreases according to temperature and changes according to the alkali concentration.

Bound with other precipitates, it forms very strong scales that increase in volume according to the working temperature of the generator.

Scale is already a problem in hot water boilers and deserves greater attention in steam boilers as it can give rise to the following troubles:

- the generator decreases its performance because of the insulating action caused by scaling (in terms of heat conductivity, 1 mm of scaling corresponds to approximately 83 mm of steel);
- uneven distribution of thermal loads which affects the mechanical features of metal sheets that in consequence will "roast".
- hardness of water pipes with progressive loss in capacity of the generator.

### Corrosion

Corrosion is a wide and complex problem which affects steam generators. Here again, this is a far greater issue than for hot water boilers.

Corrosion is caused by:

- carbon dioxide that is released in transformation reactions by the salts in the water after the latter has been heated (do not forget that the carbon dioxide solubility decreases as temperature increases);
- free oxygen that is present in water and decreases as temperature increases but never disappears;
- chemical-physical features of water;
- solid matters in suspension or water impurities.

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These fundamental elements play different roles but always enhance the phenomena occurred which are basically of electrochemical nature.

Water often turns into cathode while the generator walls turns into anode and polarised atoms are transferred from one electrode to the other (in more simply but wrongly-used words: the walls of the generator melt in water).

The phenomena described above have always an adverse impact on the generator life span. Failures, holes and damages that cannot be repaired are the consequences that one suffers for having disregarded these problems.

It is also worth mentioning another extremely severe phenomenon that occurs when the generator is serviced carelessly: "caustic embrittlement". This can be interpreted as a modification in the molecular structure of the iron in a very alkaline environment such as when drainage is not sufficient versus the quantity of salts contained in the generator water.

This phenomenon causes irreversible damages and eventually mechanical failure.

### Entrainment

The salts precipitated in the water mass become mud and eventually pollute steam if above certain limits.

Besides muds, steam can be also affected by foams too that originate by combining with the organic materials contained in water.

In similar events, steam "entrains" other elements too that contaminate its purity and eventually jeopardise technological plant operations.

In addition to this severe situation, entrainment can damage seriously the safety and regulation appliances of the generator.

Damages caused by insufficient drainage versus mud are dramatic and result in failures of the product and production plant to burst of the generator.

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## **PRELIMINARY OPERATIONS PRIOR TO STARTING UP FOR THE FIRST TIME**

Before starting up:

- check that thermostats are calibrated: the safety thermostat at the maximum pressure permitted by the generator; the regulation thermostats at the pressure required (however lower than the maximum permitted pressure) with the differential selected for intervention;
- check that the furnace is free from foreign matters;
- ensure that the turbolators do not protrude from the front of smoke pipes;
- check that the refractory lining of the door has not been damaged;
- check that the burner draught tube has been correctly plugged and that the door has been correctly tightened (see pages 13-14);
- ensure that there is enough fuel available and that the fuel cocks are open;
- check that the discharge valve and the valve under the level gauge are closed and the on-off valves of the water pump are completely open;
- check that the steam intake valve is close and the on-off valves of the injector are closed;
- ensure that the safety valve weight is at the end of the rod;
- ensure that the electric motor of both the burner and the motor-driven pump ventilator run in the correct direction of rotation;
- check that the water treatment system is correctly operated;
- turn on the water pump (selector on "manual") and check through the level gauge that the boiler is filled to the minimum level.

The little water that leaks initially from the pump seal is normal as the seal must get adapted. However, if the leak continues for some working hours or increases, tighten the screws which regulate the seal.

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## **FIRST START UP AND FURTHER CHECKS**

After performing the preliminary checks, power on the burner.

During the heating phase, the volume of water increases and the level tends to increase: check the gauge and maintain it at the set level by actuating slowly the discharge at intervals.

After the pressure required is reached, the burner must stop automatically. Now set the operation selector switch on "automatic" .

At the next operation, which must be performed very slowly, the steam inlet valve is opened so that steam can heat the pipes slowly thus preventing any sudden expansion (this measure is necessary when the plant is new; if the plant is old, empty thoroughly the pipes to prevent water hammering).

As soon as the pressure decreases, pressure switches must give again the burner consent.

Repeat this operation until the minimum level of the generator is reached. In this way, when the water pump runs automatically, the level is reset in its working position.

Now set the safety valve as described hereafter: increase the calibration of the regulation pressure switch to reach the maximum permitted pressure and close the steam intake.

When the burner has stopped, check the manometer to see that the arm coincides with the red mark.

This must set off the alarm for maximum pressure from the safety pressure switch.

If the safety valve is a spring valve, the calibration is pre-set.

Very carefully move the lever forward until the valve is totally opened. Fix the weight in this position and reset the calibration of the regulation pressure switch on the value desired.

Press the alarm reset push button to release the burner that should restart.

Check the safety of the minimum level by powering off the pump (selector switch on "O"): let the burner run and open the steam intake. Once the minimum level is reached, the burner must block.

Once all the conditions are satisfied, the burner must be correctly set to the maximum power permitted by the boiler as it is contained in instructions booklet supplied with the generator, analysing the combustion products to obtain correct combustion and lowest possible emission of contaminants.

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Check the seal on all the gaskets on the water and fume side; they must be further tightened while hot in order to guarantee a perfect seal.

This operation is of fundamental importance for the gaskets of the door, of the burner plate and of the smokebox to prevent leakage of toxic and therefore hazardous combustion fumes into the boiler room.

The weight of the overhanging burner tends to loosen the gasket of the burner plate and the door at the top.

It is also very important to check the boiler/flue coupling seal for the above reasons.

As pressure increases, it is also extremely important to tighten progressively the seal of the generator hatch for a perfect seal. If not, at the first leakage the seal must be replaced.

### **ALKALINE WASHING OR BOILING**

This treatment must be carried out by qualified companies on new generators.

After the boiler has been prepared and installed, all deposits are removed such as residues of oil, grease, metal oxides.

If these substances are not removed, they help the onset of corrosive phenomena caused by the formation of a passivating film on water-exposed surfaces.

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## **DRAINING AND CHECKING**

Drain daily the level gauge following this procedure: open the draining of the level gauge very slowly to prevent any breakage of the crystals. Close the lower valve in order to clean the upper one using steam; open the lower and close the upper one to clean the lower valve with water. Finally open the upper valve and close the discharge valve.

After performing this operation, the level must promptly return to its correct position.

Each idle or delay in the water motion proves a partial obstruction of the gauge and the reading can be misinterpreted.

Ensure also that level testing cocks are cleaned and open them at least once a day.

Every day open the boiler draining system to remove the newly formed muds.

The quantity of water per hour (kg/h) to be drained depends on the quantity of TDS (total dissolved solids) in the fed water and boiler water as illustrated by the formula below:

$$\frac{\text{TDS feed water (ppm)}}{\text{TDS boiler water} - \text{TDS feed water (ppm)}} \times \text{Max steam production (kg/h)}$$

This operation is rather important: if you drain a small quantity of water, you can face the risk of scaling, entrainment and corrosion; on the contrary, if you drain too much water, you waste heat, i.e. fuel.

The generator conductor must be adjusted according to the weekly analysis of feed water and boiler water in order to define the correct quantity of water to be drained daily.

Automatic draining systems with continuous monitoring of the boiler water can be installed. In this way it will be much easier to carry out this operation which will guarantee that draining is correctly performed.

The manometer of the generator should be inspected every day: its operation must be continuous and without joggling (malfunction).

Test both feed water and boiler water following the schedule listed in the chapter "feed water – specifications" (page 20).

Inspect weekly the efficiency of the level regulator (minimum level alarm test) and safety pressure switch (maximum pressure alarm test).

Ensure that no steam or water is leaking from valves and seals: if yes, fix immediately the leakage by servicing the valves and tightening or replacing the seals.

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## **TURNING OFF THE GENERATOR**

Follow this procedure to turn off daily the generator:

- Ensure that the pressure is off;
- Close the on-off valve on the pump flow to prevent depression caused by steam condensation caused by the sucking of water from the tank and the filling of the boiler. This problem can be solved by installing a vacuum-breaker valve which acts on the steam chamber of the generator (usually near pressure switches). If the tank is provided with an on-off solenoid valve (as described in the chapter "feed water – condensate collecting basin"), it is not necessary to close the valve or to install a vacuum-breaker valve.
- Turn off the main switch on the electrical board.
- If the main switch remains on, the burner and pump switches must be turned off anyhow.

To turn off the generator for a longer period of inactivity, follow this procedure:

- The "wet" or "dry" conservation procedure of the water side must be performed ;
- Turn off the main switch from the electrical board and disconnect power supply;
- Close the fuel on-off valve;
- Follow the conservation procedure from the smoke side;
- Protect all controls, adjustment and safety devices against dust and humidity.

"Wet" conservation requires the boiler to be completely flooded adding water with preservatives or neutralizers.

The plant is sealed by closing all on-off valves.

This type of conservation is not recommended in case of frost.

In "dry conservation", the boiler must be emptied. Open the hatch, dry completely the inside of the generator with air and add highly hygroscopic substances (ex.: caustic lime).

Close all on-off valves and the manhole so as to seal the generator.

The conservation on the smoke side must be performed in this way: open the door and the small door on the smoke box, pull out turbolators from the flue and clean thoroughly all surfaces from soot (it can contain sulphur that becomes sulphuric acid in wet environments) and add highly hygroscopic substances in the furnace and the smoke box (ex.: caustic lime).

Fit turbolators and close hermetically the door and the small cleaning door.

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## **MAINTENANCE**

Periodical maintenance is essential for safety, output and the generator life span.

Before servicing:

- wait until the generator has cooled and pressure is off.
- turn off the system by closing the main general switch on the electrical and plant boards;
- close the fuel on-off cocks.

Clean the smoke side every 3 months if you use fuel oil , every 6 months if you use gas oil and one year if you use methane.

Before cleaning the smoke side it is recommended that a fuel analysis be performed to find out the operating conditions that will be compared to those after cleaning.

Cleaning on the smoke side: open the door and the cleaning door on the smoke box, pull out turbolators from the flue and remove soot from all surfaces. Suck all soot passing through the cleaning door.

Check the seal of the fuel supply system. This inspection is absolutely necessary when gaseous fuels are used.

Check the perfect seal of the smoke circuit and, if needed, replace worn seals.

Inspections to be carried out every 6 months:

- open the hatch when the generator is cold and check that scale thickness is not above 0.5 mm: if not, contact qualified companies to have a chemical washing carried out and check the softening system.

Caution: every time the hatch is opened, replace its hatch gasket and tighten it gradually both in cold and hot conditions.

- When the generator is cold, disassemble the probes and ensure that they are clean. If necessary clean them with an extra-finely grained sandpaper. It is recommended that they are dismantle one at a time to avoid making mistakes when re-connecting the electrical board.
- Check that the contact of the remote control switches on the electrical board is not oxidised. This operation must be carried out once every month when the generators installed are located by the sea.

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- After cleaning the machine, repeat the preliminary operations for first time start-up (see page 23), control the calibration of the burner and analyse the smoke to verify it is working correctly.

## **RECOMMENDED SPARE PARTS**

Spare parts recommended for two working years:

- No.1 - regulation pressure switch
- No.1 - safety pressure switch
- No.3 - level probes
- No.2 - electronic level regulators
- No.4 - hatch gaskets
- No.3 - sets of gaskets for the door and the small cleaning door.

## **TROUBLESHOOTING**

Below is the description of the most common faults and their remedies:

**FAULT:** the burner does not turn on.

**REMEDY:**

- check electric connections;
- check the regular fuel supply;
- check the integrity and the cleanness of the fuel supply system and that no air is present;
- check that ignition sparks form regularly and the burner appliance works correctly;
- check that the generator alarms are functioning;
- check the calibration of the regulation pressure switch.

**FAULT:** the burner turns on well but turns off immediately after.

**REMEDY:**

- check the pilot flame, the air calibration and that the burner appliance works correctly.

**FAULT:** the burner is difficult to be adjusted and/or no output.

**REMEDY:**

- check for the cleanness of burner, boiler, boiler/flue pipes and flue;
- check the hermetic seal of the smoke circuit (door, burner plate, smoke box, boiler/flue connection);
- check that the fuel supply is flowing regularly and verify the effective power of the burner;
- check for the presence of scale and carry out a chemical washing.

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FAULT: the boiler gets easily covered with soot.

REMEDY:

- check the burner regulation (smoke analysis);
- check the fuel quality;
- check the flue for clogging and the cleanliness of the burner air intake (dust).

FAULT: smell of gas and/or unburnt products.

REMEDY:

- check the seal of the fuel supply system (if gas fuel);
- check the hermetic seal of the smoke circuit (door, burner plate, smoke box, boiler/flue connection);
- check that the rubber holder on the pilot flame is connected to the burner air intake or clogged.

FAULT: the boiler does not reach set pressure.

REMEDY:

- check that the smoke side and water side of the boiler are clean;
- check the combination, regulation and performance of the burner;
- check the regulation of the pressure switches and that they work correctly;
- check the seal of the nonreturn valve;
- ensure that the boiler capacity is appropriate for the plant.

FAULT: the safety valve of the boiler intervenes.

REMEDY:

- check the calibration of the pressure switches and that they are working correctly.

FAULT: the low level alarm is set off.

REMEDY:

- Check that probes are clean and inspect the contact on their caps;
- Check that the level regulators on the board are working correctly;
- Check that the pump is working correctly.

FAULT: the safety valve of the boiler intervenes.

REMEDY:

- check the calibration of the pressure switches and that they are working correctly;
- check the calibration of the valve itself.

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FAULT: membranes overheating due to lack of water in the boiler.

REMEDY:

- Turn off the burner, do not pour water and do not open the door; wait until the ambience temperature is restored before performing any operation.

FAULT: the pump does not load or loads to slowly

REMEDY:

- Check feed water temperature and the head at the pump inlet;
- Check that no valves are partially closed or clogged;
- Check that the inlet water pipe of the generator is not clogged for scaling.



**I.VAR INDUSTRY S.r.l.**

Via S. Pierino, 4 (Z.A.I.) - 37060 Trenzuelo – VERONA - Italy  
Telephone 045/6680082 -Fax 045/6680051 - P.IVA 02835480233

e-mail: [info@ivarindustry.it](mailto:info@ivarindustry.it) – Web site: [www.ivarindustry.it](http://www.ivarindustry.it)

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