



AKKAYA
B O I L E R S

USER MANUAL

**HWB MODEL
HOT /SUPERHEATED WATER
BOILERS**





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1. INTRODUCTION

Valuable Customer,

Akkaya hot/superheated water boiler you have purchased is produced according to EN & TURKISH norms.

This user guide is prepared for Akkaya HWB model, solid fuel fired hot/superheated water boiler.

This user guide includes technical information about the boiler and operating and safety instructions as well.



Owner must employ a licensed or certificated boiler operator for a safe and efficient use. Any accidents or breakdowns caused by operating conditions, other than described in this guide, shall be customer's responsibility. All local legal requirements must be fulfilled by the owner prior and during operation of the boiler.

There are some information and charts referred to standards and norms in this manual. Please refer to the latest versions of the standards and norms.



GENERAL DESIGN and CONSTRUCTION



2.GENERAL DESIGN AND CONSTRUCTION FEATURES




2.1 Design

- HWB model boilers are designed and manufactured to burn different kind of solid fuels and produce high pressure hot or superheated water. The front combustion chamber is made of water tube section and the back boiler part is made of fire tube section. This model is also known as “HYBRID TYPE” as it is a combination of fire tube and water tube boiler design.
- The heat transfer area of the boiler and the combustion chamber dimensions are selected properly to increase the efficiency and the lifetime of the boiler. The heat load per heat transfer surface area (W/m^2) of the boiler is selected properly. Because of this feature boiler has a safe and reliable operation.
- A large furnace is produced with water tubes to allow enough combustion volume and this property allows easy cleaning and operation with solid fuels.
- There are refractory covered water-cooled walls inside the furnace to keep the furnace temperature at higher level and to keep the combustion residence time longer. This feature helps to obtain a complete combustion and to decrease the harmful CO emissions.
- Isolation of the boiler is specially made to minimize the thermal energy loss. Special covering materials are used on the surface, to protect the shell of the boiler from outdoor conditions and to prevent the tearing at maximum.
- Smoke tubes door hinges are designed for effortless operation. Opening the doors are quite easy and safe.
- Automatic – pneumatic, smoke tube cleaning system can be installed to the doors for efficient and easy operation.
- Front smoke box and rear door side panels are isolated by ceramic-based insulation materials to decrease heat loss and to provide safer operation.
- There is a man way with stairs and railing on top of the boilers for easy access and safe operation.
- The boiler body is designed according to PED2014/68 directive and CE marked.
- EN12953, EN12952, EN13445 & EN1090 norms are followed where applicable.
- Akkaya Boilers has ISO3834 & ISO9001 quality system certificates.

2.2 Working Principle



Figure 2.2.1 HWB Boiler Working Principle

-  : FIRST STAGE WITH COMBUSTION
-  : SECOND STAGE
-  : THIRD STAGE

The flame from the grate or stoker first reaches to the wall inside the furnace (refractory covered water tube wall) and from here it goes into the fire tube boiler's first pass tubes. At the rear smoke box, the exhaust gases enter to the second pass smoke tubes. And finally, hot gas is discharged from the chimney to the atmosphere. By this way 3 stages are completed.

2.3 Construction

HWB boiler body consists of: Water tube combustion chamber and 2-pass fire tube boiler body. The design is made according to the boiler's operating pressure. EN12953, EN12952, EN13445 & EN 1090 are taken as reference for design calculations where applicable.

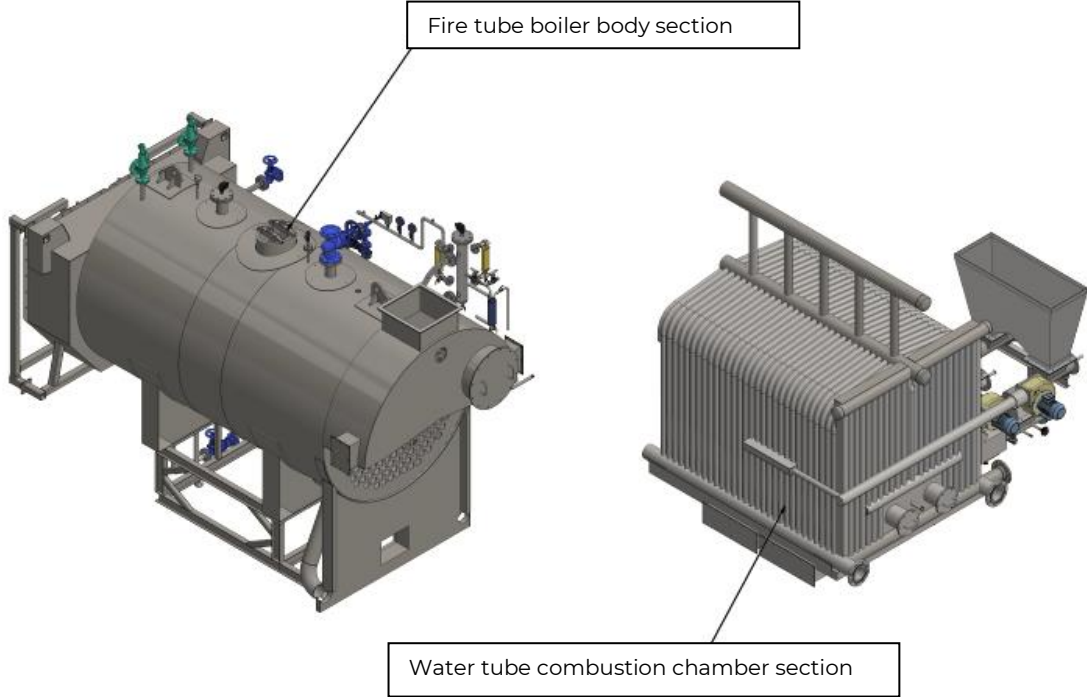


Figure 2.3.1 HWB Boiler Main Parts

2.4 Quality

2.4.1. Steel Materials

Steel materials are selected according to the requirements of EN12953-2. Generally, boilers are made of carbon steel of quality P265GH - P295GH -P355GH in accordance with EN10028-2 standard in the pressure-exposed parts and of S235JR - S355JR quality in non-pressure parts. The details of the materials used can be found in the "Technical File" of the boiler.

2.4.2 Tubes

In accordance with the requirements of EN12953-2 & EN12952-2: EN10216-2 P235GH, 16Mo3 or similar quality seamless steel tubes and EN10217-2 P235GH quality ERW (welded) tubes are used. The details of the materials used can be found in the "Technical File" of the boiler.

2.4.3 Welding

Welds were performed by certified welders according to EN9606, in accordance with EN15609, EN15614-1, EN15614-8 requirements of welding procedure specifications. According to EN12953-5, welds are subjected to necessary non-destructive testing procedures (UT / RT, VT, MT / PT). The weld details including WPS, PQR, welding maps, NDT reports, welder certificates can be found in the "Technical File" of the boiler.

2.4.4 Isolation

On 50 mm thick rockwool or glasswool, PVC and protective film coated galvanized sheet, aluminum or, stainless steel coating (specifications of which can be changed according to customer request and boiler's operation temperature) is applied. Rear smoke box and front door side panels are isolated by ceramic-based insulation materials to decrease heat loss and to provide safer operation. On the water tube combustion section an additional 25 mm thick ceramic blanket insulation is applied under the rockwool.

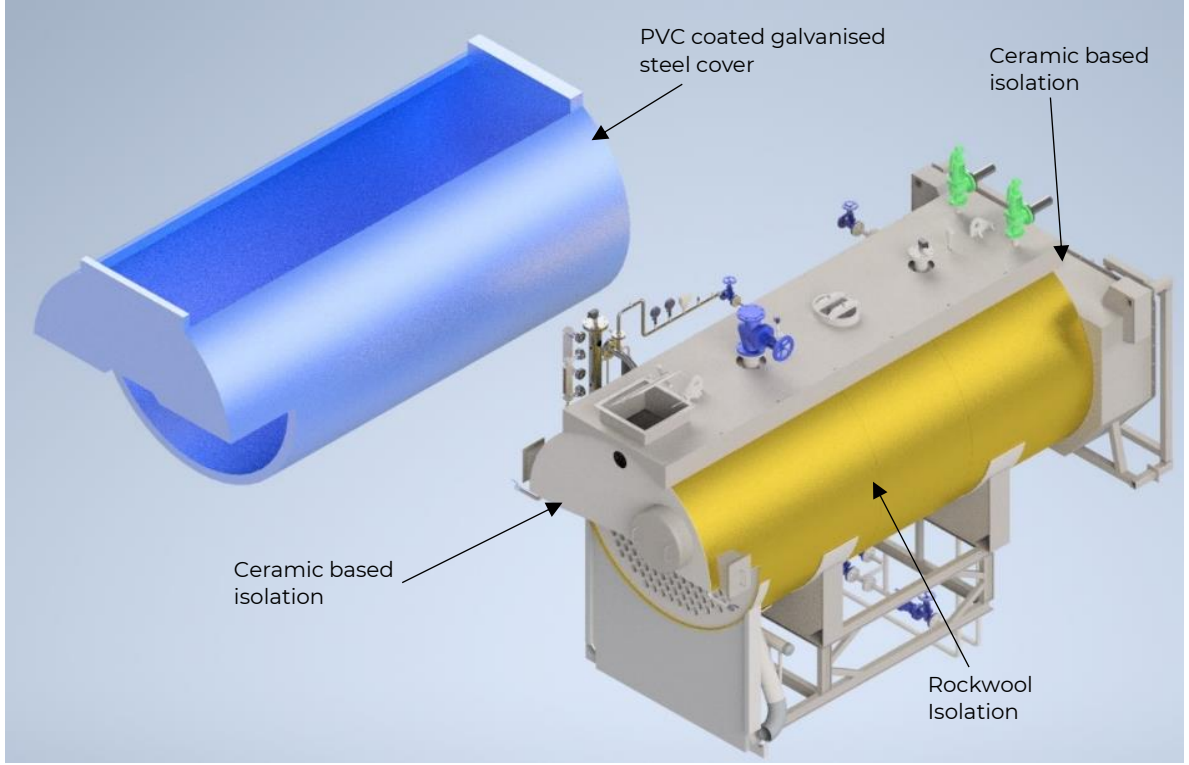



Figure 2.4.4.1 Isolation

2.5. Product Coding



2.6. Boiler Name Plate (Sample)

 <p>AKKAYA B O I L E R S</p> <p>AKKAYA ISI MAKİNALARI VE DOĞALGAZ SAN. VE TİC. A.Ş. AKKAYA HEATING INSTRUMENTS & NATURAL GAS INC.</p>
Tanım Description
Tipi Type
Seri No Serial Number
Standart Standard
Max. Isıl Kapasitesi Maximum Thermal Capacity
Akışkan Tipi Fluid Type
Isıtma Yüzeyi Heating Surface
Müsaade Edilen En Yüksek Basınç Max. Allowable Working Pressure
Müsaade Edilen En Yüksek Sıcaklık Max. Allowable Working Temperature
Hidrostatik Test Basıncı (bar) Hydrostatic Test Pressure (bar)
Hidrostatik Test Tarihi Hydrostatic Testing Date
İmalat Tarihi Manufacturing Date
CE
<p>1.OSB.Yerli Su Sok. No:2 Selçuklu / KONYA - TÜRKİYE +90 332 248 92 21 +90 332 248 91 45 akkaya@akkaya.com.tr</p> <p>www.akkaya.com.tr</p>



TRANSPORTATION INSTRUCTIONS



3. TRANSPORTATION INSTRUCTIONS

3.1. Placing the Boiler on Transport Vehicle

- 1- An open top vehicle must be selected for transportation of the boiler (either with truck or container)
- 2- While loading boiler on a vehicle, a crane (with proper load capacity) must certainly be used. All the covers / doors of the vehicle must be opened before the boiler is lifted for placing.
- 3- Lifting eyebolts of the boiler must be used while lifting to place it on the vehicle.
- 4- Rope or chain must be selected carefully to carry the boiler safely. Connection and angle of the ropes/chains must be done according to the instructions & confirmations given by Akkaya.
- 5- Placing on the vehicle and positioning the boiler must be done carefully and instructions from the transport vehicle operator must be followed.
- 6- The lashing of the boiler on the vehicle or container must be carried out by professional and certificated companies.



When you lift the boiler from the ground level, there must be **NOBODY under or close to the boiler. Utmost care must be taken to avoid accidents.**

3.2. Transporting The Boiler

- 1- Before carrying the boiler on a vehicle, it must be fixed to the vehicle by being tied with barrier to prevent slipping. The lashing must be done by certificated companies.
- 2- Boiler mustn't be carried together with fragile equipment and/or living creatures.
- 3- The driver of the vehicle must avoid any sudden movements. The speed limits of the road must strictly be obeyed.

3.3. Placing The Boiler In The Boiler Room

- 1- Boiler must be placed in a boiler room, specially built for boiler and boiler auxiliaries.
- 2- Local legal regulations and rules must be followed for the boiler room placement and construction.
- 3- Boiler must be unloaded from the vehicle, using a crane. The eyebolts of the boiler must be used for crane operation.
- 4- If it is not possible to take the boiler inside the boiler room, either from its roof or doors, some agents like rollers or similar items can be used to slide the boiler on.
- 5- Experienced staff must be in charge for unloading and placing the boiler in the boiler room. Safety tools like helmets, gloves, eye protectors... etc. must be provided.
- 6- The boiler room must be free from dust, flammable materials, dangerous or corrosive gases.
- 7- The fire protection & extinguishing system must be installed.



INSTALLATION OF BOILER AND AUXILIARIES



4. INSTALLATION OF BOILER AND AUXILIARIES

For the boiler room dimensions and construction rules please refer to the local regulations. Please consult Akkaya for the dimensions of the boiler and auxiliary equipment to be installed inside the boiler room.

- 1- All required legal permissions for boiler fuel supply, electrical power supply, piping & plumbing must be completed and provided by the owner.
- 2- The height of the boiler room must be built at least 2 m higher than boiler's height.
- 3- The boiler room must have at least two facing doors one of which must have ventilation openings to allow air circulation.
- 4- The doors must have at least 2 m height and 0,9 m width.
- 5- The boiler room floor must be a smooth concrete or a non-flammable basement.
- 6- The boiler room must be well ventilated but protected from outdoor conditions or wind.
- 7- Any flammable objects mustn't exist in the room.
- 8- The installation of the boiler and its auxiliary accessories must be carried out by an experienced and qualified staff.
- 9- If there is more than one boiler to be installed in the same boiler room, there must be minimum 1 m space between boilers.
- 10- Adequate space must be left to access the boiler for inspection or service purposes.
- 11- Easy access to the electrical control board and sufficient clearance must be provided.
- 12- Pressure drop in the boiler room can be maximum 0,5 mbar. It must be ensured that there is no negative pressure in the boiler room.
- 13- In case any kind of suction fan exists in the boiler room, it must be ensured that boiler flame draft is not affected. In case needed a draft inducer or engineered flue system must be provided.
- 14- The proper water and fuel line piping must be completed before the boiler start-up. P&ID (piping and instrumentation diagram) and item list of the equipment must be provided and must be kept for future records.

If the auxiliaries and accessories of the boiler is in the scope of contract, P&ID and item list is supplied by Akkaya. Please consult Akkaya for these documents.



The owner of the boiler must complete the following pre-works before start-up.

- 1- Proper water supply line and water drain must be built.
- 2- For the specifications of the water to be connected to the feed water tank and to the boiler feed pump is described in the user manual and in EN 12953-10 standard.
- 3- Piping between boiler and circulation pumps must be done. For the dimensions of the pipes please refer to P&ID.
- 4- A proper electrical power supply cabling to the electrical control board must be done and its earthing (grounding) must be completed. Please refer to the electrical wiring diagram for selection of the power supply cables and protection switches (to be supplied by Akkaya if the control system supply is in the scope of the contract).
- 5- In case the boiler is not delivered as a packaged system with all accessories mounted on, Akkaya's authorized staff must be waited to connect all the accessories to the boiler. Also, the electrical control board connection of the boiler accessories shall be done by Akkaya's technicians, too if these works are in the Akkaya's scope of supply.
- 6- The safety valve outlets must be taken out of boiler room with proper separate piping for each of them. Do not connect the exits of the safety valves to a common pipe.
- 7- Boiler must be connected to a properly designed and certificated chimney. The calculations and the construction of the chimney and the smoke channels must be done according to EN norms.



Too long horizontal section or improper dimensioned smoke channels may cause poor draft. Chimney draft is very important for the combustion quality. Also, the diameter of the chimney is very important for draft and must be selected properly.

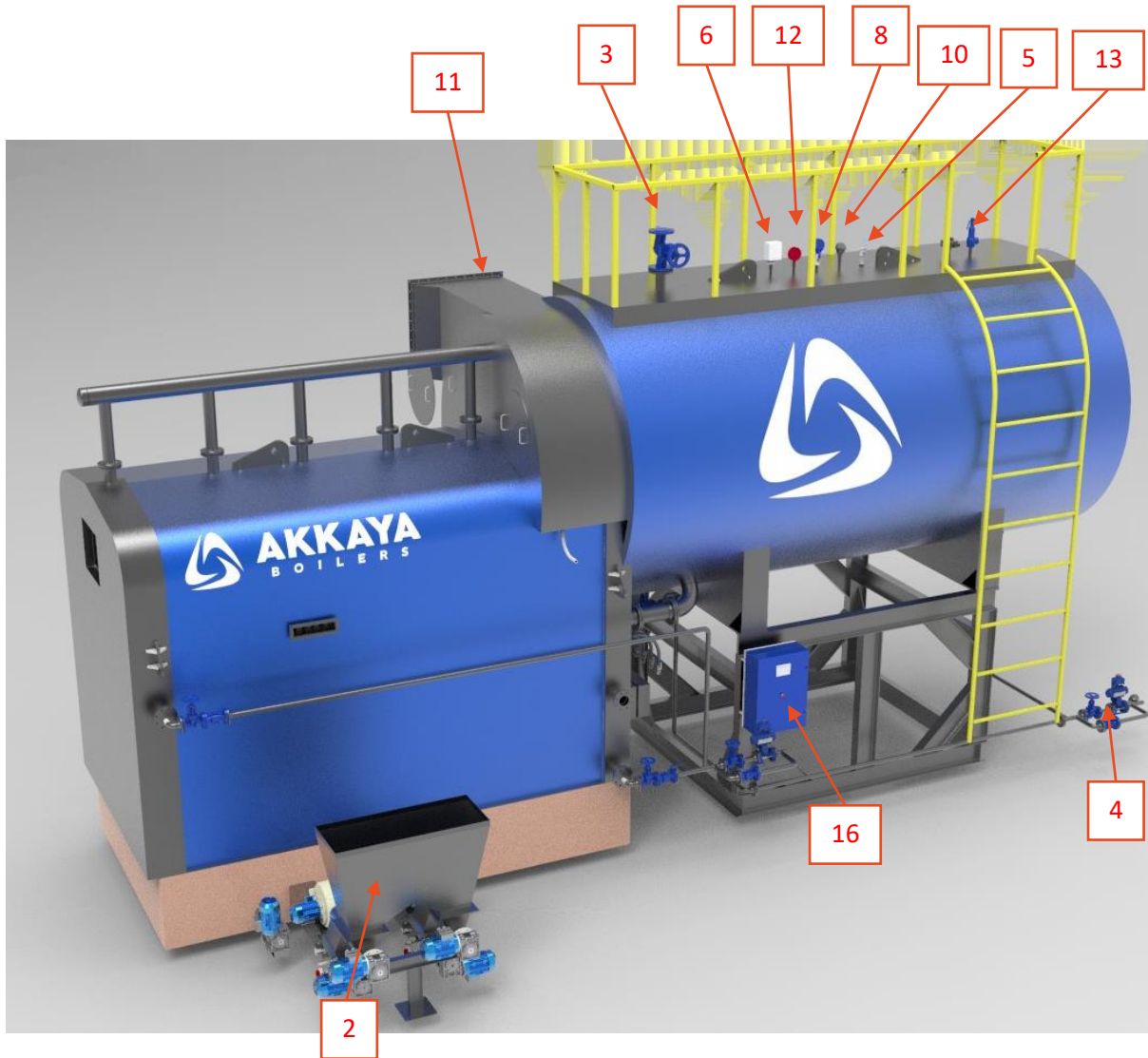


Figure 4 Sample Boiler Accessories & Auxiliaries

No	Component	No	Component
1	Hot/Superheated Water Boiler Body	9	Boiler Temperature Switch
2	Stoker	10	Boiler Temperature Sensor
3	Boiler Superheated Water Exit & Return Valves	11	Exhaust Gas Temperature Sensor
4	Boiler Drain and Water Filling Valves	12	Boiler Thermometer
5	Boiler Air Discharge Valve	13	Safety Valve
6	Pressure Switch (Min – Max.)	14	Flow Switch
7	Pressure Transmitter	15	Boiler Automatic Low Water Level Controller
8	Manometer and Manometer Valve	16	Electrical Control Board

The configuration and the equipment descriptions given in this manual are for a standard package HWB boiler system. The specifications and quantities of the accessories may vary due to customer's requests. For safety accessories EN12953 has been taken as reference where applicable.



START-UP, OPERATING, CLEANING AND MAINTENANCE INSTRUCTIONS



5. START-UP , OPERATING, CLEANING AND MAINTANENCE

5.1 Start-Up And Operating The Boiler



The boiler's first start-up & commissioning must be done by Akkaya's Technical Service. The guarantee of the boiler will be invalid unless the commissioning is done or approved by Akkaya.

When the boiler is turned off manually and needs to be started up again the following steps must be completed to operate the boiler safely.

Boiler operators must have a valid license, or a certificate taken from official authorities (In Türkiye MYK certification is required). The operators must be responsible for interfering in any urgent situation. So, it is very important that they know the functional properties and operating principles of all equipment used in boiler systems.

The operators must have a control form and must fill it in daily.

(For sample daily control chart see Appendix 1)

- 1- All combustion equipment and chimney system must be checked for a safe operation. This check is done to be sure:
 - a) There is no unfired fuel / oil / flammable object deposit inside the combustion chamber.
 - b) There is no gas deposition inside the boiler.
 - c) The chimney and smoke channels are open and clean. Proper suction exists in the combustion chamber. There are no hurdles in the smoke way. All the auxiliaries' (like economizer, recuperator, etc.) dampers are fully open, and smoke can pass through easily.
 - d) There are no hurdles in front of the gas explosion door, and it is functioning well.
- 2- If there is any automatic combustion or control equipment in the system; electrical protection and functional controls and locking system controls must be done. All this equipment must be in operation.
- 3- All valves must be checked for no leakage.
- 4- Minimum pressure level control system and the water flow control of the boiler must be checked strictly, for correct operation. The correct operation of this system must be ensured before the boiler is started-up.
- 5- If the boiler has stayed non-operating for more than 2 weeks, all valves, fittings and control equipment must be checked for any kind of faults before restarting.
- 6- Water with appropriate chemical composition complying with EN12953-10 must be filled in the boiler. Akkaya control systems has a manual filling option on the control board.

(For boiler water chemical composition information see Appendix 2)



Akkaya's manufacturer guarantee shall not be valid unless above mentioned chemical composition of boiler water is provided.

- 7- The boiler combustion system can be ignited, or the boiler can be started after making all the checks described above.



Before the first ignition of the fuel make sure that there is nobody in front of the boiler doors or in front of the explosion door. At this stage boiler operator(s) must stay at the side of the boiler. There may be a gas explosion and the boiler doors, or the burner can blow away by this explosion. This may cause deadly injuries.

- 8- For first ignition, if fixed grate system is installed, solid fuel must be loaded from the front fuel inlet door.
- 9- In case stoker system is installed, automatic fuel feeding shall be carried on by starting the screw drivers.
- 10- Pieces of wood and easy flammable objects (like saw dust, paper, or small branches) must be spread over the main fuel, and they must be manually fired in grate systems.



Never use flammable and volatile materials like alcohol, paint thinner, gasoline etc. for ignition. Such volatile and flammable materials can cause accidents and fire.

- 11- The fuel dimensions and specifications must be suitable for the burner system. For the automatic fuel feeding systems with augers, fuel dimensions must be in between 5-50 mm. The fuel's humidity must be less than 10%. The fuel shape and characteristics must be suitable to be transported by auger (screw) type feeding.
- 12- The fuel bunker and the feeding path must be kept clean. The materials like big sized fuel, stones, iron, or steel parts inside the fuel that can break or block the fuel feeding system must be removed.
- 13- In case an automatic ignition system is installed, first ignition will be done by the hot air blowers.
- 14- Fuel must be ignited from the top of the fuel. Ignition obtained from the bottom causes air pollution because of flying particles. This may also increase fuel consumption at a rate between 20% - 30%.
- 15- Fuel feeding door must be closed after ignition and must be kept closed.
- 16- During first ignition air inlet door and secondary air inlet on the fuel feeding door must be opened.
- 17- Not to let flying particles escape to atmosphere and to prevent air pollution, do not add new fuel on top of burning fuel directly.
- 18- New fuel feeding must be done after taking the ashes out manually or with automatic ash remover (in case installed), and from the bottom ash room in grate systems.
- 19- Boiler inlet & exit valves must be controlled manually by opening and closing it. These valves must not be tightened too much during operation regarding expansion or squeezing.
- 20- The control values like pressure, temperature and stack temperature must be observed. Boiler pressure manometer and the pressure value on the control screen obtained by the pressure transmitter and the temperature value seen on thermometer and on the screen must be observed and controlled. There may be slight difference between mechanical devices and digital values on the screen. If the difference is higher than 5% Akkaya Technical service must be informed. The temperature of the boiler can be controlled during water circulation continue. The stationary water temperature can be different than the actual value.
- 21- Combustion Air to Fuel ratio adjustment must be done by an expert with an exhaust gas analyzer.
- 22- During first ignition the burner must be operating less than its full capacity. The flame must be observed at minimum length at least one hour without increasing.
- 23- Water level rises because of thermal expansion due to temperature increase. The water volume expansion is compensated by using expansion vessel. Expansion vessel can be closed type or open type. The expansion vessel volume, type and structure must be selected according to operation temperature, pressure, and system full water volume. Please refer to P&ID and item list for detailed information.
- 24- After obtaining homogenous heat inside the boiler, the burner flame and the boiler temperature can be increased gradually. (For example, 15° C in every 15 minutes). Sudden temperature increases must be avoided.
- 25- When the boiler temperature arrives at the set value the fuel feeding and the air flow must stop automatically. There may be a hysteresis set value for restart of the burner. This value must be checked and if it is not well defined for the system needs Akkaya Technical Service must be informed. If the operation of the burner is not stable the Akkaya technical service must be informed.
- 26- Safety valve's operation must be checked. When the boiler pressure reaches to set value, the safety valves handles can be lifted to let some water flow. Never try to increase the pressure of the boiler to the safety valve's set value by firing the burner (by making shortcut in burner control line). The check of the safety valves at their set values can only be done by authorized Akkaya Technical Services.
- 27- Check all the flange or nozzle connections for water leakages during the temperature rise of the boiler.



In case any water leakage is detected at a boiler under pressure and when the temperature is higher than 50°C do not attempt to solve the problem immediately. Wait for the boiler and the water to cool down. Be sure that there is no steam inside the boiler. Superheated water can leak as steam for the high-pressure systems. Breathing steam can burn your trachea and cause suffocation. Steam and hot water can burn your skin. Pressurized water and steam can cause mechanical elements (like bolts, nuts, valves, handles, etc.) to rupture and hit your body. These incidents can cause fatal injuries. Utmost care must be taken during fixing any leakage.

- 28- During the boiler's operation, the flame must always be kept stable and smooth regardless the fuel type. The boiler operator must also check the fuel consumption and follow it to notice any kind of efficiency loss.
- 29- Water level or system pressure must stay at normal level when boiler is operating. Even if the water pressure level is controlled automatically, boiler operator must still observe the level and the water flow as the automatic system may be out of order because of mechanical or electronic breakdowns.



- 30- Water level controller, flow controller and minimum pressure controller must be cleaned monthly to obtain safe and efficient operation.
- 31- Boiler feed water must be continuously analyzed chemically to prevent improper composition. Water sample must be taken in certain periods and be analyzed as described in Appendix 1 & Appendix 2 of this manual.
- 32- The circulation water pipes and pumps must be controlled frequently (Ave. monthly). The calcination or scale formation inside the pipeline is a frequently faced issue. In case scaling or mud formation is seen they must be fully cleaned by mechanical or chemical means.
- 33- Boiler operator must record all the operations done on the boiler regularly.
- 34- During the whole operation the valves of the circulation pump (the working one, not the stand-by pump) must be kept open.
- 35- The pump rotating direction must have been controlled at the startup by an experienced electrical technician.
- 36- After the boiler and the system is filled in with enough water, take air from the air discharge valve located on top of the boiler and from the air vent screws of the pumps.
- 37- The set values must not be changed by any unauthorized person.



IF WATER LEVEL FALLS BELOW THE NORMAL LEVEL (THIS IS CONTROLLED BY PRESSURE AND FLOW SWITCH) AND THE BURNER KEEPS ON RUNNING THIS WILL CAUSE OVER HEATING OF THE BOILER PARTS. IN SUCH CASE BOILER&BURNER MUST BE STOPPED IMMEDIATELY. ALL ELECTRICAL POWER SWITCHES MUST BE TURNED OFF. ESPECIALLY WATER CIRCULATION PUMPS POWER CONNECTION MUST BE CUT IMMEDIATELY. NO BODY MUST BE ABLE TO RESTART THE PUMPS ACCIDENTALLY. CIRCULATION PUMP VALVES, BOILER EXIT AND INLET VALVES MUST BE CLOSED. ALL THE BURNING AND UNBURNED FUELS INSIDE THE COMBUSTION CHAMBER, ON THE GRATE OR ON THE STOKER MUST BE TAKEN OUT OF THE BOILER. ALL PRIMARY AND SECONDARY AIR SUPPLY FANS MUST BE STOPPED AND THEIR DAMPERS MUST BE CLOSED. BOILER MUST BE COOLED DOWN BY OPENING ITS FRONT SMOKE DOORS AND BY LETTING COLD AIR ENTER IN THE SMOKE TUBES. NEVER TRY TO FEED WATER TO THE HOT BOILER. NEVER TRY TO COOL DOWN THE BOILER BY FEEDING WATER. AFTER THE REASON FOR LOW LEVEL IS INVESTIGATED AND ELIMINATED IT MUST BE CHECKED FOR ANY MECHANICAL DAMAGE. ESPECIALLY COMBUSTION CHAMBER OR REVERSAL CHAMBER CAN GET HARMED BECAUSE OF LACK OF WATER. IN ORDER TO CHECK THE SITUATION, AKKAYA TECHNICAL SERVICE MUST BE CONSULTED. BOILER MAY EXPLODE IF YOU FEED THE HOT BOILER WITH WATER!



THE FLAME MUST BE OBSERVED DURING BOILER OPERATION. IF THE BURNER (STOKER / GRATE FUEL FEED AND AIR SUPPLY) DOES NOT STOP AUTOMATICALLY AT THE SET TEMPERATURE VALUE, THE FUEL FEEDING AND AIR SUPPLY FAN MOTOR'S POWER SWITCHES MUST BE TURNED OFF, ALL THE BURNING AND UNBURNED FUELS INSIDE THE COMBUSTION CHAMBER ON THE GRATE OR ON THE STOKER MUST BE TAKEN OUT OF THE BOILER AND AKKAYA TECHNICAL SERVICE MUST BE INFORMED IMMEDIATELY.



IF THE FLAME CAN NOT BE FORMED IN A SHORT TIME AT THE FIRST IGNITION, THE FUEL FEEDING MUST BE STOPPED. THE IGNITION MUST BE TRIED AGAIN AFTER COMBUSTION CHAMBER IS FULLY VENTILATED AND CLEANED FROM EXCESS FUEL RESIDUES. DEPOSITED FUEL RESIDUES OR COMBUSTIBLE GASES MAY CAUSE EXPLOSION!



IF THE BOILER OR ANY OTHER PERIPHERAL EQUIPMENT IS FROZEN DO NOT START THE BOILER BEFORE HAVING AKKAYA'S AUTHORIZED TECHNICAL SERVICE MAKE THE NECESSARY CONTROLS. NEVER TRY TO MELT THE FROZEN PARTS INSIDE THE BOILER BY FIRING THE BURNER. THE BOILER MAY EXPLODE IF YOU TRY TO RUN FROZEN BOILER!

5.2 Shutdown And Discharging The Boiler

- 1- Boiler is electrically shutdown from the control board by pressing stop button on HMI. (For different type of control board system please refer to electrical wiring diagram)
- 2- After shutdown be sure that the burner is fully stopped. All air supply must be closed and the fire on the grate must be extinguished under control of the operator.
- 3- After the burner is fully stopped and no flame or burning fuel is left inside the boiler air suction fan must be turned off.
- 4- Let the boiler cool down naturally. To prevent sudden temperature changes in the boiler, avoid sudden cooling.
- 5- The circulation pump must keep on working until the temperature of the boiler decreases below 50 C.
- 6- The boiler can be discharged from bottom drain valve after the water temperature is measured below 50 ° C and 0 BarG pressure is observed at the boiler manometers. If only the boiler is intended to be discharged exit and inlet valves of the boiler must be closed before drain.



It is dangerous to discharge the boiler when it is still hot.

- 7- Drain valves must be closed tightly after the boiler is fully discharged and warning signs as “do not open” on the drain valves must be placed.

5.3 Shutdown Procedures At Emergency Situations

- 1- If there is an emergency case like low water level, low pressure, lack of flow, high temperature, high pressure, or low temperature, press the emergency stop button.
- 2- Be sure the burner and pumps are not working. Turn off the fuel feeding system from screw feeder motors and air supply fan power switches. Shut off the water inlet valve of the boiler.
- 3- Take out the fire and unburned fuel from the combustion chamber.
- 4- For boilers which have been left without water and heated with lack of water, open the fire tube cleaning doors to let the boiler cool down naturally.
- 5- Never restart the boiler without inspection of an authorized body after an emergency stop.

5.4 Precautions

- 1- Do not fire the boiler if the water is under the normal water level.
- 2- Do not put your hands, your head or any of your body parts into the boiler gas side or water side during operation. Do not enter inside the boiler while the boiler is hot.
- 3- Do not close any of dampers on the smoke way fully. These dampers are boiler stack exit damper, economizer damper, recuperator damper or any damper that can stop the exhaust flow.
- 4- Insufficient chimney draft is harmful for human health and reduces boiler efficiency. So, the boiler draft must be kept adequate by means of cleaning and if needed by installation of a suction fan.
- 5- Chimney must be kept clean and in good condition for sufficient combustion. Before starting the boiler, the chimney draft must be controlled.
- 6- Be careful about the possible leakage at chimney and chimney connections.
- 7- Cleaning door on the chimney connection must be closed during operation.
- 8- The doors of fume box and chimney cleaning door must not be opened during operation.
- 9- Do not open the doors of the boiler during operation.
- 10- Before starting the burner, be sure that there are no flammable objects in the boiler and the furnace is clean.
- 11- You must keep the boiler under control during operation frequently.
- 12- Do not cook anything in the boiler.
- 13- Explosion door behind the boiler must be kept clear to be opened easily. Do not put anything in front of the door.
- 14- Do not use fuel with high sulfur content or materials that are harmful for human health.
- 15- Do not put explosive materials in the boiler.
- 16- There mustn't be any materials that can burn around the boiler (like woods, coal, oil, gas, textile materials, plastic materials etc.). Sparks or some heat can get out of the boiler, and this can cause fire. That's why the boiler room and the surrounding of the boiler must always be kept clean and free of materials that can burn.

The solid fuels composition has big impact on the combustion efficiency and safe operation of the boiler please check the below table to understand the effect of elements on fuel composition.

SUBSTANCE IN FUEL COMPOSITION	Unit	EFFECTS
S SULFUR	kg/kg	S > 0.1wt% (d.b.): There is a risk of corrosion. It is necessary to increase the thickness of the material in the boiler or the need for coating application occurs in critical areas. An automatic cleaning system should be installed, frequent cleaning should be done. It is recommended to change or leach the fuel. S > 0.2wt% (d.b.): There is an additional risk of SO _x emissions. The fuel should be leached, and a special filter should be used for precaution.
N NITROGEN	kg/kg	N > 0.6wt% (d.b.): There is a risk of NO _x emissions. Attention should be paid to EGR, air and combustion chamber design. Additional warning N > 2.5wt% (d.b.): There is a high risk of NO _x emissions, SNCR or SCR should be applied.
Cl CHLORINE	kg/kg	Cl > 0.1wt% (d.b.): There is a risk of corrosion and HCl emissions, it is necessary to increase the thickness of the material in the boiler or the need for coating application occurs in critical areas. An automatic cleaning system should be installed, frequent cleaning should be done. It is recommended to change or rehabilitate the fuel. Use a special filter for HCl emission. Cl > 0.3wt% (d.b.): It is recommended to use PCDD/F emission risk and activated carbon filter as an additional warning.
Ca CALCIUM	kg/kg	Ca > 35wt% (d.b.): There is a risk of low ash melting temperature. It is recommended to apply a water-cooled grate and a low combustion chamber temperature. There is often a need for cleaning the grate and boiler.
K POTASSIUM	kg/kg	K > 7wt% (d.b.): Low ash melting temperature, there is a risk of pollution, slag, corrosion, and aerosol formation. It is recommended to apply a water-cooled grate and a low combustion chamber temperature. Increase material thicknesses or apply coating in critical areas, install automatic cleaning system, need to clean the grate and boiler often. Special filter application and fuel reclamation are recommended
Zn ZINC	kg/kg	Zn > 0.08wt% (d.b.): There is a risk of unburned ash, pollution, high emission of particles. Heavy metal separation, ash recycling system, automatic cleaning system should be installed. The need for frequent cleaning of the grate and boiler occurs. Special filter application and fuel reclamation are recommended.
Cd CADMIUM	kg/kg	Cd > 0.0005wt% (d.b.): There is a risk of unburned ash, pollution, high emission of particles. Heavy metal separation, ash recycling system, automatic cleaning system should be installed. The need for frequent cleaning of the grate and boiler occurs. Special filter application and fuel reclamation are recommended.
TashM Fuel Ash Melting Temperature	C	TashM < 1100 °C: There is a risk of slag and high pollution. Automatic cleaning, water cooled grate, boiler with low furnace temperature and frequent grate and boiler cleaning are recommended.
Fuel with size (0-5 mm)	%	>10%: There is an increase in the amount of fly ash and a decrease in combustion efficiency.

5.5 Cleaning & Maintenance

The perfect reference for a boiler operator is a clean and well cared boiler room. Obtaining high efficiency and continuous operation depend on boiler's and boiler room's condition.

The cleaning and maintenance cost can be kept at a very low level by performing it correctly and frequently. If done so the boiler will have a very long operating life, high efficiency and return of the investment cost will take shorter time.

General cleaning Instructions:

- 1- All equipment that does not belong to the boiler room must be removed.
- 2- The clean water supply connection and drain connections must exist in the boiler room. The boiler shall be cleaned easily by water.
- 3- The boiler outer shell must be cleaned frequently to keep new and good appearance.
- 4- The control and safety equipment, bushings, flanges must be checked for leakage. If there is no water or steam leakage on any part of the boiler system, the boiler will be clean all the time as there will be no salt, dirt formation or calcification at any part.
- 5- The manholes and flanges must be tightened at least every two months to prevent leakages.
- 6- Front door, burner connection flanges and rear explosion door can be used to clean the gas parts of the boiler.
- 7- If soot layer is less than 0,5 mm, you may leave it. Thicker soot / dirt must be cleaned with special boiler tube brush. The soot inside the tubes decreases the boiler efficiency too much.

- 8- Due to fuel composition and operational conditions, hard layers of soot and sulfur formation may be observed. As these layers are dangerous for boiler materials, they must be cleaned as soon as possible. Cleaning with boiler tube brush shall not be enough for hard layers, a special electric cleaning equipment or movable head cleaning machines can be used.
- 9- Grease oil like molykote must be applied on bolts and nuts before closing the front doors, after cleaning.
- 10- The inlet (return) valve connection nozzle at the back bottom of the boiler can be used to inspect water side of the boiler. There may be additional hand holes on the boiler too. Please refer to the technical file of the boiler and consult to Akkaya Technical Team for further information. Before opening the handholes or any inspection nozzle the steps described in "5.2 - Shutdown & Discharging" section must be completed. Prepare gaskets before opening the hand holes and change the gaskets each time you open these ports. The mud and scale at the bottom of the boiler must be cleaned and washed through these handholes.
- 11- There may be manholes on your boiler. These openings are also used to observe scale formation and sediments on the water part of the boiler. For interior inspection of the boiler Manholes are used. Manholes are heavy accessories. The operator must be very careful during handling these manhole covers. The manhole cover's weight is approximately 30-40 kg. The gasket of these manholes is special. Before attempting to open a manhole be sure to prepare at least 2 spare gaskets. Before opening the manholes, the steps described in "5.2 - Shutdown & Discharging" section must be completed. The doors/covers of manholes must be produced to face the sides of the manhole port with the letting no cavity. Before placing the gaskets, gasket's sockets must be cleaned up and the gaskets must be pulled in the sockets. The space between gaskets and their sockets must be equal in every side. Gaskets of the doors must be tightened equally and gradually. High quality gaskets with graphite or the gaskets advised by Akkaya Technical Service must be used.
- 12- Even just very thin layer like 1 mm of scale/lime on the water side of the boiler, not only drops the efficiency but also causes extra heating of the materials. It must be cleaned with pressurized water. If you fail to get rid of all the lime, chemicals can be used for cleaning.
- 13- If proper water is fed to the boiler, lime formation on the heating surfaces will not occur. In normal conditions the system's water must not be renewed or fresh water must not be added to the system. New water addition can only be considered because of leakages or repair works.
- 14- While filling the system with water antifreeze liquid addition must be considered. Type selection and the mixing rate of this antifreeze liquid must be determined by technical consultant.
- 15- Special filters, air separators mixing tanks must be specified and chosen by the system designer. This equipment increases the lifetime and efficiency of the system.
- 16- Feed water must always be checked for oil content. Oil content in feed water must strictly be avoided.

5.5.1 Automatic Cleaning of Smoke Pipes

In some boilers the automatic tube cleaning is installed as an optional equipment. The operation principle is cleaning the smoke tubes by blowing high pressure air. The air must be supplied at 8 bars. There must be an air storage tank of minimum 2000 l and a compressor capable of making 200 l/min air.

The solenoid valves connected to the cleaning tubes must be airtight and must not leak.

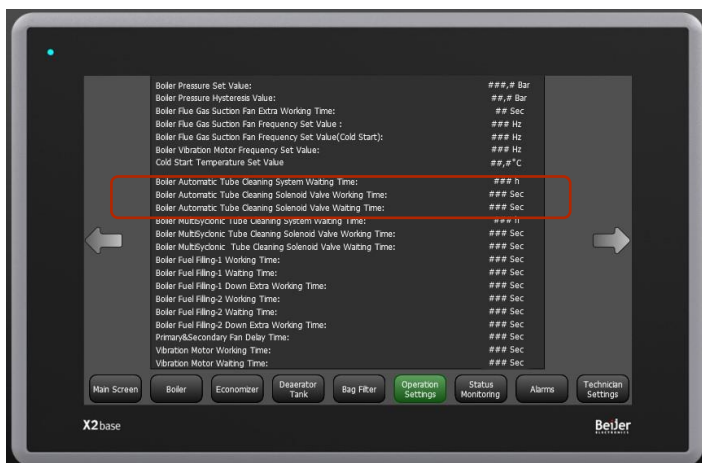
As a sample operation; the steps to be followed for the automatic air cleaning system is explained below. The screen design and the menu of the controller may vary due to system model but the principle is the same. Please follow the instructions on the screen and consult Akkaya technical service for correct setup.

- 1- The control system has a function of making the automatic cleaning system active and passive on the operation settings page. If the active button is pressed (the boiler must be in operation condition), the waiting time pre-set on the operating settings page starts to count. When the time expires, the pulse valve operates during the specified working time. And while it waits during the specified waiting time, the other pulse valve continues to operate and all pulse valves work in turn until the automatic cleaning is completed.
- 2- When the inactive button in the automatic cleaning section on the operation page is pressed, the time counter will not start, so automatic cleaning will not work.
- 3- When the automatic tube cleaning manual button on the "work settings" page is pressed, the cleaning starts and continues in order. After the process is completed, the button becomes passive.



- 4- In the operation settings page, the working time is determined in seconds and the waiting time is determined in hours, and automatic cleaning is performed according to the specified times.

Note: The waiting time between the operating intervals of the pulse valves should be adjusted according to the volume of the air tank and capacity of the compressor in order to provide high pressure air during the whole cleaning sequence.



5.5.2 Manual Cleaning of Smoke Pipes



When the smoke pipes are not cleaned as shown in the picture on the left side, soot may form and this reduces the efficiency of the boiler. In order to avoid this, firstly, the front covers should be opened and the smoke pipes should be cleaned one by one until no soot is left inside smoke pipes.



Even if it is automatically or manually cleaned, the soot that is pushed by air or by brush will accumulate in the rear smoke box. The rear smoke box must be cleaned by opening its hand holes and all the exhaust way from boiler to chimney must be free and clean.

5.6 Protecting The Non-Operating Boiler



If the boiler is not going to be used longer than one week, the following process must be carried out to prevent rust and corrosion formation.

- 1- Smoke pipes and smoke side of mirror plates must be cleaned at a boiler temperature of approximately 40 ° C.
- 2- All smoke surfaces of the boiler must be cleaned with oil to prevent direct air contact.
- 3- The air at the smoke side of the boiler must be dry. This can be achieved by putting air drier chemicals inside the boiler.



When the boiler is out of service, corrosion formation can take place faster than an operating boiler. If there is water with a little alkali content in the boiler, rust and corrosion occurs quickly. If precautions are not taken, corrosion will keep on forming, even when the water is discharged completely. Corrosion can only be prevented if there is NO water in the boiler and the oxygen attack to the metal surfaces are prevented when it is NOT operating.



If the boiler will not be operated for a long period and it will be disconnected from the system, it must be kept free of water. The following steps must be followed.

- 1- Boiler water must be discharged through drain valve.
- 2- All inspection ports (manholes and handholes) must be opened and controlled whether inside of the boiler is dry or not. It must be dried if still wet.
- 3- The pots of diminished lime and calcium chloride must be put in the boiler. These pots must be discharged in every three months.
- 4- To eliminate the rest of oxygen in the boiler, a firing pot with oil-lamp and firewood must be placed in the boiler.
- 5- All inspection ports and valves must be closed.
- 6- Holes, flanges, and valves must be tightly closed and double checked to prevent leakage.

5.7 Boiler Water Quality

The possible risks and their results are:

- 1- Lime or scale formation on the boiler surface because of water hardness. This may cause safety failures, heat transfer difficulties, efficiency loss, heat deposition and non-operating boiler.
- 2- Thin layers of oil and organic material on the boiler's heating surface can cause excessive heat in the boiler.
- 3- Free oxygen and free carbon dioxide weaken the boiler material and cause corrosion.
- 4- High organic components quantity causes foam formation, and this foam carries organic substances. When evaporation starts particulate deposition and transfer will occur in the pipelines and equipment which will end up with blockings and breakdowns.



Proper water according to EN12953-10 must be used for generating hot/superheated water.



MANUFACTURER'S GUARANTEE SHALL BE VALID IF ONLY CUSTOMER CARRIES OUT THE RESPONSIBILITY TO PROVIDE PROPER FEED WATER CONDITIONS.

APPENDIXES



APPENDIX 1 -SAMPLE DAILY CONTROL CHART

Observation and testing	Clauses Ref. EN 12953-6	Daily *	1 month	3 months	6 months	12 months	Remarks
Safeguards against excessive pressure (safety valves)	4.1	O			T		-
Water level indication	5.1	T					Compared with limiters and controls
Drain and blow-down devices	4.6	T					-
Valves	5.3	O			T		As per manufacturer's operating instruction
Feed water control	5.5	O			T		-
Low water protection	5.6.1	O	T				Functional check by lowering the water level to the switching points
Boiler pressure and temperature indication	5.2	O					Compared with limiters and controls
Pressure limitation	5.6.2	O	T				Functional check by increasing the pressure to the switching points
Temperature limitation	5.6.3	O	T				
Devices for water quality protection	4.8	O	T (1)		T(2)		(1) Comparison of the measured values with the reliable samples (see 4.7.2 of EN12953-6) (2) Performed by a suitably qualified and competent person
Protective device	4.3	O			T(3)		(3) Electrical and mechanical testing performed by a suitably qualified and competent person
Pressure parts (pipes, inspection openings, flanges, gaskets, joints...)			O				
Pressure controller and temperature controller	4.4.1	O			T		
Feed water supply	5.4	O		T			
Water quality	4.7	T(4)					(4) see EN 12953-10:2003
Energy Supply	4.4	O				T(5)	Performed by a suitably qualified and competent person as per operating instruction but not less than once a year.

(O) Observation of abnormal noises, smells or other noticeable factors.

(T) Checking and/or testing the functional behavior of equipment parts, including observation.

* In the standard it is written as 72 hours, Akkaya Boilers strictly recommends these controls to be done DAILY.

A daily control chart must be recorded and kept by the operator of the boiler. If the daily controls are not done and recorded properly manufacturer's guarantee will be invalid. A safe and efficient operation of the boiler can be sustained by making these controls.

APPENDIX 2 - WATER QUALITY REQUIREMENTS

ICS 13.060.25; 27.060.30;
27.100

TS 377 10
EN 12953-10 JANUARY 2006

Table 5-1 — Feedwater for steam boilers (except attemperator spray water) and hot water boilers				
Parameter	Unit	Feed water for steam boilers		Feed water for warm water boilers
Working pressure	bar (= 0,1 MPa)	> 0,5 - 20	> 20	Total interval
Appearance	-	clear, free from suspended solids		
Direct conductivity 25 °C	µS/cm	not specified, only guide values relevant for boiler water see table 5-2		
pH value at 25 °C*	-	> 9,2**	> 9,2**	> 7,0
Totalhardness (Ca + Mg)	mmol/L	< 0,01***	< 0,01	< 0,05
Iron (Fe) concentration	mg/L	< 0,3	< 0,1	< 0,2
Copper (Cu) concentration	mg/L	< 0,05	< 0,03	< 0,1
Siliciumdioxide (SiO ₂) concentration	mg/L	not specified, only guide values for boiler water relevant, see table 5-2		-
Oxygen (O ₂) concentration	mg/L	< 0,05****	< 0,02	-
Oil/ grease concentration (see EN 12953-6)	mg/L	< 1	< 1	< 1
Organic substances (as TOC) concentration	-	See Footnote *****		

* pH must be in between 8,7 - 9,2 for copper alloys.

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

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

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

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

ICS 13.060.25; 27.060.30;
27.100

TS 377-10
EN 12953-10 JANUARY 2006

Table 5-2 — Boiler water for steam boilers and hot water boilers					
Parameter	Unit	Water for steam boilers			Boiler water for hot water boilers
		Feed water direct conductivity > 30 µS/cm		Feed water direct conductivity 30 µS/cm	
Working pressure	bar (= 0,1 MPa)	> 0,5 - 20	> 20	> 0,5	total range
Appearance	-	clear, no stable foam			
Direct conductivity at 25 °C	µS/cm	< 6000 - (a)	Şekil 5.1-(a)	< 1500	< 1500
pH value at 25 °C	-	10,5 to 12,0	10,5 to 11,8	10,0 to 11,0 (b,c)	9,0 to 11,5 (d)
Composite alkalinity	mmol/L	1-15 (a)	1-10 (a)	0,1 to 1,0 (c)	< 5
Silica (SiO ₂) concentration	mg/l	pressure dependent, according to figure 5-2			-
Phosphate - PO ₄ (e)	mg/l	10 to 13	10 to 30	6 to 15	-
Organic substances	-	see footnote (f)			-

a- With superheater consider 50 % of the indicated upper value as maximum value.

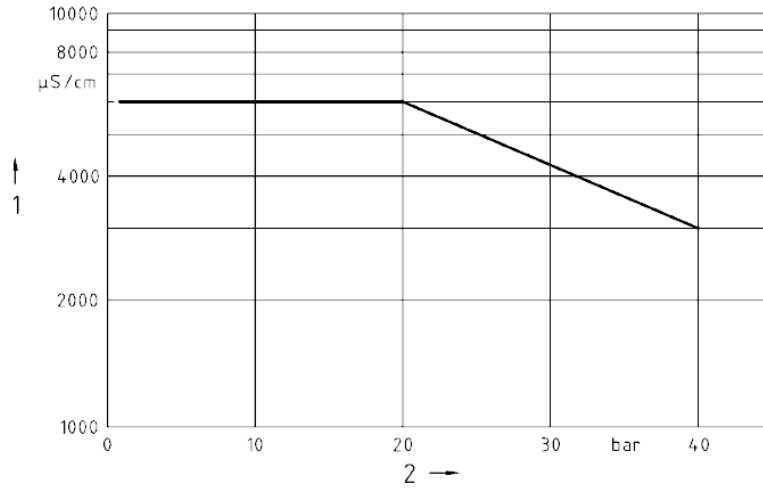
b- Basic pH adjustment by injecting Na₃PO₄, additional NaOH injection only if the pH value is < 10.

c- If the acid conductivity of the boiler feedwater is < 0,2 Na + K concentration is < 0,010 mg/l, phosphate injection is not necessary. Under the conditions AVT (all volatile treatment, feedwater pH 9,2 and boiler water pH 8,0) can be applied, in this case the acid conductivity of the boiler water is < 5

d- If non-ferrous materials are present in the system, e. g. aluminium, they may require lower pH value and direct conductivity, however, the protection of the boiler has priority.

e- If coordinated phosphate treatment is used; considering all other values higher PO₄-concentrations are acceptable (see also clause 4).

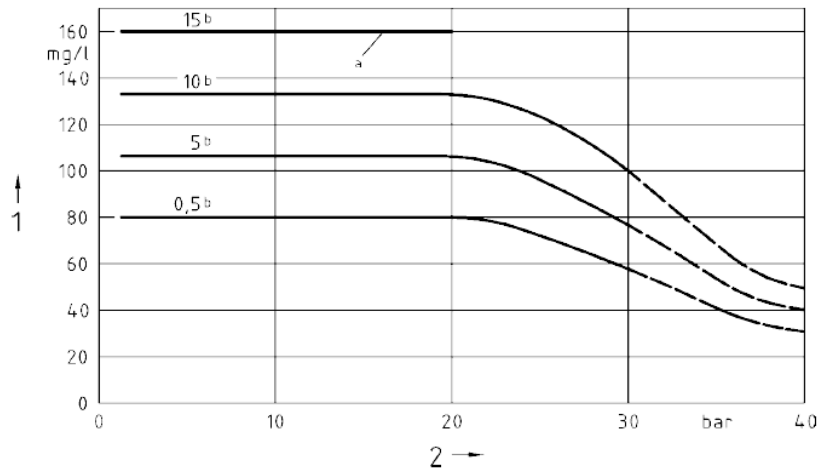
f- See e in table 5-1.



1: Direct Conductivity

2: Operating Pressure

Chart 1.1 Maximum acceptable direct conductivity of the boiler water dependent on the pressure; feedwater direct conductivity $\geq 30\mu\text{S} / \text{cm}$



1: Maximum silica content

2: Operating pressure

a) This level of alkalinity is not permissible ≥ 20 bar

a) Alkalinity in mmol / l

Chart 1.2 Maximum acceptable silica content (SiO₂) of the boiler water dependent on the pressure

APPENDIX 3 - DIMENSION TABLE OF HWB MODEL BOILERS

Model	Maximum Thermal Capacity (kcal/h)	Minimum Water Flowrate ($\Delta T 20^{\circ}C$) (m ³ /h)	Length (mm)	Width (mm)	Height (mm)	Weight (kg)
HWB750	633.900	32	6000	2160	3110	9800
HWB1000	854.400	43	7500	2160	3110	11500
HWB1250	1.100.800	55	8850	2160	3310	13750
HWB1750	1.511.600	76	8500	2610	3600	18000
HWB2000	1.736.000	87	9000	2610	3600	19500
HWB2250	1.946.200	98	9500	2610	3600	20600
HWB3000	2.634.200	132	9500	2810	3750	27750
HWB3500	3.021.800	151	10100	2810	3750	30100
HWB4000	3.538.500	177	10900	2810	3750	32700
HWB4750	4.088.500	205	12100	3200	3950	39300
HWB6000	5.101.600	255	13200	3200	3950	45300
HWB7000	6.113.600	306	16250	3200	4950	53800
HWB8000	7.178.100	359	18450	3200	4950	60500
HWB9000	8.025.400	402	17000	3600	5250	70000
HWB10000	9.024.800	452	18300	3600	5250	75500
HWB11000	10.037.090	502	18000	3800	5750	82000

Akkaya keeps the right to make modifications and changes in the design and dimensions. For the exact dimensions and design information of your boiler please refer to the technical file provided by Akkaya.

APPENDIX 4 - SYSTEM ACCESSORIES AND AUXILIARY EQUIPMENT EXPLANATIONS

The accessories and auxiliaries explained here may be different than the configuration you have purchased. To be sure about your equipment scope please refer to P&ID and item list provided to you by Akkaya.

APPENDIX 4.1 - COMBUSTION SYSTEMS

HWB Boilers can have different types of combustion and fuel feeding systems. The common systems installed by Akkaya Boilers are "Under Feed Stoker System", "Water Cooled Vibrating Grate System" and "Fixed Grate Manual Feeding System."

4.1.1 UNDERFEED STOKER SYSTEMS



Figure Ap. 4.1.1.1 Underfeed Stoker System on The Boiler

In underfeed stoker systems solid fuels are transferred to the combustion chamber by means of an auger. Akkaya Stoker systems have a two-stage transfer system. The fuel is transferred with a short auger to the secondary (longer) auger. By this system it is possible to keep the fuel transportation tube free of fuels to prevent backfire. The fuel is fed to the stoker's fuel pot inside the combustion chamber. The combustion occurs at the top of this fire pot. Stoker number and capacities are selected according to boiler model and capacity.

Stoker bodies are manufactured from special alloy cast iron slices. These replaceable slices are resistant to high temperatures.

The stokers have fire extinguishing and backfire prevention system. There is a mechanical safety thermostatic valve which opens automatically when its sensor reaches to 90° C. It is installed on the fuel transfer tube. There is also an electrical thermostat which operates the secondary auger to empty the fuel transfer tube when high temperature is detected.

Bunker fuel level control automation is available upon request. Fuel mixing arms or airlocks are also optional equipment that can be selected according to the fuel type.

Primary and secondary air fans are provided for homogeneous and optimum combustion. Primary fans are installed on the stoker. Secondary fan is installed on the boiler's front chamber sides.

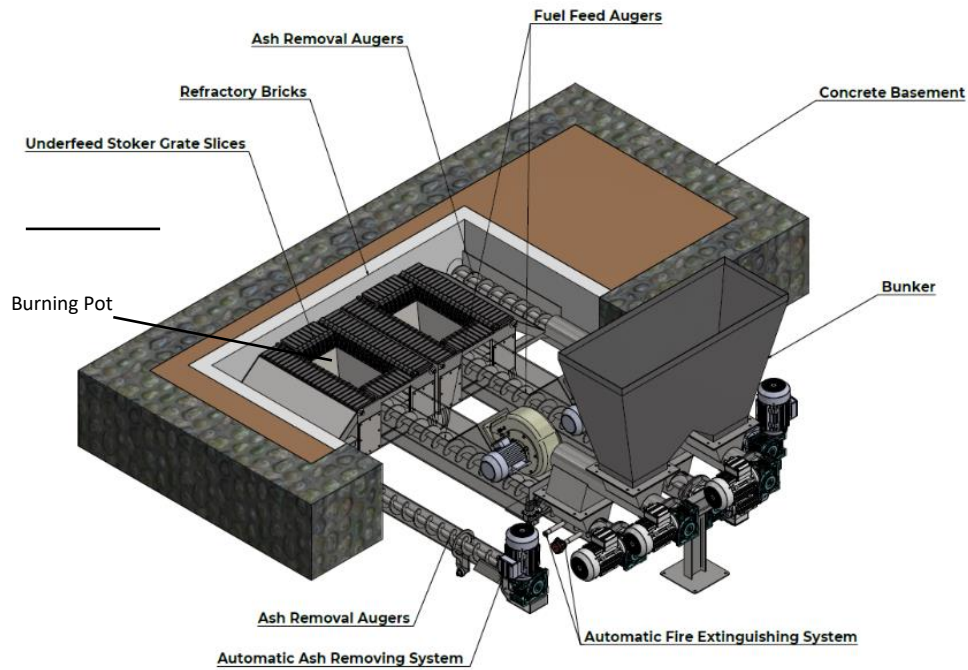


Figure Ap. 4.1.1.2 Underfeed Stoker System Components

The proper fuel specifications for underfeed stoker:

Moisture:

The moisture level is suggested to be as low as possible (less than 5%) to obtain required power out of combustion. The moisture level can affect the particle structure of the fuel which is quite important for transportation with screw augers. The high moisture can cause slag formation and unburnt ash formation. Considering all these factors the moisture level must be kept below 30%.

Dimensions:

5-50 mm particle size.

200 – 1100 kg/m³ density

It should have a density and particle structure suitable for transportation with an automatic screw system. The fuel must not cause accumulation or bridge formation in the fuel bunker, it must easily fall from the screw. If bridge formation occurs inside the bunker, additional measures like mixing arm installation must be applied.

Calorific Value:

The preferred calorific values are within the range of; Min. 3000 kcal/kg Lower Calorific Value (LHV) – Max. 7500 kcal/kg (LHV). The boiler's combustion chamber volume design, stoker's surface area selection, fuel feeding rate, heat transfer surface area construction and steam output capacity of the boiler depend on the calorific value of the fuel. The calorific value changes by the moisture level and fuel's elementary structure. The correct selection of the fuel is quite important to get the required heat output.

Ash Content:

The chemical composition of the fuel and the structure of the ash should not allow slag formation. The ash melting temperature should be above 1000 °C. For normal operation, the ash content ratio by mass is recommended to be between 10% and 25%.

Please Check the Table at "Section 5.4 Precautions" to understand the effect of elements on fuel composition.

Fuel Feeding and Ash Removal Adjustments of the Underfeed Stokers

The following recommendations should be considered to achieve good combustion in underfeed stokers.

- a) If the fuel dimensions and characteristics are as recommended (such as pellets), the fuel feeding and waiting time should be adjusted so that the fuel remains around 5 cm from the edges of the pot surface. A smooth curved pattern of fuel pile on top of the pot as seen at below pictures must be reached.

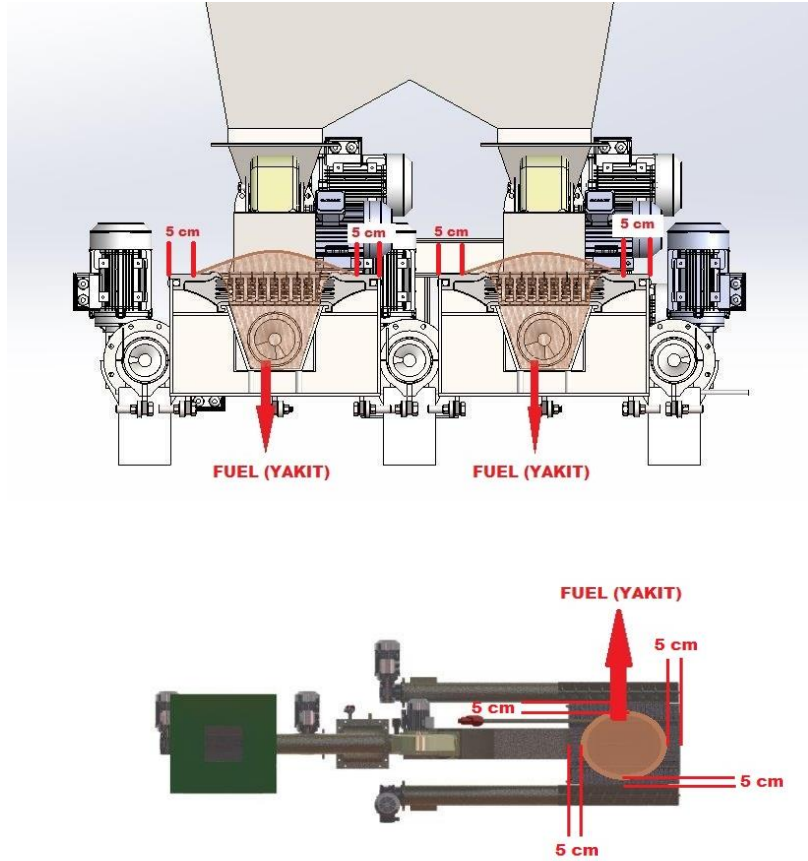


Figure Ap. 4.1.1.3 Fuel Distribution on The Stoker Pot

- b) If the fuel has a lighter and more volatile structure than the recommended properties (this type of fuel is not recommended), the fuel should be burned by trapping it in the filling chamber of the stoker pot. Fuel level should be 3-5 cm below the pot surface.

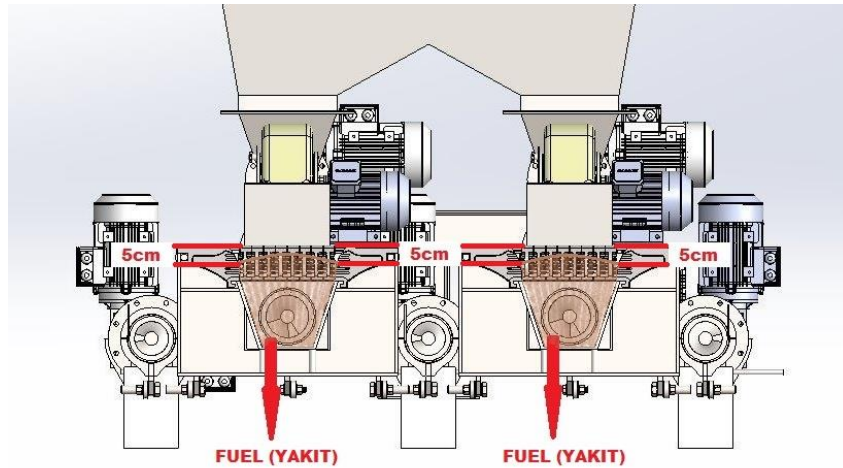


Figure Ap. 4.1.1.4 Fuel Distribution of Light Fuels on The Stoker Pot

- c) If there is automatic ash removing system to protect the ash remover screws from unburned fuels and high temperature, the ash in ash extraction systems should always be kept 5 cm above the ash carrying screws (augers). Ash discharge dampers should be checked frequently to ensure that they are fully closed. If any ash and slag are trapped in the covers of these dampers, they must be cleaned manually. If the dampers are not fully closed, air enters the ash removing system and causes burning and deformation in that area. In addition, the air sucked from the ash damper also disrupts the air/fuel adjustment in the boiler combustion chamber. Ash discharge is of great importance. If ash accumulates excessively, there is a possibility of slag forming.

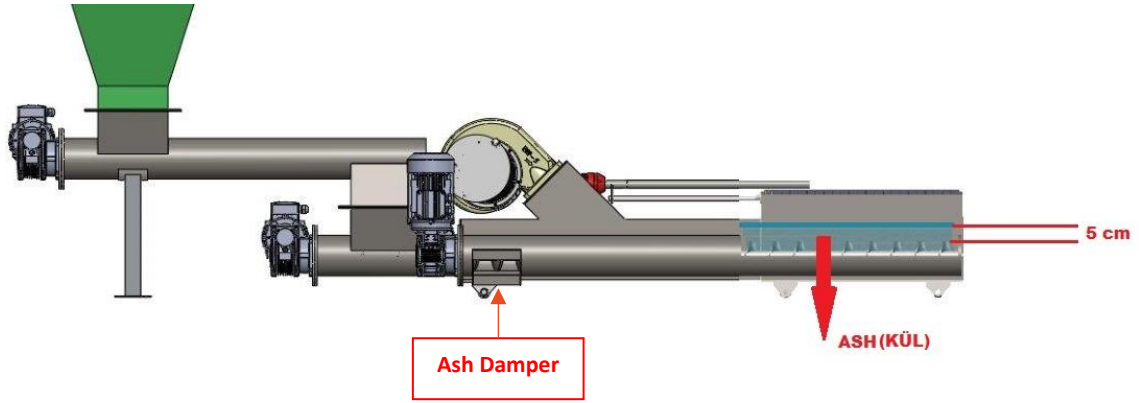


Figure Ap. 4.1.1.5 Ash Removing System

- d) To prevent the fire from flowing back towards the bunker, the two-stage feeding must be operated in a manner to ensure that the fuel in the second stage is completely discharged. This is done that way; when the system (boiler) will go to a standstill, the second stage screw must operate 10 more seconds than the first stage screw. (This period may vary depending on the design of the system). Akkaya Technical Service must be consulted for proper adjustment.

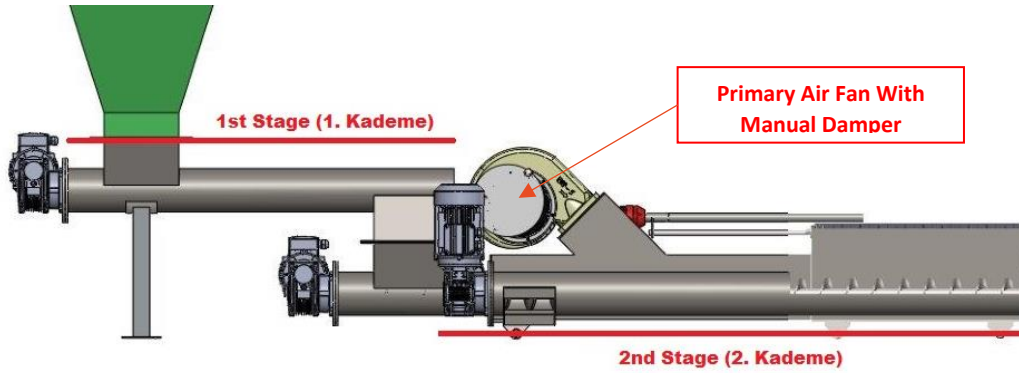


Figure Ap. 4.1.1.6 Fuel Feeding System Stages & Primary Air Fan

- e) The adjustment of the air sent to the combustion chamber by the primary and secondary air fans is done by the manual flaps on the fans. While the primary air fan is located on the stoker, the secondary air blower is a unit that is directly connected to the boiler body and is separate from the stoker. The outlet of the primary air fans has an automatic damper for safety. This air damper is controlled by means of a pneumatic actuator. This damper opens when the primary air fan is activated and closes when the fan is disengaged. When it is in the closed position, air entry into the combustion chamber is blocked. By this way, unwanted combustion is prevented.

Stoker Installation & Basement Preparation

Installation preparation for the underfeed stoker must be done by consulting with Akkaya Design Team. A sample photo of a basement preparation can be found below.



As the solid fuel burning and fuel feeding systems are designed specifically according to the customer's requests, additional information from Akkaya technical team must be asked for each system design.

4.1.2 WCVG – WATER COOLED VIBRATING GRATE SYSTEMS



Figure Ap. 4.1.2.1 WCVG – Water Cooled Vibrating Grate System Under HWB Boiler

WCVG is one of the newest technologies used in the combustion of various types of solid fuels. The principle is to move the fuel on the grate with the effect of vibration created by a vibro-motor.

With the water-cooled grate area, fuels with low melting temperature can be burnt. The system provides flexibility in burning a wide range of solid fuels and biomass types.

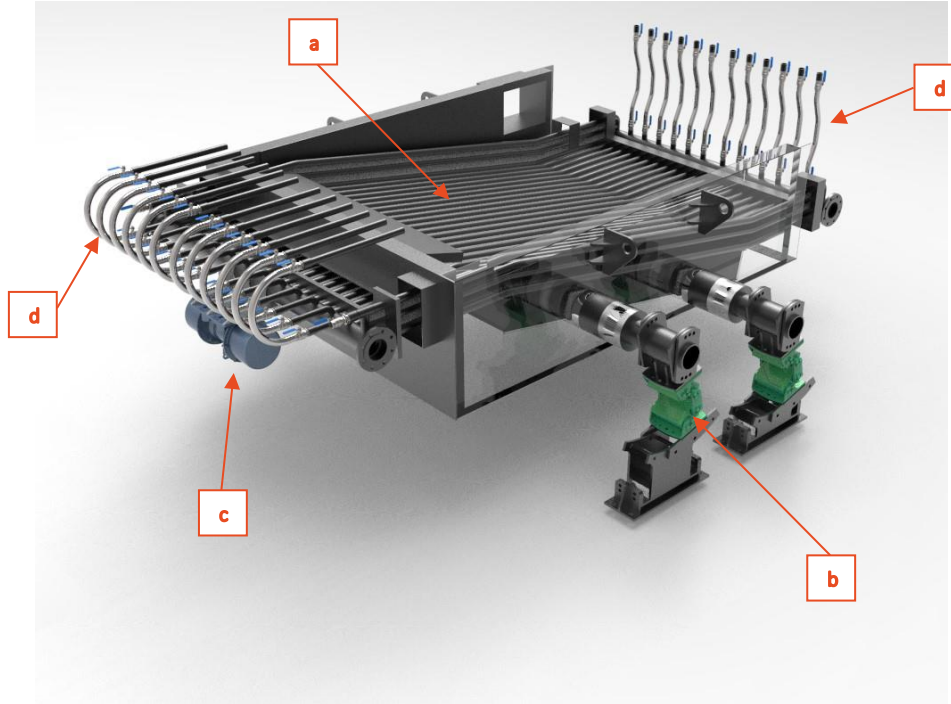


Figure Ap. 4.1.2.2 WCVG – Water Cooled Vibrating Grate Components

The WCVG system main components are,

- a) Grate with membrane wall tubes: The membranes have air injection holes to supply primary air under the fuel bed. The grate is the surface that fuel completes its combustion. The grate is installed with a minimum inclination to help the movement of the fuels from top to bottom.
- b) Oscillation elements: These elements can be ready made oscillating elements with special rubber cords, leaf springs or spiral springs. The type of the oscillating element depends on the design. Detailed information can be obtained from Akkaya Technical Service. The oscillating elements used to give direction to the fuel feed.
- c) Vibration motor: The vibration motor can be one piece or at multiple numbers. In some applications instead of vibration motor, a mechanical cam system can be used to give the vibration movement.
- d) Water loop connection hoses with valves: These hoses or tubes are used to provide water circulation inside the grate tubes. The water loop can be connected to the boiler's own water circuit or to an external cooling loop.

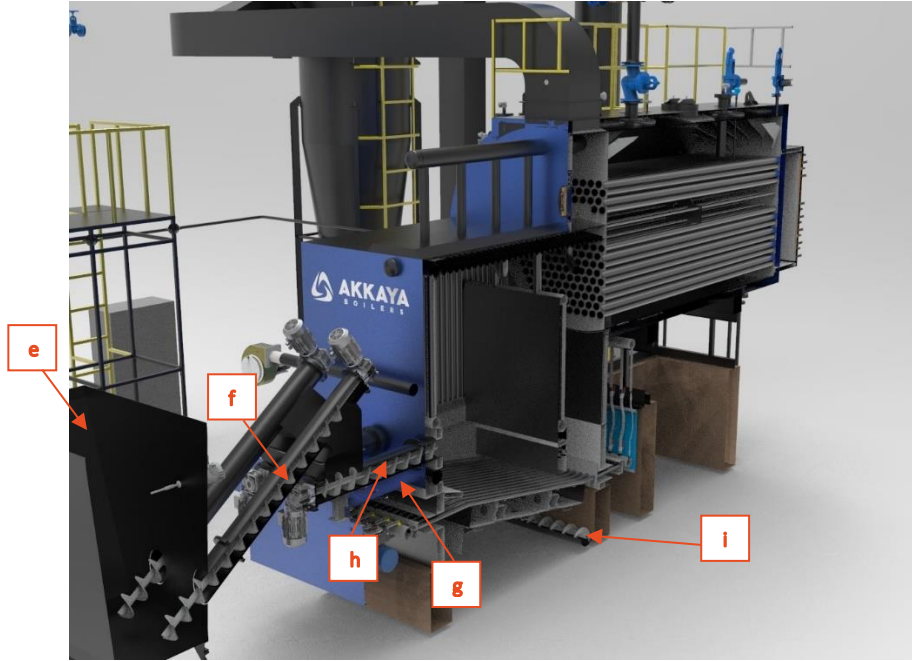


Figure Ap. 4.1.2.3 WCVG – Water Cooled Vibrating Grate Components

- e) Fuel bunker: As an option the fuel bunker can be supplied with level controller and fuel mixer.
- f) First Stage Auger: First stage screw feeder line.
- g) Second Stage Auger: Second stage screw feeder line.
- h) Fire extinguisher thermostatic valve.
- i) Ash remover

The proper fuel specifications for WCVG:

Moisture:

The moisture level is suggested to be as low as possible (less than 5%) to obtain required power out of combustion. The moisture level can affect the particle structure of the fuel which is quite important for transportation with screw augers. The high moisture can cause slag formation and unburnt ash formation. Considering all these factors the moisture level must be kept below 30%. With WCVG it is possible to increase the combustion chamber's temperature to help to burn high moist fuels. If the fuel feeding and transport issues can be solved up to 50% high moist fuels can be burnt with a WCVG with a proper furnace design.

Dimensions:

Recommended dimensions for standard WCVG have 5-50 mm particle size.

With special feeding mechanisms and with changing the grate membrane design the particle size dimensions can be enlarged to (1 mm to 100 mm)

200 – 1100 kg/m³ density.

The fuel should have a density and particle structure suitable for transportation with an automatic system. The fuel must not cause accumulation or bridge formation in the fuel bunker, it must easily fall from the screw/feeder. If bridge formation occurs inside the bunker, additional measures like mixing arm installation must be applied.

Calorific Value:

The preferred calorific values are within the range of; Min. 3000 kcal/kg Lower Calorific Value (LHV) – Max. 7500 kcal/kg (LHV). The boiler's combustion chamber volume design, grate surface area selection, fuel feeding rate, heat transfer surface area construction and steam output capacity of the boiler depend on the calorific value of the fuel. The calorific value changes by the moisture level and fuel's elementary structure. The correct selection of the fuel is quite important to get the required steam output.

Ash Content:

The chemical composition of the fuel and the structure of the ash should not allow slag formation. The ash melting temperature should be above 900 °C. For normal operation, the ash content ratio by mass is recommended to be between 10% and 25%.

Please Check the Table at "Section 5.4 Precautions" to understand the effect of elements on fuel composition.

Fuel Feeding and Ash Removal Adjustments of the WCVG Systems

- a) WCVG systems are fed with time-controlled augers. Auger adjustments are determined according to the capacity of the boiler. To prevent the fire from flowing back towards the bunker. The two-stage feeding must be operated in a manner to ensure that the fuel in the second stage is completely discharged. This is done in that way; when the system (boiler) will go to a standstill, the second stage screw must operate 10 more seconds than the first stage screw. (This period may vary depending on the design of the system). Akkaya Technical Service must be consulted for proper adjustment.
- b) Fuel distribution should be adjusted to have a distribution as seen in the below figure. When the grate surface is divided into 3 sections, 1st section with 20 cm thick fuel bed is the fuel entrance and primary gasification section. 2nd section with approximately 10-5 cm thick is the section where the main combustion occurs. The 3rd section is the part of grate where the combustion is completed, and ash is formed.
- c) Vibration time should be determined according to fuel distribution. It is not preferred that the vibration motor works too fast and too much. (For example: It is appropriate to work for 10 seconds every 1 or 2 minutes). The less vibration amplitude and the less working frequency is the best operational condition. Increasing the vibration amplitude will cause mechanical failures to happen in a short time.
- d) If there is automatic ash removing system, to protect the ash remover screws from unburned fuels and high temperature, the ash in ash extraction systems should always be kept 5 cm above the ash carrying screws (augers). Ash discharge dampers should be checked frequently to ensure that they are fully closed. If any ash and slag are trapped in the covers of these dampers, they must be cleaned manually. If the dampers are not fully closed, air enters the ash removing system and causes burning and deformation in that area. In addition, the air sucked from the ash damper also disrupts the air/fuel adjustment in the boiler combustion chamber. Ash discharge is of great importance. If ash accumulates excessively, there is a possibility of slag forming.

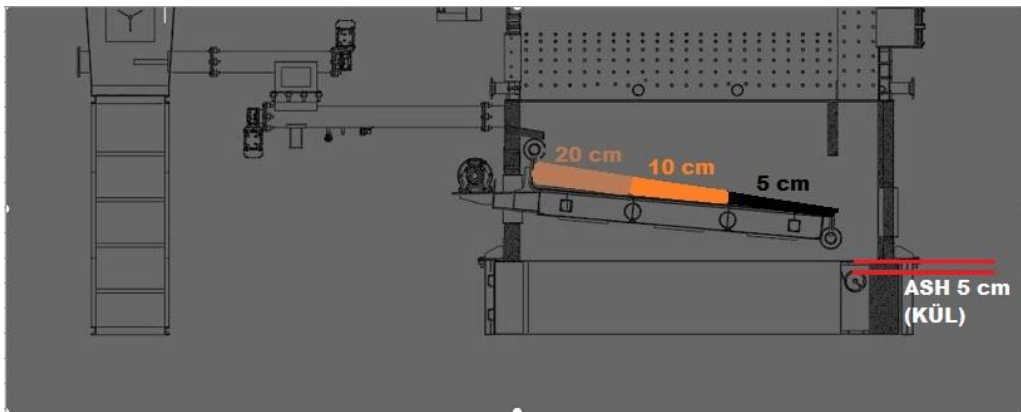


Figure Ap. 4.1.2.4 WCVG – Water Cooled Vibrating Grate Fuel Distribution

- e) WCVG bottom collector and hand hole must be checked and cleaned if scaling or mud accumulation occurs.
- f) The system's all bolts and nuts must be checked and tightened at least once in a month. These nuts can get loose due to vibration.
- g) The ash port and primary air holes must be kept clean always.
- h) The fuel / air adjustment and secondary air adjustment must be done by Akkaya Technical Service.
- i) The oscillating elements position and condition must be controlled during operation.
- j) Any unusual noise or vibration on the boiler or grate body must be reported to the Akkaya Technical Service.

4.1.3 MANUAL FEEDING FIXED GRATE SYSTEMS

The manual fed fixed grate systems can be used with HWB boilers. These systems preferred to burn fuels with dimensions up to 50 cm wood logs.

The fuel characteristics other than dimensions are similar with the fuels used in under feed stokers. (Please see; **The proper fuel specifications for underfeed stoker on 4.1.1**)

The grates are cast iron grates the air gaps at the grates are about 20 mm, that's why fuels with dimensions less than 25 mm cannot be burned in these systems.

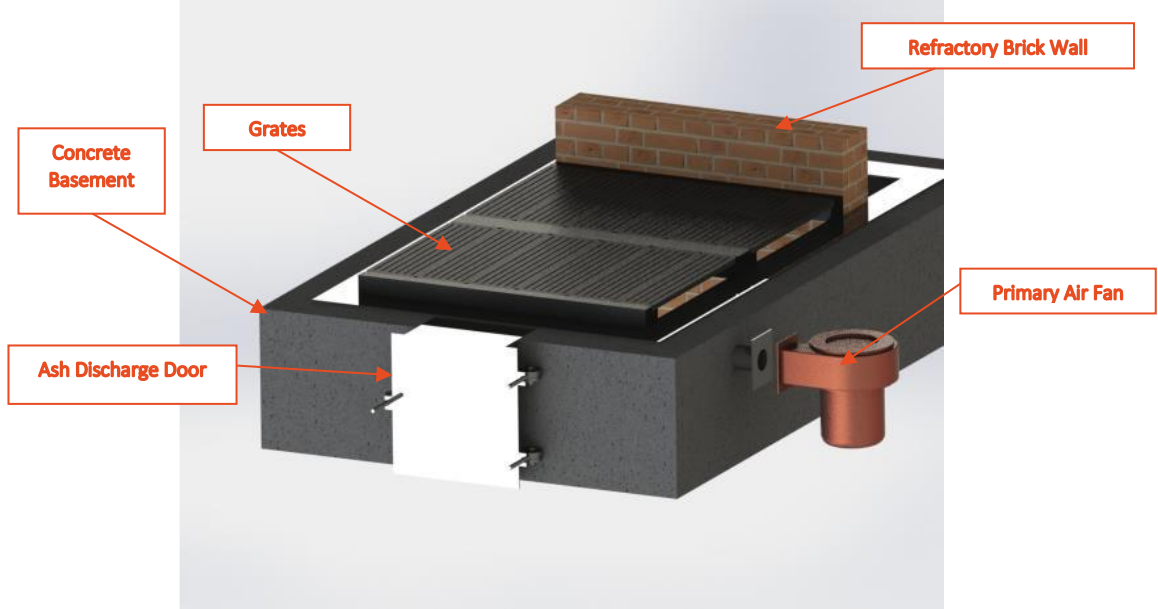


Figure Ap. 4.1.3.1 Fixed Grate Components

The fuel bed height must not be thicker than 200 mm on the grate. If the bed is too thick the primary air cannot pass through the fuel and the combustion cannot be completed.

Feed the fuel from front door by moving the ashes on the grate to one side. Do not feed the new fuel onto the burning fuel. This will cause an increase in CO amount.

The ashes under the grate must be cleaned daily. The air passages on the grate must always be kept clean and open.

As the feeding is done manually in case of an emergency or alarm situation the fire on the grate must be taken out quickly by operator. The air fan can be stopped by the control system but the fire on the grate can go on that's why operator's intervention is necessary.

4.1.4 AUTOMATIC IGNITION SYSTEM

In some combustion systems automatic ignition system can be supplied as an optional accessory. This system is basically a hot air supplier. The hot air blower creates air around 600° C to start the ignition of the fuel. The fuel's structure must be suitable for ignition around 500° C. The air supply of the blower continues during combustion to keep the ignitor safe. The dust accumulation at the air intake of the blower must always be clean. If dust accumulates in the ignition blower the heating resistance of the item burns out and gets damaged. The blower's motors contact carbons must be replaced after 2000 working hours.



Figure Ap. 4.1.4.1 Automatic Ignition Blower

APPENDIX 4.2 Boiler Exit&Return Valves

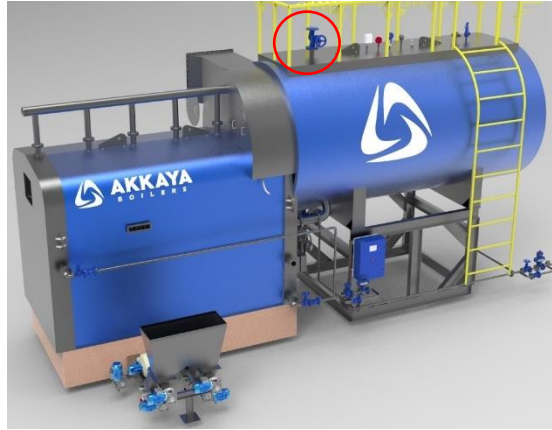


Figure Ap. 4.2 Water Exit and Return Valve Positions on The Boiler

Return and Exit valves are selected according to the flow rate and pressure of the hot/superheated water circulation. The valve at the back bottom side of the boiler is return valve (inlet) and the valve at the front top is the exit valve.

APPENDIX 4.3 Drain and Water Filling Valves

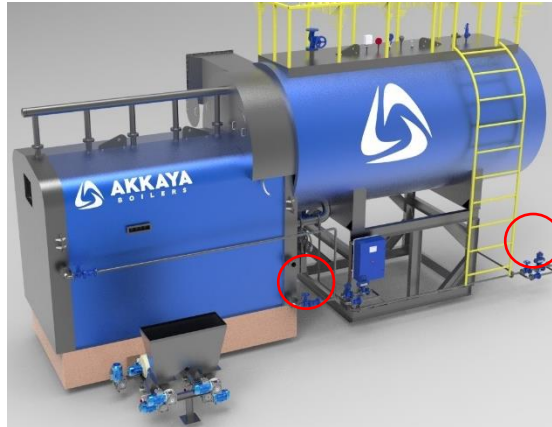


Figure Ap. 4.3 Drain and Water Filling Valves

Boiler drain valve is used to drain water from boiler when needed. Boiler water filling valve allows water to enter the boiler.

APPENDIX 4.4 Air Discharge Valve



Figure Ap. 4.4 Air Discharge Valve

Air discharge valve is used to release air from boiler.

APPENDIX 4.5 Pressure Switches



Figure Ap. 4.5 Pressure Switches

At least one pressure switch for alarm and safety must be installed on the boiler. The set value interval of the pressure switches must be proper for the maximum operating pressure of purchased SKK model. The pressure switches can be used for low pressure alarm and high-pressure alarm.

The pressure switches must be connected onto a siphon (or omega) type tube. This prevents the pressure switch to get harmed by high temperature and sudden pressure hit. Some water is added into the siphon before connecting the pressure switch.

APPENDIX 4.6 Pressure Transmitter

Pressure transmitter is used to convert the measured pressure to an electrical value (4-20 mA).

Pressure transmitter sends the pressure value information to the main board to regulate the burner's operation during pressure alarms.

The pressure transmitters must be connected onto a siphon (or omega) type tube. This prevents the pressure transmitter to get harmed by high temperature and sudden pressure hit. Some water is added into the siphon before connecting the pressure transmitter.

APPENDIX 4.7 Manometer & Manometer Valves



Figure Ap. 4.7 Manometer & Manometer Valves

Manometers with valve is used to observe the pressure of the boiler. The recommended minimum diameter of the manometers is 100 mm. The scale of the manometer must be able to show maximum working pressure of the boiler. A valve with drain outlet is used under the manometer. The manometers must be connected onto a siphon (or omega) type tube. This prevents the manometer to get harmed by high temperature and sudden pressure hit. Some water is added into the siphon before connecting the manometer.

APPENDIX 4.8 Temperature Switch

Temperature switch controls the alarm for high temperature of the boiler.

APPENDIX 4.9 Boiler Temperature Sensor

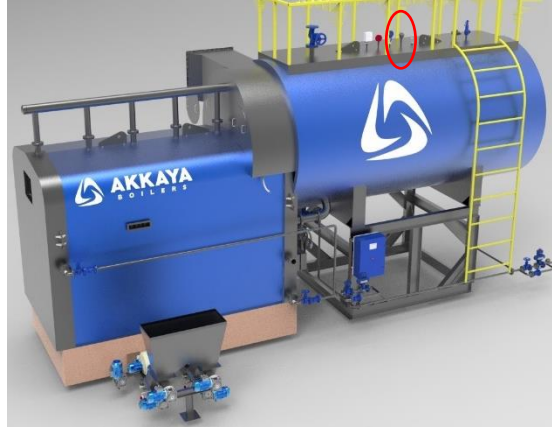


Figure Ap. 4.9 Temperature Sensor

HWB model boilers' control panel is equipped with a digital heat indicator and alarm system, receiving the heat value by the help of a thermocouple placed on the boiler top. This heat controller gives signal to the burner for operation. It is also a safety device. It saves the boiler from getting damaged by low or high temperature. For low temperatures (less than 5 °C) there is always a risk of ice formation inside the boiler or inside the control & safety accessories. In such cases this controller shuts down the burner. In some applications the temperature set value adjustment must also be done from burner's controller too. Please consult Akkaya Technical Service for accurate information about your boiler control system.

For high temperature there is a risk of low water level in the boiler. This is quite hazardous. In this case this controller stops the burner.

APPENDIX 4.10 Exhaust Gas Temperature Sensor

HWB boilers' control panel is equipped with a digital heat indicator and alarm system, receiving the heat value by the help of a thermocouple that is placed between chimney and boiler. This heat controller is a safety device.

Received temperature information is used to understand the heat loss from boiler. In case of lime or slag formation inside the boiler, the stack temperature increases. In this case smoke tube cleaning and water parts cleaning must be carried out. Also, low water case can cause high stack temperature. This sensor stops the burner and prevents water pumps to operate if the alarm value is reached.

APPENDIX 4.11 Boiler Thermometer

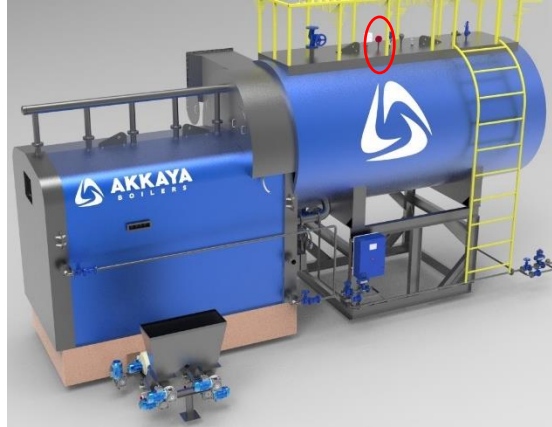


Figure Ap. 4.11 Boiler Thermometer

Thermometer is used to observe the temperature of the boiler. The recommended minimum diameter of the thermometer is 100 mm. The thermometer is connected to the boiler with a well, it is recommended to fill this well with water or oil in order to increase the heat transfer and to obtain better readings.

APPENDIX 4.12 Safety Valve



Figure Ap. 4.12 Safety Valve

The safety valve is designed to open and relieve excess pressure from boiler. The safety valves must be chosen according to EN12953-8 norm. The exit line of the safety valve must be taken to a safe area with a same or bigger diameter pipe with the valve's exit nozzle. The valve must be directly connected to the boiler or system without any shut off valve.

APPENDIX 4.13 Automatic Boiler Low Water Level Controller

In some boiler installations an automatic low water level control system is used for preventing water level inside the boiler from decreasing to a level lower than the set value on controller. Refer to P&ID and item list to learn about your system's components.

For the exact dimensions of the level probe please consult Akkaya Service. Do not try to adjust probe levels without supervision and approval of Akkaya Technical Service.

APPENDIX 4.14 Flow Switch

In some boiler installations a flow switch is used to ensure the circulation of water through the boiler. Refer to P&ID and item list to learn about your system's components.

APPENDIX 4.15 Electrical Control Board

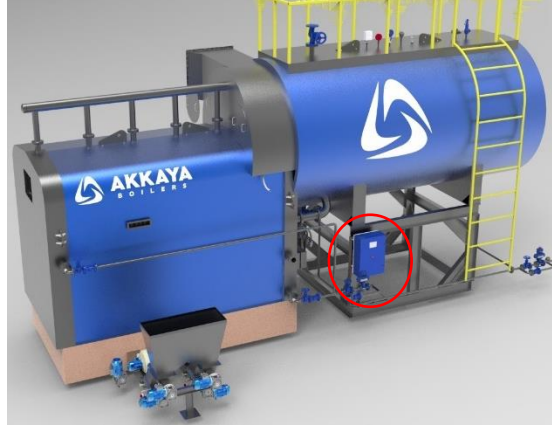


Figure Ap. 4.15 Electrical Control Board

A PLC board is provided in the standard package of HWB model boilers. The control board contains the boiler operation system, and the safety system controls.

There is an emergency stop button (can be increased in serial connections) to stop the whole operation in case of emergency or unexpected situations.

A hooter connected to board gives an auidial alarm signal in case of safety failures. Also, a flashlight on top of the board gives visual alarm.

A remote connection option is included in the control board by which Akkaya technicians can connect the boiler system remotely if customer provides a cable internet connection to the board.

A separate electrical control board manual and wiring diagram is provided by Akkaya for each purchased boiler.

APPENDIX 5 -BOILER CONTROL SYSTEM STANDARD ALARMS EXPLANATIONS

Boiler Water Low Level

If there is a water level controller on the boiler, this alarm turns on when the water inside the boiler is at a lower level than normal set level. When boiler gets into alarm position, fuel and air feeding stops. To operate the boiler again, MANUAL RESTART must be done. The causes of low water level must be investigated. (Faulty pump, lack of water in the system, blocked water feed line... etc.)

Low Temperature Alarm

This alarm turns on when the water temperature inside the boiler comes close to the freezing point (+5°C). In this case pumps and fuel feeding and air supply do not operate. After the ambient temperature rises and the ice inside the boiler is checked and safely eliminated, boiler can be operated by MANUAL RESTART.

High Temperature Alarm

Boiler high temperature alarm turns on in cases where the water temperature inside the boiler exceeds the set value. In this case pumps and fuel feeding and air supply do not operate. Boiler can be operated again by MANUAL RESTART after the temperature is decreased. Lack of water in the boiler may cause this situation. It must strictly be investigated by the authorized personal / service.

High Pressure Alarm

This alarm triggered by the pressure switch or by the pressure transmitter installed on the boiler. It turns on when the system pressure is higher than the pre-set value. In this case fuel feeding and air supply stops automatically. To operate the boiler again, after the pressure decreases to normal value, MANUAL RESTART must be done.



In high pressure cases fuel feeding and air supply automatically stops. But if the pressure continues to increase, safety valves automatically open and water is discharged until the pressure decreases to set value and alarm turns-off.

Low Pressure Alarm

This alarm triggered by the pressure switch or the pressure transmitter. When there is lack of water in the boiler and in the system, this alarm stops the fuel feeding and air supply.

Flow Alarm

This alarm triggered by the flow switch if the circulation of water through the boiler is less than the normal value. The faulty circulation pump or lack of water can cause this alarm.

Circulation Pump Operation

-Boiler 1. Circulation Pump On / Off must be "on" in normal operation.

-Boiler 2. Circulation Pump On / Off must be "off" in normal operation as stand-by.

In cases where "pump error" signals are on, faulty pump must be stopped manually and other one must be operated. The pump error signal comes from the motor protection thermic switch. It must be reset from thermic relay.

Hooter/ Siren Shutdown

It is for shutting down the voice of boiler controls. It only shuts down the voice alarms, signals continue to function.

Manual Restart Button

It is for deleting the alarm warning on the screen and to re-start the boiler. It aims to prevent the boiler's self, re-starting and forces the operator to go next to the boiler physically to see the alarm and take necessary actions.

ATTENTION: Information in this section is to give general idea to the operator, about boiler control board and main controls on it. The number of equipment, switches and controllers may vary according to the purchased configuration. The main source for reference shall be the special "electrical control board diagram" that is provided to the customer during the system installation.

PLEASE KEEP THE FOLLOWING DOCUMENTS WHICH HAS BEEN SUPPLIED BY AKKAYA IN A SAFE LOCATION DURING THE ENTIRE LIFETIME OF THE BOILER

- a. USER MANUAL**
- b. P&ID (PIPING AND INSTRUMENTATION DIAGRAM)**
- c. ITEM LIST**
- d. TECHNICAL FILE, INCLUDING CERTIFICATES**
- e. ELECTRICAL WIRING DIAGRAM WITH CONTROL ALGORITHM**

A COPY OF THIS USER MANUAL WITH THE ABOVE DOCUMENTS HAS BEEN RECEIVED BY US AND THE EXPLANATION OF THIS USER MANUAL HAS BEEN DONE BY AKKAYA TECHNICAL SERVICE. WE AGREE TO OPERATE THE BOILER UNDER THE CONDITIONS EXPLAINED IN THIS USER MANUAL.

CUSTOMER NAME:

ADRESS:

DATE:

SIGNED BY (NAME-SURNAME-SIGNATURE):



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