INSTALLATION, OPERATION AND MAINTENANCE MANUAL

RB / RBC Series

Gas / Oil / Dual Fuel Horizontal Steam Boilers

This manual must be available to the boiler operator at all times.

RB-RBC-IOMM-2017-2

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Electrical diagrams supplied separately

⚠ CAUTION

In case of emergency

This boiler has been designed and constructed to meet all of the essential requirements of the applicable European Directives and subject to proper maintenance should not give occasion to any hazardous conditions.

If such a condition should occur during commissioning or during subsequent operation of this product, whatever the cause, then the fuel supply to the boiler should be isolated immediately, until the fault has been investigated by a competent person and rectified.

For your safety!
The following WARNINGS, CAUTIONS and NOTES appear in various sections of this manual.

- **WARNINGS** must be observed to prevent serious injury or death to personnel.
- **CAUTIONS** must be observed to prevent damage or destruction of equipment or loss of operating effectiveness.
- **Notes:** *must be observed for essential and effective operating procedures, conditions and as a statement to be highlighted.*

It is the responsibility and duty of all personnel involved in the operation and maintenance of this equipment to fully understand the **WARNINGS, CAUTIONS** and **NOTES** by which hazards are to be eliminated or reduced.

Personnel must become familiar with all aspects of safety and equipment prior to operation or maintenance of the equipment.

⚠ WARNING

Steam boilers are a potential hazard, possibly fatal if not properly maintained.

⚠ CAUTION

It is vitally important that the instructions given in this manual are strictly adhered to. Failure to carry out the routine maintenance checks could result in a drastic reduction in the life expectancy of the system and increase the possibility of fire, explosion, property damage, personal injury or loss of life.

The Pressure System Safety Regulations 2000

Fulton boilers fall within the scope of the Pressure Systems Examination Scheme.
Regular inspections are therefore required by a **competent person**.
The scope of the examination and the actual intervals between examinations is at the discretion of the competent person.
It is the responsibility of the user to provide a written scheme of examination for those parts of the system in which a defect may give rise to danger.
Instructions in this manual are provided for the safe operation and maintenance of the boiler and do not cover periodic statutory inspections.

For further information contact:

(a) SAFed
SAFETY ASSESSMENT FEDERATION Limited.
Nutmeg House,
60 Gainsford Street,
Butlers Wharf,
London, SE1 2NY.

(b) Health and Safety Executive local office.

(c) Your Competent Person.

SAFETY

The instructions provided for the operation and maintenance of the boiler MUST be observed. Failure to do so could result in damage to the heater and serious personal injury.

⚠ WARNING

Do not try to do repairs or any other maintenance work you do not understand. Obtain a service manual from Fulton Ltd or call a Fulton service engineer.

It is the responsibility of the installer to ensure all parts supplied with the boiler are fitted in a correct and safe manner.

Understand the electrical circuit before connecting or disconnecting an electrical component. A wrong connection can cause injury and or damage.

A defective boiler can injure you or others. Do not operate a boiler which is defective or has missing parts. Make sure that all maintenance procedures are completed before using the boiler.

Do not change the boiler fuel without consulting the boiler manufacturer.

LIFTING EQUIPMENT
Make sure that lifting equipment complies with all local regulations and is suitable for the job. You can be injured if you use faulty lifting equipment. Make sure the lifting equipment is in good condition.

Operating the boiler beyond its design limits can damage the boiler, it can also be dangerous. Do not operate the boiler outside its limits. Do not try to upgrade the boiler performance by unapproved modifications.

Non-approved modifications can cause injury and damage. Contact your Fulton dealer before modifying the boiler.

Only qualified persons should be allowed to operate and maintain the boiler and its equipment.
Boilers should always be drained through an approved blowdown vessel.

The installation of gas appliances including the flue system should only be carried out by Gas Safe registered engineers.

Steam boilers have high temperature surfaces, that if touched may cause serious burns. Only competent and qualified personnel should work on or in the locality of a steam boiler and ancillary equipment. Always ensure the working area and floor are clear of potential hazards, work slowly and methodically.
Do NOT store inflammable materials near the boiler.

The importance of correct boiler water and feedwater cannot be over emphasised, see the relevant section in this manual.

⚠ WARNING

DANGER FROM INCOMPLETE COMBUSTION
The importance of correct burner adjustment to achieve low emissions, safe, clean and efficient combustion is paramount. Poor combustion, where unburnt gas forms carbon monoxide is both a health hazard, and the potential risk to the boiler from overheating, caused by re-burning of the unburnt gas in the secondary flue passes.

Prior to the commencement of any work requiring the removal of cover plates and the opening of control panel box, the electrical supply to the boiler must be isolated.

⚠ CAUTION

Obey all laws and local regulations which affect you and your boiler.

LOW FEEDWATER TEMPERATURE
Low feedwater temperature can result in thermal shock to the boiler pressure vessel. Return the maximum amount of condensate and if necessary preheat the feedwater. If in doubt consult Fulton Ltd.

WATER SOFTENER and CHEMICAL TREATMENT
The chemicals required to operate the water softeners and chemical treatment plants **CAN BE SUPPLIED** by Fulton Ltd.
It is the responsibility of the operator to ensure adequate supplies of chemical are available at all times (including commissioning). Costly repairs could be required should the plant operate without chemicals or the wrong dosage of chemicals.

HYDRAULIC TEST - RISK OF BRITTLE FRACTURE
Hydraulic testing requires specialist equipment and is normally only required by engineering surveyors / inspectors. In order to ensure the material/ pressure vessel does not suffer from brittle fracture, hydraulic testing should not be carried out below 7 °C.

SECTION 1 - INTRODUCTION

1.1 GENERAL

The Fulton RB and RBC Series fuel fired steam boiler service manual is a generic publication, providing information on standard boiler operation and maintenance.

Every care has been taken in the manufacture of the boiler to ensure that quality and reliability standards are maintained. Satisfactory performance can only be ensured if the installation recommendations, operating routines and maintenance schedules laid out in this manual are adhered to.

1.2 PRODUCT OVERVIEW

The Fulton RB and RBC series steam boilers are conventional, reverse-fired, three-pass, wet-back boilers with an optional internal/external economiser constructed to BS 2790 1992.

The **RB** uses a naming system that refers to steam output.

The **RBC** uses a naming system that refers to kW rating.

The boiler is mounted on a skid frame and is equipped with control and combustion equipment according to individual specifications. The control and combustion equipment can be fitted on either side of the boiler to suit the installation.

The boiler is fitted with front and rear access doors to the combustion zones for cleaning and maintenance purposes. Waterside access is via a manhole in the crown of the boiler, while hand/head holes are provided in the lower boiler shell to facilitate inspection. The optional economiser is a finned tube heat exchanger mounted in the rear smoke box of the boiler.

Boiler combustion is provided by gas, oil or dual fuel fired burners designed for high/low flame operation. Combustion air is normally controlled by a motorised butterfly damper incorporating a proof of closure interlock.

Burner controls and a fuel pump unit (oil-fired models only) are mounted on the burner.

Note: *Consult burner manufacturer's Operation and Maintenance instructions for more details.*

1.3 TECHNICAL DATA

For a full specification refer to:

RB
Appendix A - TI-135-RB Dimensions & Specification.

RBC
Appendix A - TI-109-RBC Dimensions & Specification.

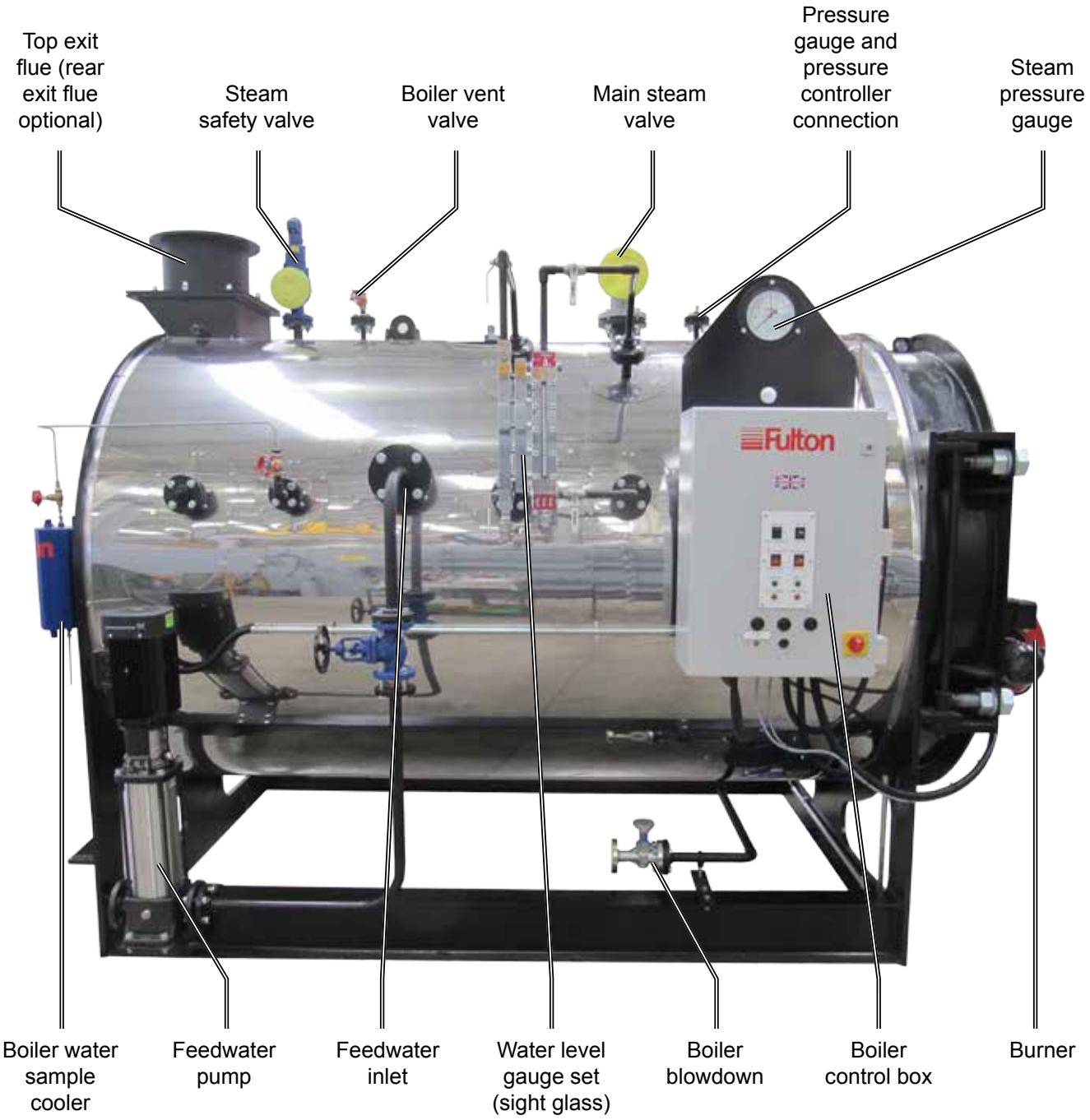


Figure. 1 - General Arrangement

SECTION 2 - INSTALLATION

2.1 GENERAL

The installation of an RB/RBC series fuel fired steam boiler should be carried out by competent personnel in accordance with all relevant safety regulations. It is the responsibility of the installer to ensure that these regulations are complied with.

2.2 PRE-INSTALLATION

Prior to delivery of the boiler, consideration should be given to the following:
(Planning regulations may call for more consents than those listed below, always check with your Local Planning Authority).

A. Local Planning consents where appropriate.

B. Consideration given to access for delivery and positioning of the boiler.

C. Preparation of a suitable base, which must be able to support the total weight of the system under operating conditions.

The locations of services to the site required for the system, under operating conditions.

D. Electricity supply, check the loading required/available.

E. Drainage system, check the suitability of the drainage system.

F. Local regulations for discharge into existing drains.

G. Suitable access for delivery and off-loading.

H. Safe access to the plant when installation is complete.

2.2.1 SITING

(Reference should be made to Utilisation Procedures as stated in IGE/UP/10 Part 1 Communication 1676, and in particular to Section 5, Location of Appliances).

The boiler house should be sufficiently sized to allow easy and safe access to all parts of the boiler for operational and maintenance purposes.

Reference should be made to **Appendix A - TI-135-RB Dimensions & Specification & TI-109-RBC Dimensions & Specification** to ascertain the relevant dimensions and weights. The flooring must be level, laid in a non-combustible material and be of sufficient strength to support the boiler.

⚠ WARNING

Lifting Equipment
Make sure that lifting equipment complies with all local regulations and is suitable for the job.
You can be injured if you use faulty lifting equipment.
Make sure the lifting equipment is in good condition.

2.3 VENTILATION

Adequate fresh, clean air is necessary for safe and efficient combustion, and should be provided at high and low level in accordance with BS 6644 1991 and IGE/UP/10 Part 1 Communication 1676.

Note: *Ensure that there is adequate ventilation in the boiler room. Lack of ventilation will create a high temperature and cause control lockout. There is a minimum ventilation requirement to supply the air for combustion.*

Note: *Do not keep exhaust fans running with windows, doors and vents closed, this will interfere with the necessary boiler draught.*

Note: *Do not store chemicals such as perclorethylene in the boiler house, the fumes may damage the boiler and flue and cause the burner to lock out on flame failure.*

Note: *see* **Appendix A - TI-135-RB Dimensions & Specification & TI-109-RBC Dimensions & Specification** *for low and high level values.*

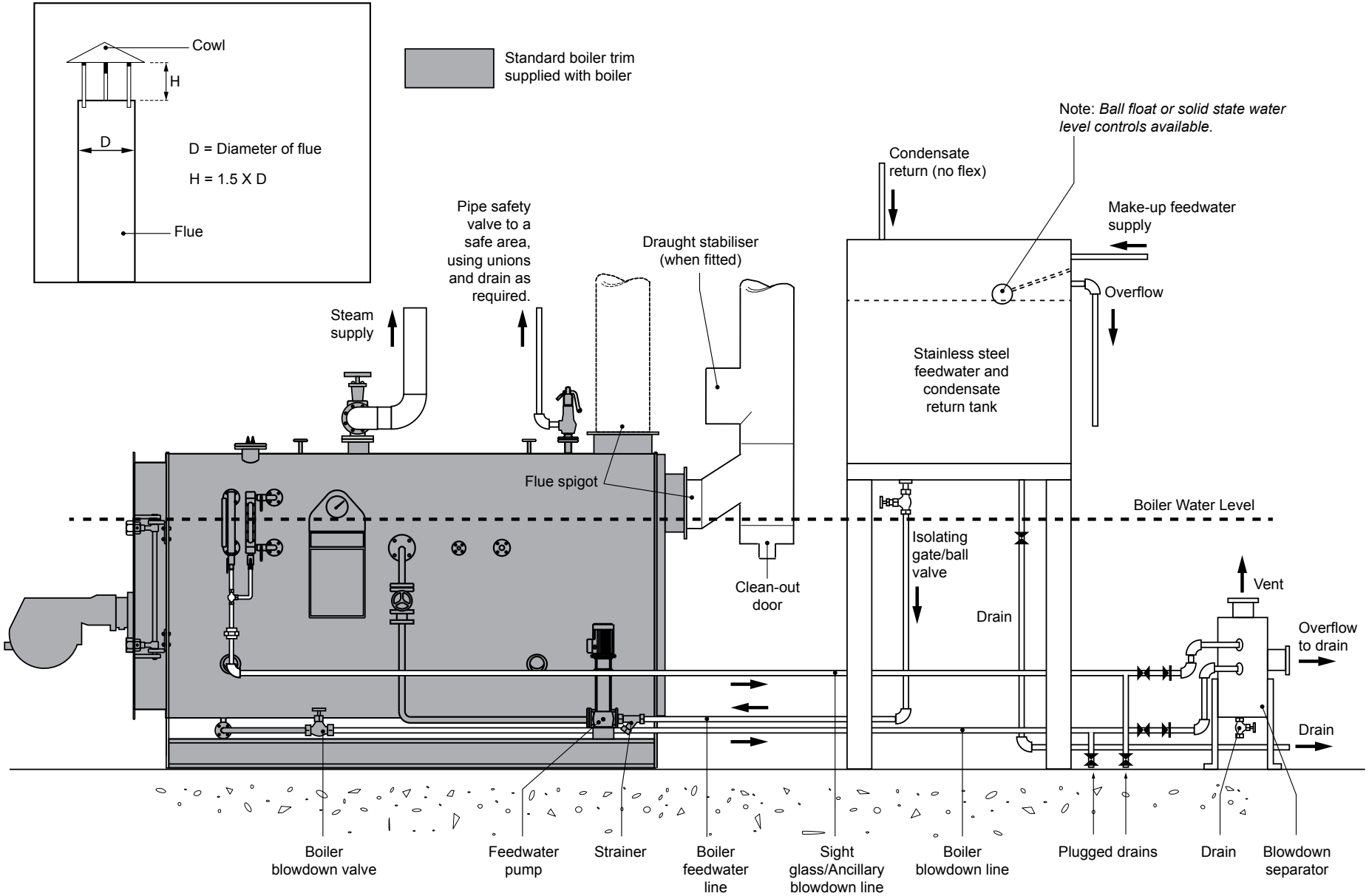


Figure. 2 - Typical Installation

2.4 MAJOR COMPONENTS

Main steam valve. Steam outlet stop valve fitted centrally on the top centre line of the boiler.

Steam vent valve. Fitted to the rear, on the top centre line of the boiler.

Safety valve. Fitted to the rear, on the top centre line of the boiler.

Boiler control box

Steam pressure gauge. Fitted to the control box mounting plate on the side of the boiler.

Main boiler blowdown valve. A main boiler blowdown valve connected to pipework at the front of the boiler on the underside centre line.

Automatic timed blowdown valve (optional). Connected to the manual main boiler blowdown valve.

Water level gauge set (sight glasses)

Boiler feedwater pump (Grundfos). 1 x Grundfos feedwater pump is provided for the boiler feedwater mounted to side rear of the boiler supporting frame.
For more information on the feedwater pump, please refer to the Grundfos OEM literature.

Feedwater valve. Water supply inlet stop valve mounted on the side of the boiler.

Feedwater non-return (check) valve. Water supply NRV mounted on the side of the boiler directly under the main feedwater inlet valve.

Boiler water sample valve. Fitted behind the feedwater inlet on the control side of the boiler.

Boiler water sample cooler. 1 x boiler water sample cooler is mounted to the rear of the boiler on the controls side.
For more information on the water sample cooler, please refer to **Appendix A - TI-122-Boiler Water Sample Cooler**.

TDS Blowdown System (optional)

Burner. Mounted to the front access door.

Note: *For detailed burner information, see burner manufacturers Installation & Maintenance manual.*

Burner Programmer. Is located in the burner mounted control panel.

Gas Train Assembly. Consists of pilot and main supply lines, each line having a manual cock, a governor and solenoid operated valves.

Gas booster

Flame sensor (UV photocell)

Burner sequence control

2.5 FLUE OUTLET

The height and type of flue will be subject to local planning regulations and approvals, and to the requirements of the Clean Air Act or similar local regulations.

Note: *Before erecting a flue, Public Health Authority and Planning permission must be obtained.*

The following information is intended to provide assistance where the installation of a simple flue is required. Where multi-boiler flues are necessary, or difficulties could be experienced, specialist advice must be obtained.
Boilers are fitted with a flanged flue outlet. The flue manufacturer/installer must be consulted at an early stage to ensure a correct mating component for flue connection (see Figure. 3).

The flue diameter must be the same or larger than the boiler flue outlet. A reduction in flue diameter will cause additional resistance which could have an adverse effect on combustion.

Note: *Avoid fitting 90° short radius elbows, 90° tees and long horizontal runs wherever possible.*

Note: *All horizontal flue runs should have a rising pitch of 15° minimum to prevent condensate build-up and subsequent corrosion.*

Note: *Oil-fired boiler installations are generally more critical because of the sulphur content in the fuel and the higher dew-point temperature.*

Note: *Specialist advice should be obtained on flue material and insulation.*

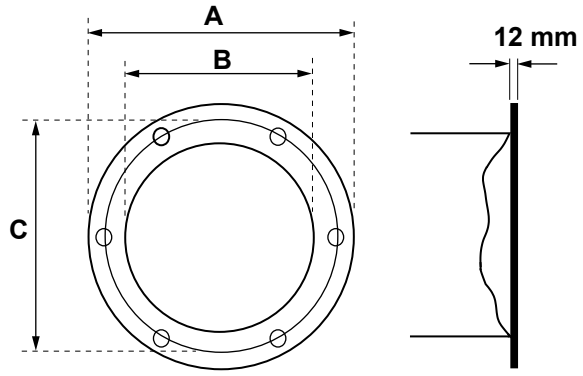


Figure. 3 - Boiler Flue Flange

RB Flange				
Model	**A**	**B**	**C (PCD)**	**Holes**
1600	400	300	360	6
2600	450	350	410	6
3400	550	450	510	6
4800	600	500	560	8
5500	650	550	610	8

RBC Flange				
Model	**A**	**B**	**C (PCD)**	**Holes**
600	350	250	310	6
750	400	300	360	6
1000	400	300	360	6
1250	450	350	410	6
1500	500	400	460	6
1850	550	450	510	6
2100	550	450	510	6
2500	600	500	560	8
3000	650	550	610	8

2.6 BLOWDOWN VALVES

There are three blowdown valves on the boiler, the boiler blowdown valve at the front underside of the boiler and two water level gauge (sight glass) blowdown valves.

All of these valves must be connected to a blowdown receptacle of approved design. Regulations exist covering such items and care must be taken to ensure compliance with these regulations.

If in doubt regarding blowdown arrangements, consult Fulton Ltd or Health and Safety Executive Guidance Note PM60 which covers blowdown tanks and associated pipework installation.

⚠ WARNING

Never discharge blowdown from the boiler directly to a drain. Where a high level of blowdown or automatic blowdown systems are installed, serious consideration should be given to fitting a Blowdown After Cooling System.

2.6.1 MAIN BOILER BLOWDOWN VALVE

A manual boiler blowdown valve is fitted to the blowdown pipework as standard and an automatic boiler blowdown valve can be added to it.

Figure. 4 - Automatic Boiler Blowdown

2.6.2 WATER LEVEL GAUGE SET (SIGHT GLASS)

All RB/RBC series boilers are fitted with two, 'Clifton' type (unless otherwise specified) reflex water level gauges.

The water level gauge blowdown valves should be connected to the auxiliary blowdown line; final connection to the blowdown valves being via soft copper tubing.

The valve fittings are 6 mm.

Figure. 5 - Water Level Gauges

2.7 MAIN STEAM VALVE

Distribution pipework should be run from the main steam valve on top of the boiler to the steam delivery point(s). Care should be taken to ensure that adequate condensate drainage and expansion facilities are provided within the pipework run(s).

To prevent excessive loads being imposed on the main steam isolating valve, the pipework should be secured near the boiler, ensuring adequate flexibility exists in the pipework between the steam valve and the securing point, to minimise any loads imposed on the valve.

Figure. 6 - Main Steam Valve

2.8 STEAM SAFETY VALVE

⚠ WARNING

Factory fitted safety valves are pre-set to protect the boiler only and must not be used to protect any other items not capable of accepting boiler pressure.

Safety valves are factory fitted and pre-set, they MUST NOT be adjusted. The discharge outlet should be piped to a safe discharge point and the piping so arranged that any condensate trapped in the pipework will drain away from the valve.

Note: *Safety Valve Outlet connections should be piped two sizes larger than the inlet connection size, this will ensure there are no accumulation issues.*

a) The lift pressure is indicated on the safety valve **(do not adjust).**

b) The safety valve fitted to the boiler is designed to prevent the boiler exceeding its design pressure.

c) Any system connected to the boiler not capable of accepting boiler pressure must be protected by a separate safety valve set to the required pressure.

Figure. 7 - Safety Valve

2.9 WATER SUPPLY

⚠ CAUTION

WATER SOFTENER and CHEMICAL TREATMENT
The chemicals required to operate the water softeners and chemical treatment plants CAN BE SUPPLIED by Fulton. It is the responsibility of the operator to ensure adequate supplies of chemical are available at all times (including commissioning). Costly repairs could be required should the plant operate without chemicals or the wrong dosage of chemicals.

The quality of the feedwater will affect the life and performance of a steam boiler.
Steam is produced by heat transfer from the heat source into the water confined within the boiler cylindrical shell, by the passage of hot gases through the furnace and tubes. It should be noted that solids entering the boiler with the feedwater can rapidly concentrate at areas of high heat transfer. Such deposits can restrict heat transfer and consequently raise mean metal temperature, which can cause corrosion and reduce safety margins possibly to the point of failure.

It is therefore strongly recommended that a reputable water treatment specialist is consulted prior to putting the boiler into service.

Note: *See* ***Appendix A - TI-140-Recommended Water Conditions.***

Water characteristics are generally as specified in BS2486 1997 “Treatment of Water for Steam Boilers and Water Heaters”, Table 2.

Boilers operating in areas with high residual hardness, high levels of Bicarbonate (temporary) hardness and low condensate return rates, will have difficulty in maintaining Total and Caustic Alkalinity (TDS) figures, within the specified limits when base exchange softening is used.

This will result in a tendency of the boiler water to foam causing unstable water level conditions possibly leading to priming and carry over. In these instances particular care should be taken to establish a suitable water treatment programme and blowdown schedule in consultation with your water treatment specialist.

Cold feedwater contains high levels of dissolved oxygen which is highly corrosive when released within a steam boiler. Always pre-heat the feedwater to 80 °C - 85 °C to reduce dissolved oxygen to a minimum and prevent thermal shock. Water treatment chemicals should be used to remove the remainder of the dissolved oxygen.

Failure to do so will result in premature failure of the boiler tubes which will not be covered by guarantee.

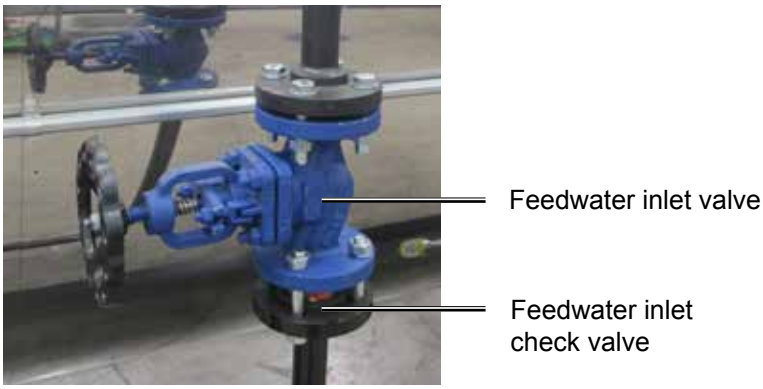


Figure. 8 - Boiler Feedwater Inlet Valve

2.10 FUEL SUPPLY

⚠ WARNING

Do not change the boiler fuel without consulting the boiler manufacturer.

2.10.1 GAS SUPPLY

The gas/pressure requirement varies according to the burner size and the gas train selected.
Verify that the type and pressure of the gas available on the site is suitable for the burner fitted.
If the site gas pressure is too low, it will be necessary to fit a gas booster system. Consult Fulton Ltd if in doubt.

To minimise pressure drops, eliminate all unnecessary bends and elbows in the pipework between the gas meter and the inlet to the gas train.
Ensure that a gas cock of the correct size is installed as close as possible to the gas train.

All gas pipework must be installed by 'Competent Persons' in accordance with the gas regulations.

Figure. 9 - Gas Burner Installation

Note: *Installation will change with the type of burner fitted.*

2.10.2 OIL SUPPLY

Oil-fired boilers are supplied with a matched, automatic high/low oil burner suitable for use with 35 SRNI fuel oil.

A single-pipe system can be used where the suction is fully flooded, however, for systems where 'lift' is required, it will be necessary to install a two-pipe system. For more details consult the burner manufacturer's instruction manual.

The following points should be observed:

a) Always install an oil filter.

b) Use flexible pipework for the final oil connections to the oil pump.

c) Fit isolating valves to the pump.

d) Ensure that the supply pipework is sized to cause a minimum pressure drop.

Figure. 10 - Oil Burner Installation

Note: *Installation will change with the type of burner fitted.*

2.10.3 DUAL FUEL SUPPLY

Figure. 11 - Dual Fuel Burner Installation

Note: *Installation will change with the type of burner fitted.*

2.11 ELECTRICAL REQUIREMENTS

⚠ CAUTION

Any electrical work should be undertaken by a qualified electrician to current local regulations.

An individual wiring diagram for the boiler is located on the inside cover of the control box. When referring to the electrical specification of the boiler, the reference number located on the rear inside wall of the control box and the wiring diagram number should be quoted.

The audible alarms provided are mounted on the front of the control panel, if not audible they should be repositioned where they can be heard by a person competent to take the appropriate action should the alarm be activated.

A 3-phase, neutral and earth isolated supply is required; this should be connected to the supply terminals of the main isolator in the boiler control panel.

Note: *The power ratings and requirements are given in* ***Appendix A - TI-135-RB Dimensions & Specification & TI-109-RBC Dimensions & Specification.***

2.12 CLEANING STEAM LINES AND PRESSURE VESSELS

During the first week of boiler operation, clean all oil and dirt from the boiler, the steam line and condensate return line.

1. Disconnect the condensate return pipe adjacent to the condensate return tank.
2. Direct the returns to a floor drain or other safe discharge point and make safe.
3. Leave in this position for one week to allow all impurities to flush through.
4. Drain the boiler completely each day.
5. After the week is completed, drain and flush the condensate return tank, removing all installation sediment. Reconnect the condensate return pipe to the condensate return tank.

SECTION 3 - OPERATION

⚠ CAUTION

The following instructions are given for the guidance of the operator in the use of the Fulton steam boiler. No responsibility can be accepted by Fulton Ltd if these instructions are ignored.

3.1 GENERAL

The following instructions are given for the guidance of the operator in the use of the RB/RBC series gas fired steam boiler and to provide adequate information to ensure that when the boiler is put into use it will be done safely and without risk to health. Where original equipment service manuals are supplied, they must be read and understood in conjunction with this manual.
All warnings and cautions must be observed.

3.2 CONTROLS

The following brief description of the controls used on the RB/RBC series fuel fired steam boiler is intended to provide the operator with a basic understanding of the operating principles, which is essential for the continued efficient operation of the boiler.

3.2.1 SYSTEM CONTROLS

Low Water Safety Relays and Feedwater Pump Relays
These relays operate in conjunction with probes suspended in the boiler shell to automatically maintain the water level in the boiler between set limits.
If the water should fall to an unsafe level, the burner is cut out and an alarm is sounded.
The probes are located in two, 100 mm diameter standpipe flanges mounted on either side of the boiler center line towards the front of the boiler.

A standard boiler is fitted with Feedwater Pump On/Off, 1st Low Water and 2nd Low Water probes.

A 15 mm TDS (surface) Blowdown connection is supplied, fitted with a blank flange.

If a TDS monitored system is fitted it should be interlocked such that the valve will not open when the feedwater pump is running.

Steam Pressure Control(s). Located on the control panel box and connected to the steam pressure gauge by copper tube, the pressure regulator controls the on/off cycle of the burner, shutting the burner off when maximum pressure is reached and switching it on when the steam pressure falls.

CONTINUED ON NEXT PAGE

Burner Programmer
Is located in the burner mounted control panel. Acts in conjunction with a sensing device to 'supervise' the ignition sequence, prove the flame is satisfactory and finally 'monitor' the established flame. Should any fault occur, either during the ignition sequence or during normal running, the programmer will immediately go to 'lock-out' and both main and pilot gas/oil valves will shut to isolate the fuel lines to the burner.

Air Pressure Switch (Gas and Dual Fuel Burners only)
Mounted on the burner, this switch is operated by the pressure of air entering the burner through the throat of the scroll. Lack of combustion air, or insufficient air pressure, will stop the switch completing the circuit, preventing the burner from operating.

Gas Train Assembly
Consists of pilot and main supply lines, each line having a manual cock, a governor and solenoid operated valves. The governors maintain a consistent pressure of fuel entering the burner and are adjustable. The solenoid valves are electronically controlled by the burner programmer. For specific details, consult the burner manufacturers Instruction Manual.

Note: *Boilers fitted on skid systems and in plantrooms are interlocked with the feedwater and condensate return tank, after switching the boiler on at the boiler control box isolator switch, the reset button on the tank control box must be reset. This reset must also be selected after any electrical outage.*

3.2.2 STEAM PRESSURE CONTROLS

Pressure controls are mounted on the side of the control box together with a syphon pipe, pressure test point and steam pressure gauge.

Pressure controls are as follows:

Control Pressure On/Off Switch
Controls the ON/OFF cycle of the burner, switching the burner off when the desired steam pressure is reached and switching it on when steam pressure falls.

High Limit Switch
Should the Control Pressure Switch fail, the steam pressure will raise above the preset limit causing the High Limit Switch (set at least 0.5 barg higher than the Control Pressure Switch) to switch off and lock out the burner.

A High Limit Indicator will illuminate and an alarm will sound.

Should this happen, switch the boiler to pump only and wait until the steam pressure is discharged. Check the connection to the pressure switch, replace as required.

High/Low Pressure Switch

Air pressure transducer for fully modulated burners switches the burner from high to low flame and vice-versa.

Provides a proportional control signal to the burner combustion control.

CONTINUED ON NEXT PAGE

Figure. 12 - Pressure Switch Locations - Non Modulating

Figure. 13 - Pressure Switch Locations - Modulating

3.2.2.1 ADJUSTING STEAM PRESSURE CONTROLS

1. Start the boiler.
2. SHUT the main steam valve.
3. Set the control pressure switch to its maximum.
4. Set the high limit pressure switch to 0.5 barg below the safety valve setting.
5. Allow the steam pressure to rise until the high limit pressure switch trips.
   On the steam pressure gauge, check that the pressure is not less than 0.5 barg below the safety valve lift pressure.

If the pressure is incorrect, repeat steps 2, 4 and 5.

6. OPEN the main steam valve to lower the steam pressure.
7. Reset the control pressure switch to the required working pressure and the high/low pressure switch to 0.3 barg - 0.5 barg below the control pressure switch setting.
8. SHUT the main steam valve.
9. Reset the high limit pressure switch and allow the steam pressure to rise until the high/low pressure switch reduces the burner to low fire, and then the burner shuts down under the control pressure switch.
10. Readjust if necessary to achieve the required settings.

Note: *The requirement for a difference between the control and high limit pressure switches is to prevent unnecessary high limit steam pressure faults tripping the burner at no load conditions.*
The residual heat in the furnace, the flue pipes and the door refractory is capable of raising steam pressure slightly, causing the high limit pressure switch to trip out.

3.2.3 BOILER CONTROL PANEL

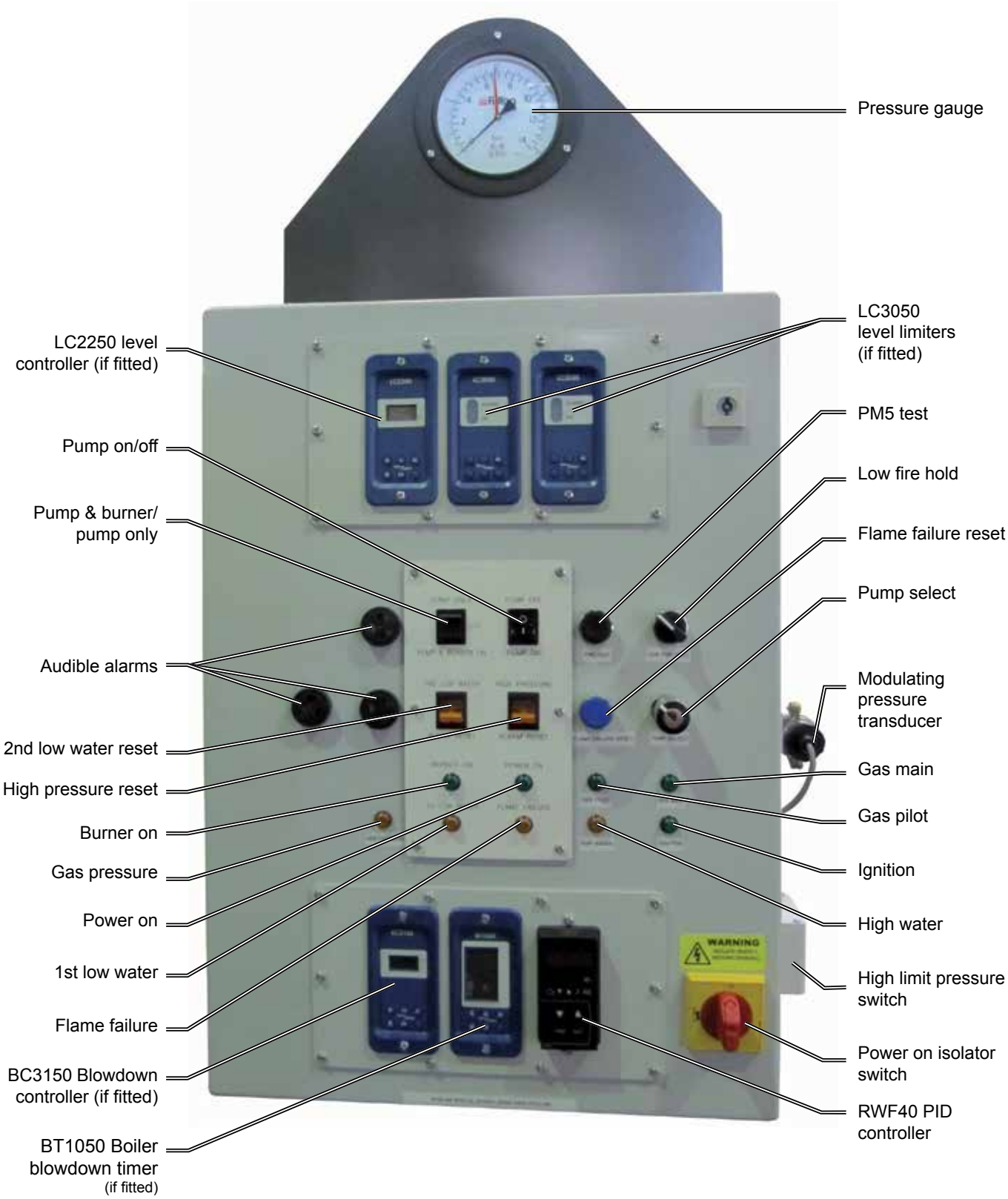


Figure. 14 - Boiler Control Box

Note: *Components and their location on the control box will vary with boiler specification.*

Boiler controls and indicators are housed in a control panel mounted on the side of the boiler.

These are as follows:

Power Isolator Switch
Control panel power supply ON/OFF switch, mounted on the panel door.

Power On Indicator
Indicates that the door mounted 'power on' isolator is in the ON position and that the panel is electrically live.

⚠ CAUTION

The Power On indicator is derived from a single phase. It is possible that with the control phase down or a defective bulb the other phases could be live. Always isolate the supply before investigating any fault.

Pump Only/Off/Pump & Burner On
This rocker switch has three separate functions. In the PUMP ONLY and PUMP & BURNER ON positions, the power supply is switched through to the control system. It is a mandatory requirement of the AOTC and Gas Supply Standards that when the control system is first energised, or re-energised (power restoration), it must go to a fail-safe shutdown position, sound an alarm and require manual resetting to cancel the alarm. The alarm condition, when activated, is cancelled by resetting the 2nd low water reset switch.

PUMP ONLY Position
This position should only be selected to fill the boiler. The normal functions of the level control alarm system are overridden to prevent a continuous alarm while the boiler is being filled. The pump off level control will function normally and switch the pump off once the correct water level is reached.

Note: *The burner mounted Burner On/Off/Reset Switch should be in the OFF position during the filling process.*

Note: *The Pump On/Pump Off Switch should be in the PUMP ON position.*
Both alarms will be cancelled when pressing the reset switches irrespective of the water level in the boiler.

OFF Position
In this position the burner, feedwater pump and control system are off.

PUMP & BURNER ON Position
In this position, both burner and pump will run under automatic control providing that the burner mounted Burner On/Off/Reset Switch is in the ON position, and the Pump On/Pump Off Switch is in the PUMP ON position.

Note: *When selecting this position from either PUMP ONLY or OFF, the power restoration alarms will be activated. The alarm can be cancelled by pressing the 2nd Low Water Alarm/Reset switch.*

Note: *The 2nd Low Water alarm can only be cancelled if the boiler water level is above the 2nd low water level. If the alarm cannot be cancelled, allow the feedwater pump to restore the water level to the normal working level (approximately midway up the sight glass) and then reset the alarm.*

Pump Off/On switch
This switch is only used for evaporation and low water tests.
It interrupts the power supply to the feed pump contactor coil.

CONTINUED ON NEXT PAGE

Sequence manual/auto switch (if fitted)
Used to select either manual or automatic sequence step control. In the manual position the burner will operate under the direct control of the master pressure controller, mounted in the steam header/distribution pipework. The boiler mounted high pressure and on/off pressure switches are still functional.

1st Low Water Indicator
This lamp will be illuminated and an alarm sounded when the water level in the burner falls to the 1st low water level. The burner will shut down and the alarm will continue to sound until the water level is restored to a safe working level. The alarm will then cancel, the indicator lamp will extinguish and the burner will automatically restart.

2nd Low Water Alarm/Reset Switch
Sounds an alarm during switch on, press to reset. If the level of water in the boiler falls below the second pre-set limit during boiler operation, the 2nd Low Water Alarm/Reset Switch will illuminate, the alarm will sound and the burner will shut down. The water level must be restored before the alarm can be cancelled by pressing the switch.

High Water Indicator (if fitted)
This lamp will illuminate and an alarm sound when the water level reaches a pre-determined high level. The feedwater pump will stop.
When the water level falls to the normal working level, the indicator lamp will extinguish, the alarm cancel.

Burner Run Indicator
Indicates that the burner fan is operating.

High Steam Pressure Alarm/Reset Switch
This switch will Illuminate and an alarm sound when the high limit pressure switch is tripped. The switch/alarm must be manually reset after the pressure has reduced to a safe level.

⚠ WARNING

Before resetting this control, ascertain the reason for the alarm, and rectify.

Flame Failure Indicator. Indicates the burner combustion control relay, detects a flame failure condition.

Night Set Back Switch (if fitted)
The ‘Set Back Switch’ needs to be set to the ‘On’ position at the end of the working shift. This means the burner will only fire if the boiler pressure falls below a set stand-by pressure. This therefore reduces start-up lead time at the beginning of the next shift, when the ‘Set Back Switch’ should be set to the off position to enable the boiler to reach normal operating pressure.

3.2.4 BURNER CONTROL PANEL

Note: *A gas burner is illustrated, for specific details consult the burner manual supplied with the boiler.*

Figure. 15 - Burner Control Panel

Burner controls and indicators are mounted on the burner. The following controls are typical for a dual fuel burner, but reference should be made to the burner manufacturer's Operating Manual for the particular type used.

Burner On/Off/Reset Switch
Three-position switch used to switch on/off and/or reset the burner.

Lockout Indicator
Indicates the burner combustion control relay detects a flame failure condition.
The burner controller can be reset by setting the Burner On/Off/Reset Switch to the RESET position.

Hand Indicator
This lamp will illuminate when the hand/auto switch mounted inside the burner control panel is in the hand position, normally used for commissioning only.

Auto Indicator
This lamp will illuminate when the hand/auto switch mounted inside the panel is in the auto position.

High Pressure Indicator
This lamp is not wired when a high steam pressure alarm/lamp is provided in the boiler control panel.

Modulating Controller
Controls the firing of the burner within the pressure band selected.

3.3 FILLING THE BOILER ALL MODELS

1. Ensure the following valves are OPEN:
   a) Steam pressure gauge isolating valve.
   b) All valves in the feedwater line.
   c) Water level gauge (sight glass) isolating valves.
   d) Air release valve.
2. Ensure the following valves are SHUT:
   a) Main steam valve.
   b) Main blowdown valve.
   c) Water level gauge blowdown valves.
   d) All valves in the gas/oil train to the burner.
3. Ensure that the Burner On/Off/Reset Switch is set to OFF.
4. Ensure that the Pump On/Pump Off Switch is in the PUMP OFF position, and that the Pump Only/Off/Pump & Burner On Switch is in the OFF position.
5. Turn the door isolator to the ON position.
6. Place the Pump On/Pump Off Switch to the PUMP ON position.
7. Vent the pump.
8. Place the Pump Only/Off/Pump & Burner On switch to the PUMP ONLY position.
9. The feedwater pump should start, (check the pump direction of rotation) and fill the boiler to the correct working level and then switch OFF.

Note*: If the 2nd Low Water and High Pressure Alarm/Reset switches illuminate and the alarms sound, check that the burner mounted Burner On/Off/Reset Switch is in the OFF position, and then reset both alarms by pressing the switches.*

Note: *It may be necessary to vent the feedwater pump by bleeding air from the plug mounted in the top casting below the pump motor to pump body connection.*

3.4 DRAINING THE BOILER

⚠ CAUTION

Your local regulations could state boiler water above 43 °C must not be discharged into the drain. ALWAYS check your local regulations.

Boilers with manual blowdown valves

1. Ensure the boiler is cold.
2. Isolate the boiler electrics at the isolator on the control box door.
3. Isolate the feedwater tank and the feedwater pumps.
4. Open the drain valve in the boiler and the boiler air vent (if fitted) allowing air into the boiler.
5. Open the blowdown vessel drain valve.
6. Open all valves in the drain lines.
   (Skid Units/Plant Rooms, have internal drainage systems which require the same procedures).

Boilers with automatic blowdown systems

1. The boiler should not be under pressure.
   The boiler should be cold.
2. Close the blowdown isolation valve.
3. Using a flat-head screwdriver, locate manual blowdown button (labelled as **A** in **Figure. 16**), push the Manual Blowdown Button up and make a quarter turn clockwise, this will lock the button in position and open the blowdown valve.
4. Using the blowdown isolation valve to throttle the flow, drain the boiler.

Note: *Skid units and plant rooms have internal drainage systems which require the same procedures.*

Figure. 16 - Automatic Blowdown Valve

3.5 BOILER START-UP (FROM COLD) ALL MODELS

⚠ CAUTION

The system should be raised to temperature slowly to allow for expansion and to avoid thermal shock and water hammer.

When starting up the boiler, it is prudent to minimise the thermal and mechanical stress caused by differential expansion of various parts of the boiler as they reach working temperature.
The shell temperature is determined by the contained water/steam temperature. The furnace temperature which is higher is determined by the heat transfer/furnace wall loading and gas temperature. The tube temperature lies between the shell and furnace temperatures, but is nearer the shell temperature. Since all these components are virtually the same length, they expand longitudinally by different amounts causing mechanical and thermal stress. Whilst this is catered for in the mechanical design of the pressure vessel, the life expectancy of the boiler can be affected if the boiler is frequently heated too quickly from cold.

When starting from cold the furnace approaches its design temperature shortly after start-up, whereas the tube and shell temperatures are delayed by the time taken to bring the contained water up to temperature. As a result, the thermal expansion is at its greatest. Additionally, the temperature gradient which exists between the bottom and the top of the boiler is exaggerated. This can be reduced by blowing the boiler down during the heat-up period.

In practical terms, the ideal solution would be to gradually raise the temperature and pressure in the boiler progressively by firing the boiler on low fire for a few minutes and leaving it to ‘soak’ (e.g. allowing the temperatures in the boiler and water to even out by diffusion) for 20 to 30 minutes, blowing down the boiler, firing the boiler again for a little longer and soaking for less, and so on.

Start-Up (from cold) Procedure

1. Fill the boiler as described in **Section 3.3**.

2. Ensure the main steam valve is SHUT.

3. OPEN feedwater valves to the economiser and CLOSE the feedwater bypass valve (where economiser is fitted), see figure **Figure. 17** on page 26.

⚠ CAUTION

Where an economiser is fitted, a constant flow of water through the economiser is required when the boiler is running to prevent pressure build-up.

4. Open all the valves in the gas train/oil supply. It is assumed that the fuel supply lines have been purged prior to attempting to start the boiler/burner.

5. Turn the Pump Only/Off/Pump & Burner On Switch to the PUMP & BURNER ON position.

6. Switch the burner mounted Burner On/Off/Reset Switch to the ON position. The 2nd Low Water and High Pressure Alarm/Reset switches will illuminate and alarms will sound due to the power restoration interlock, (refer to **Section 3.2.3** - Pump Only/Off/Pump & Burner On switch description).

CONTINUED ON NEXT PAGE

Note: *If the 2nd Low Water and High Pressure Alarm/Reset switches illuminate and the alarms sound, check that the burner mounted Burner On/Off/Reset Switch is in the OFF position, and then reset both alarms by pressing the switches.*

7. The burner motor will start and, after going through the post purge/pre purge interlock checks, should fire after approximately 45 seconds.

Note: *Before leaving the boiler unattended, the daily operating tests (see* **Section 4.11.1***) should be carried out to check the functions of all the safety interlocks. For more detailed information on the burner firing sequence consult the burner manufacturer's Operation and Maintenance instructions.*

3.5.1 BOILER START-UP FOLLOWING SHORT TERM SHUT-DOWN

If the boiler has been shut-down short term (see **Section 3.6.1 - Short Term Shut-Down**), the large thermal mass in the boiler will maintain the internal temperature to a point that the boiler can be simply switched on (preferably on low fire) and then left to reach working temperature/ pressure.

3.6 BOILER SHUT-DOWN

3.6.1 SHORT TERM SHUT-DOWN (HOURS)

Select OFF on the burner control panel switch.
The burner will stop firing, post-purge and then stop.

3.6.2 MEDIUM TERM SHUT-DOWN (DAYS)

1. Select OFF on the burner control panel switch.
   The burner will stop firing, post-purge and then stop.

2. Shut the main steam valve.

3. Select pump only on the boiler control panel.

Note: *Ensure the boiler water treatment levels for dissolved oxygen are within the specified limits.*

3.6.3 LONG TERM SHUT-DOWN (WEEKS)

To store the boiler in a corrosion-free situation there are three practical solutions:

1. Fully flood the boiler to exclude as much air as possible.

2. Drain the boiler completely.
   Remove all hand hole and manhole doors.
   Open all gas/oil side access doors.

3. As (2) but also introduce a form of convection heating to the gas/oil and water side.
   A very effective solution is to install a small heater.

3.7 INTERNAL ECONOMISER (IF FITTED)

Feedwater from a constantly running modulating pump is passed through the economiser before entering the boiler.

Heat is extracted from the boiler exhaust gases by the economiser which in turn heats the feedwater to temperatures that can exceed 100 °C.

Back flow is prevented by non-return valve in the feedwater pipework on the inlet of the economiser.

The economiser is designed to reduce the boiler exhaust temperature to approximately 140 °C, if the temperature falls significantly below this figure condensation will occur which can lead to corrosion.
The economiser is fitted with inlet and outlet temperature gauges for both feedwater and exhaust gas. These gauges should be used to monitor the condition and performance of the economiser.

Note: *Sudden changes in temperature should be reported immediately as they could indicate a blockage of the economiser water ways, or a malfunction of the modulating feedwater control valve.*

In general a 10 °C increase in feedwater temperature will give an efficiency improvement of 2%. Because the boiler feedwater modulating control valve and the burner are both proportioned to the steam load, the burner heat input and cooling water flow rate to the economiser are in balance throughout the burner firing range.

A DN20 spill back line with a pneumatically operated piston valve is installed in the feedwater pipework in the discharge from the pump, the outlet from this valve must be piped back to the feedwater tank. The purpose of the spill back line is to prevent the constant running feedwater pump from overheating should the water level reach the maximum working level. An orifice plate is fitted in the spill back line in addition to the pneumatically operated piston valve, with a manually operated/adjustable globe valve for making small adjustments to the spill back water flow rate.

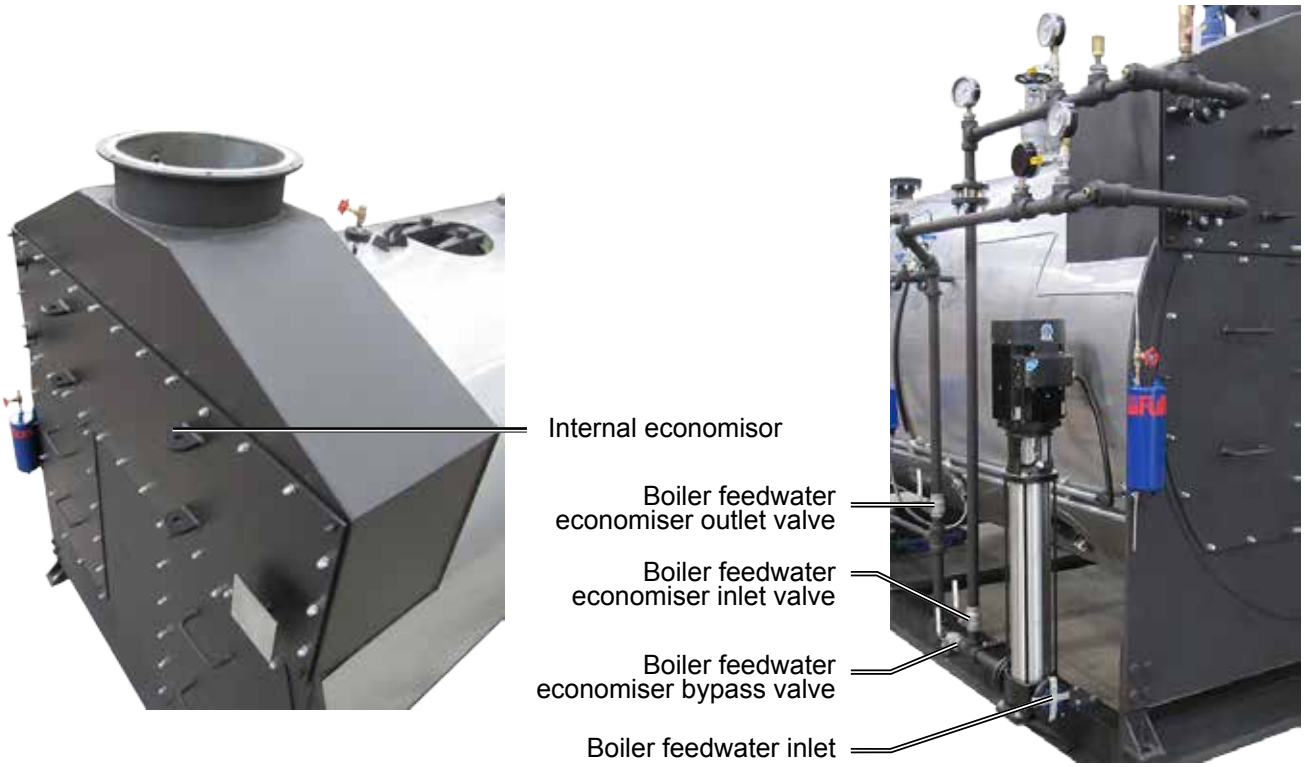


Figure. 17 - Typical Internal Economiser

SECTION 4 - MAINTENANCE

⚠ CAUTION

It is vitally important that the instructions given in this manual are strictly adhered to. Failure to carry out the daily, weekly, monthly and six monthly checks could result in a drastic reduction in the life expectancy of the boiler.

Tests should be carried out by a competent person trained to perform such tests. If any test shows that the equipment is not operating correctly, the fault should be investigated and corrected before the boiler is used.

Any rectification or repairs should be carried out by trained, competent service personnel.

4.1 BOILER PLATFORM (IF FITTED)

The platforms are mounted to the boiler base frame. They are designed to allow easy maintenance access to the components on the top of the boiler (i.e. the water level probes, main steam valve, vent and safety valves).

It is the responsibility of the user to ensure that a site risk assessment is carried out for the safe use of the ladders and working at height on the platform.

Figure. 18 - Typical Boiler Platform

4.2 VISUAL CHECKS

Inspect the steam and feedwater pipework, valves and fittings for signs of leakage. If leaks are suspected, shut-down and evacuate the system to atmospheric pressure before attempting any repairs.

Note: *Ensure that the water level is maintained during the pressure build-up. If any part of the equipment is not operating correctly, the fault should be investigated before the boiler is used. Ensure that all blowdown pipework is safe and discharged to a blowdown receptacle.*

4.3 BURNER FLAME SENSOR TEST

This test checks the operation of the flame safeguard sensor.

1. Ensure that the burner is firing.
2. Remove the flame sensor from its plug-in connection on the side of the burner.
3. Cover the sensor glass to exclude all light.
4. The burner control should immediately (2 - 3 sec gas, 5 sec oil) go to a lockout/flame failure condition and will require manual resetting.

If the test fails, turn the boiler off and ensure that the fault is rectified before the boiler is used.

5. Clean the UV photocell before replacing it.
6. Fire the burner to ensure correct operation.

Figure. 19 - Flame Sensor Removal

4.4 WATER LEVEL AND LOW WATER SAFETY CONTROL PROCEDURES

The following procedures ensure the correct functioning of the water level controls and the low water safety controls.

4.4.1 FEEDWATER PUMP TEST

a) If the boiler is not firing and not under steam pressure, lower the water level using the main blowdown valve:

If the pump is running:

1. Observe the water level in the water level gauge (sight glass).
2. Verify that the pump continues to run until the Pump Off level is reached and then switches off.

If the pump is not running:

1. Check that the water level in the water level gauge is between Pump On and Pump Off levels.
2. Lower the water level by opening the main boiler blowdown valve.
3. Verify that the pump starts to run when the water level reaches the Pump On level.
4. Close the main boiler blowdown valve.
5. Continue to observe the water level in the water level gauge and verify that the pump continues to run until the Pump Off level is reached and then switches off.

b) If the boiler is firing and under load, lower the water level by evaporation, observing a pump cycle:

If the pump is running:

1. Observe the water level in the water level gauge.
2. Verify that the pump continues to run until the Pump Off level is reached and then switches off.

If the pump is not running:

1. Check that the water level in the water level gauge is between Pump On and Pump Off levels.
2. The water level will lower through natural evaporation.
3. Verify that the pump starts to run when the water level reaches the Pump On level.
4. Continue to observe the water level in the water level gauge and verify that the pump continues to run until the Pump Off level is reached and then switches off.

4.4.2 1ST LOW WATER LEVEL CHECK STANDARD

1. Ensure that the boiler is firing, the feedwater pump is not running and that the water level is between Pump On and Pump Off.

2. Switch off the pump using the Pump on/off switch.

3. Allow the water level to lower by **natural evaporation** below the 1st Low Water level.
   Do not allow the water level to drop below the bottom of the water level gauge (sight glass).

Note: *Water level should not be lowered to 1st low water using manual blowdown when the system is running.*

4. Check:

   a) 1st Low Water lamp illuminates

   b) 1st Low Water audible alarm sounds

   c) Burner stops firing

If the test fails, turn the boiler off and ensure that the fault is rectified before the boiler is used.

5. Switch on the pump using the Pump on/off switch.

6. Check:

   a) Feedwater pump starts and refills the boiler

   b) Water level rises above the 1st Low Water level

   c) 1st low Water lamp extinguishes

   d) 1st Low Water audible alarm silences

   e) Burner automatic fire sequence starts

7. Verify that the pump continues to run until the Pump Off level is reached and then switches off.

4.4.2.1 1ST LOW WATER LEVEL CHECK WITH ECONOMISER FITTED

1. Ensure that the boiler is firing, the feedwater pump is running and that the water level is between Pump On and Pump Off.

2. Switch the spill back switch to manual.

3. Close feedwater isolation valve to boiler.

4. Allow the water level to lower by **natural evaporation** below the 1st Low Water level.
   Do not allow the water level to drop below the bottom of the water level gauge (sight glass).

Note: *Water level should not be lowered to 1st low water using manual blowdown when the system is running.*

5. Check:

   a) 1st Low Water lamp illuminates

   b) 1st Low Water audible alarm sounds

   c) Burner stops firing

   If the test fails, turn the boiler off and ensure that the fault is rectified before the boiler is used.

6. Open feedwater isolation valve.

7. Switch the spill back switch to auto.

8. Check:

   a) Feedwater pump refills the boiler

   b) Water level rises above the 1st Low Water level

   c) 1st low Water lamp extinguishes

   d) 1st Low Water audible alarm silences

   e) Burner automatic fire sequence starts

9. Verify that the pump continues to run when the correct water level in the boiler is reached (feedwater pump should run constantly to supply the economiser).

4.4.3 2ND LOW WATER LEVEL CHECK STANDARD

1. Complete steps 1 to 4 of section **4.4.2 1st Low Water Level Check**.

2. Allow the water level to lower by **natural evaporation or manual blowdown** below the 2nd Low Water level.
   Do not allow the water level to drop below the bottom of the water level gauge (sight glass).

3. Check:

   a) 2nd Low Water/Alarm Reset switch illuminates

   b) 2nd Low Water audible alarm sounds

If the test fails, turn the boiler off and ensure that the fault is rectified before the boiler is used.

4. Switch on the pump using the Pump on/off switch.

5. Check:

   a) Feedwater pump starts and refills the boiler

   b) Water level rises above the 1st Low Water level

   c) 1st Low Water lamp extinguishes

   d) 1st Low Water audible alarm silences

   e) Burner does not start

   f) 2nd Low Water audible alarm continues to sound

6. Press the 2nd Low Water/Alarm Reset switch

7. Check:

   a) 2nd Low Water/Alarm Reset switch extinguishes

   b) 2nd Low Water audible alarm silences

   c) Burner automatic fire sequence starts

8. Verify that the pump continues to run until the Pump Off level is reached and then switches off.

4.4.3.1 2ND LOW WATER LEVEL CHECK WITH ECONOMISER FITTED

1. Complete steps 1 to 5 of section **4.4.2.1 1st Low Water Level Check**.

2. Allow the water level to lower by **natural evaporation or manual blowdown** below the 2nd Low Water level.
   Do not allow the water level to drop below the bottom of the water level gauge (sight glass).

3. Check:

   a) 2nd Low Water/Alarm Reset switch illuminates

   b) 2nd Low Water audible alarm sounds

If the test fails, turn the boiler off and ensure that the fault is rectified before the boiler is used.

4. Open feedwater isolation valve.

5. Switch the spill back switch to auto.

6. Check:

   a) Feedwater pump refills the boiler

   b) Water level rises above the 1st Low Water level

   c) 1st Low Water lamp extinguishes

   d) 1st Low Water audible alarm silences

   e) Burner does not start

   f) 2nd Low Water audible alarm continues to sound

7. Press the 2nd Low Water/Alarm Reset switch

8. Check:

   a) 2nd Low Water/Alarm Reset switch extinguishes

   b) 2nd Low Water audible alarm silences

   c) Burner automatic fire sequence starts

9. Verify that the pump continues to run when the correct water level in the boiler is reached (feedwater pump should run constantly to supply the economiser).

4.4.4 EVAPORATION CHECK

This check may be required by your insurance inspector as part of the annual inspection.

To perform the evaporation check, follow the procedure in **Section 4.4.3 - 2nd Low Water Level check** allowing water to lower by natural evaporation and **not** by manual blowdown.

4.5 BLOWDOWN PROCEDURES

Keep the boiler, water level gauge (sight glass) and interconnecting pipework free from sludge and scale build-up by following these blowdown procedures.

Note: *Where a boiler is operating continuously at steam pressure, advice should be sought from Fulton Service Department regarding the appropriate blowdown procedure.*

4.5.1 MAIN BOILER BLOWDOWN

1. Start the boiler and generate not more than 10 psi of steam (see note).
2. Shut off both the burner and the pump.
3. Fully OPEN the boiler main blowdown valve for not more than 5 seconds, or as recommended by the water treatment specialist.
4. CLOSE the valve.

Note: *Where high levels of suspended solids are produced, longer and/or more frequent blowdown may be required.*

Auto Blowdown/Draining

The boiler may be drained by opening the boiler blowdown isolation valve, having mechanically opened the auto blowdown valve (see **Section 3.4 - Draining the Boiler**).

Note: *As well as removing sludge (suspended solids) from the boiler, a second and equally important function is to maintain the TDS (totally dissolved solids) level to within the required limits. The amount of blowdown, and hence time required, is dependent on the amount of TDS in the raw water supply, the percentage condensate return, water treatment chemicals added and the number of hours a day operation. In order to establish the required blowdown rate, consult your water treatment specialist who will recommend a water treatment programme in terms of appropriate chemicals and the required blowdown rate which takes these factors into account.*

Note: *The boiler blowdown shown is an automatic installation, manual blowdown is also available.*

Figure. 20 - Main Boiler Blowdown Valve

4.5.2 WATER LEVEL GAUGE (SIGHT GLASS) BLOWDOWN

Blowdown the water level gauge (sight glass) set 1.

1. Open the water level gauge glass blowdown valve A
2. Close (for approx. 3 seconds) the top gauge valve B
3. Open valve B
4. Close (for approx. 3 seconds) the bottom gauge valve C
5. Open valve C
6. Close valve A

Repeat for gauge set 2

On completion of the blowdown procedure ensure that all isolation valves are OPEN and all blowdown valves are CLOSED.

Note: *Where a boiler is operating continuously at steam pressure, advice should be taken from Fulton Ltd as to the appropriate blowdown procedure.*

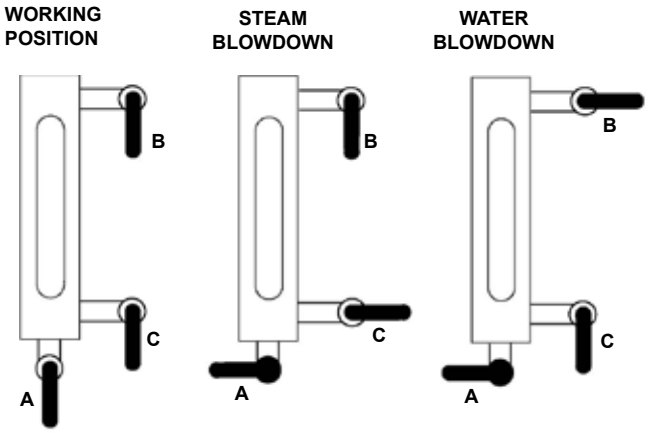


Figure. 21 - Water Level Gauge Operating Positions

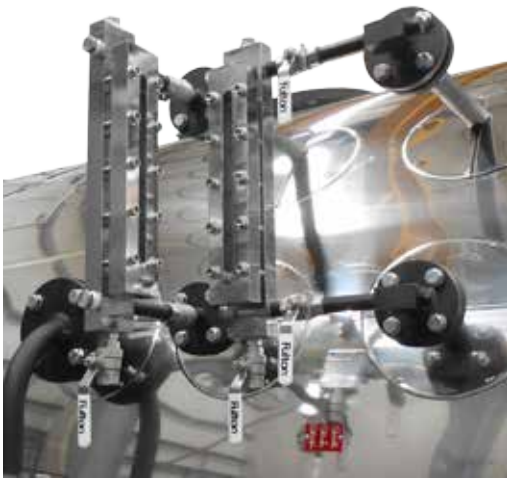


Figure. 22 - Water Level Gauges (sight glasses)

4.6 BOILER INTERNAL INSPECTION

Drain and isolate the boiler before carrying out an internal inspection of the boiler.

The lower hand hole and man hole doors should be removed after one month of operation and the interior of the boiler thoroughly examined, paying particular attention to the junction with the front tube plate and tubes for signs of pitting. If scale or sludge build-up is observed, it should be removed and the water treatment supplier advised.

During normal operation the front ends of the turbulators will be burnt off, this is normal and not a cause for concern.

New gaskets must be fitted every time a hand hole door is removed (see **Section 4.7 - Fitting New Gaskets To Boiler Inspection Holes**).

Subsequent interior examinations should be carried out on a regular basis until satisfactory conditions are observed. Thereafter, inspections should be carried out at three monthly intervals.

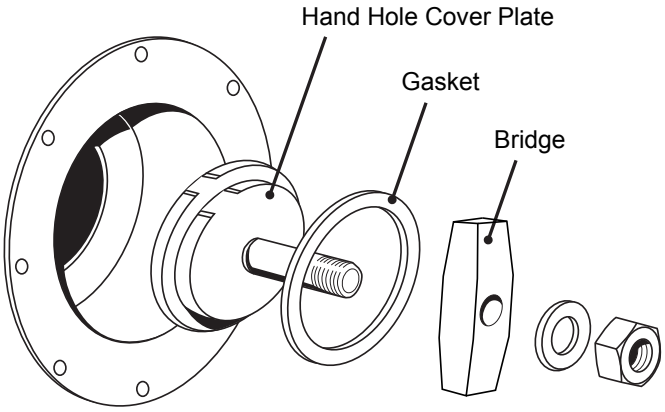


Figure. 23 - Hand Hole

4.7 FITTING NEW GASKETS TO BOILER INSPECTION HOLES

4.7.1 IMPORTANT INFORMATION

⚠ CAUTION

TOPOG-E gasket have a finite life after installation and must be renewed annually.
It is important that the instructions given in this section are adhered to.

The RB/RBC series of boilers are fitted with TOPOG-E gaskets in all the inspection holes of the boiler. These gaskets work very well and millions have been safely used over the last 30 years, however, it is absolutely essential to observe a few simple rules in order to get the best performance from your installation.

Elastomeric Vulcanizates, which form the basis of TOPOG-E gaskets, undergo degradation from many sources including heat, oxygen, stress, and overdosing from certain types of water treatment. This takes the form of material oxidation, hardening/embrittlement and cracking which may result in gasket failure. Steps must be taken to minimise the effects of such attacks.

Water treatment and oxygen attack can be minimised by ensuring that the gasket is aligned correctly so that only the extreme edges of the gasket are exposed. If a new gasket leaks after fitting this is almost certainly due to incorrect seating or alignment. As such gaskets are very flexible it is possible to cure the leak by excessive tightening, but such an action will seriously reduce the life of the gasket and cause problems later.

Undue stress can be avoided by tightening just sufficiently to stop any leakage when fitting cold and before firing the boiler. Start the boiler and gradually bring it up to working temperature, allowing the increasing steam pressure to take over and complete the seal. This will allow the gasket material to contract naturally and follow the topography of the mating surfaces. The securing nut can then be tightened gently by approximately a quarter of a turn, to ensure a ‘snug’ fit and prevent the seal from being broken when the boiler is cold and under negative pressure.

Gentle warming of the boiler on initial firing after maintenance will also help to ensure that the rubber ‘cures to shape’. If the rubber post-cures, the elastic memory will be destroyed and any initial over tightening will cause the gasket to become hardened and embrittled, leading to cracks and eventual failure.

4.7.2 FITTING PROCEDURE

Blowdown the boiler completely (see **Section 4.5.1 - Main Boiler Blowdown**) and examine all inspection holes in the boiler. If any leakage is evident, proceed as follows:

1. Disassemble the bridge and cover plate and remove the inspection hole assembly. Remove the old gasket and thoroughly clean the mating faces of the cover plate and boiler ring.

2. Place the new Topog-E gasket on the cover plate, ensure the gasket is the correct size and is seating flat against the plate. Do not use any grease, lubricant or adhesive. If the new gasket is not seated properly before the plate is tightened, the gasket may be pinched causing a failure when the pressure builds up.

3. Position the cover plate in the boiler ring, ensuring that the plate is correctly centred. An off centre cover plate can concentrate forces on the gasket and cut it in two. The cover plate may also drag on the boiler hole ring and fail to seal as the pressure rises. Set the bridge and hand tighten the securing nut(s) sufficiently to provide a snug fit. Tighten the nuts a further quarter of a turn using a spanner. DO NOT OVER TIGHTEN.

Note: *Ensure the gasket is aligned correctly so that only the extreme edges are exposed to water treatment or oxygen attack. If the gasket is misaligned, over tightening to seal a leak will not prevent subsequent leakage at a later date.*

4. Gradually warm up the boiler, allowing steam pressure to make the seal. If the gasket leaks during pressure build-up, tighten the securing nut(s) sufficiently only to stop the leakage. It is important to keep the nuts correctly tightened thereafter, this prevents the vacuum developed by cooling on shut-down from feeding and draining the boiler.

Note: *New gaskets fitted to inspection holes located along the bottom of the boiler are more difficult to install without leaking. Small particles of scale or sand tend to run down on the mating surfaces after cleaning but prior to assembling. This condition is likely to have occurred if excess tightening is required to stop a leak before warming the boiler. In this event, the best course of action is to drain the boiler and repeat the gasket fitting procedure. Failure to do so will severely reduce the life of the gasket.*

5. Clean and inspect each water level gauge (sight glass). If any water leakage is evident, renew the water level gauge gasket.

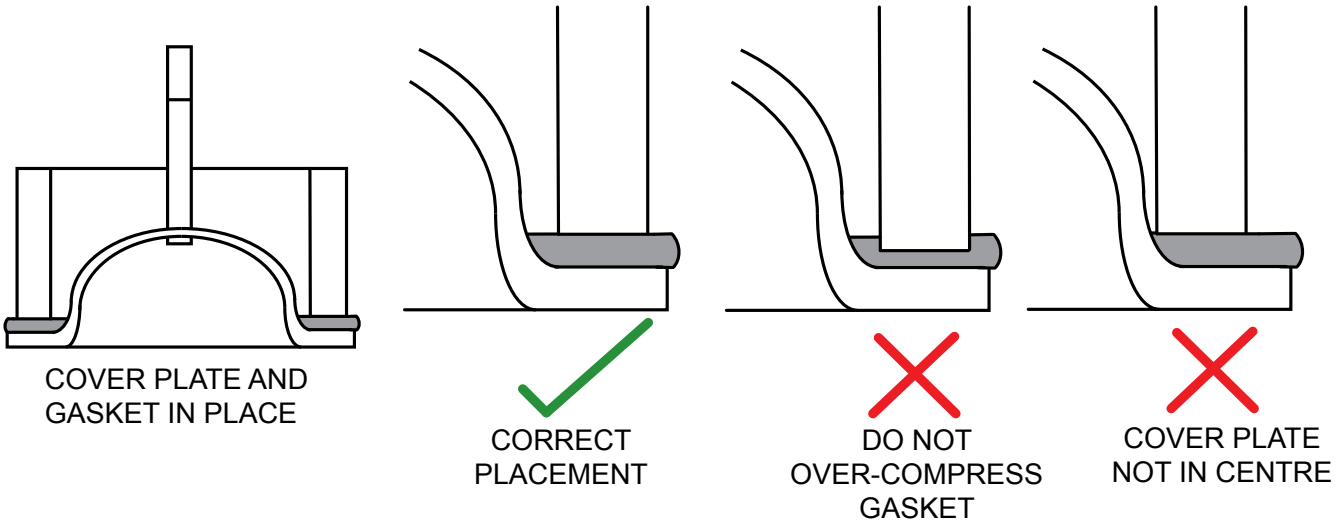


Figure. 24 - Fitting a New Topog-E Gasket

4.8 FRONT ACCESS DOOR

4.8.1 FRONT ACCESS DOOR ADJUSTMENT AND SEAL

⚠ WARNING

When handling ceramic fibre always follow the local regulations regarding such materials, including the use of breathing apparatus, suitable body protection and protective gloves.

The front access door is held in position by four swivel bolts A fitted with M48 hexagon nuts B. The hinge side is secured by a parallel hinge system allowing the door to move away from the front face of the boiler when turning the hinge nuts B anti-clockwise, but still secures the door to the hinge pin.

The swivel bolts A on the latching side can be moved out of their securing slots once the nuts are undone. In order to seal the door fully around the circumference, it is important to ensure the door is parallel to the front sealing face of the boiler before finally tightening the securing nuts to effect a seal. When opening and closing the door always slacken and then tighten all four nuts B, not just the two on the latching side.

The door seal utilises a 25 mm x 35 mm square section glass rope which is glued into an angle section welded into the perimeter of the door. Over a period of time the glass rope will lose its ability to deform sufficiently to take up the irregularities between the door and sealing faces, which may result in a gas leak, if leakage occurs the boiler should be shut down and the seal replaced. To remove the seal, locate the joint (usually at the six o'clock position). Prise out one end and using a chisel or similar to break the glued joint, pull out the remainder of the seal.

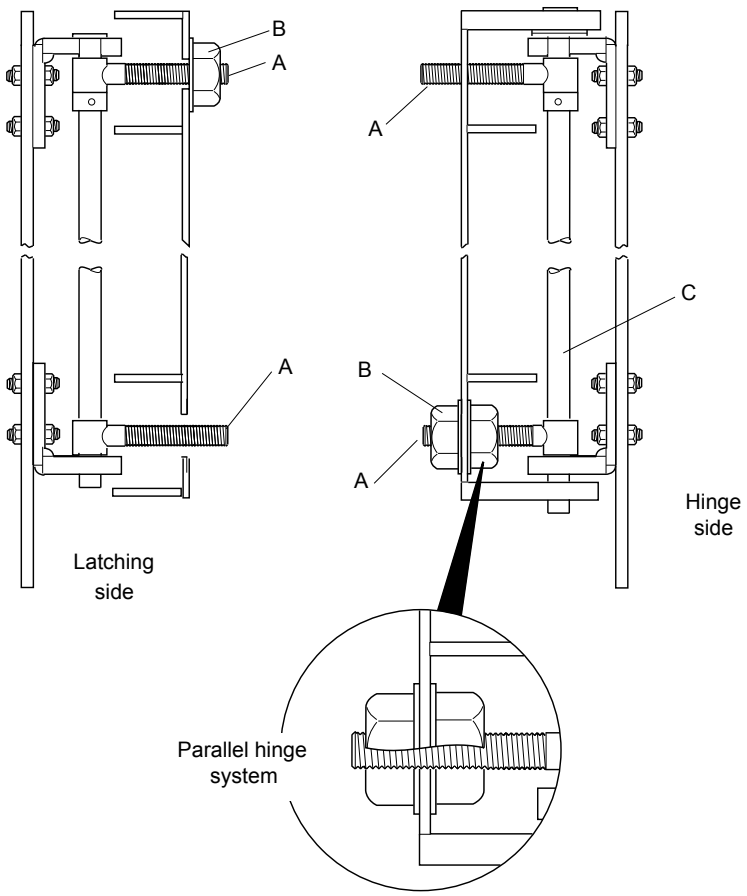


Figure. 25 - Door Hinge and Latch Assembly

4.8.2 FRONT ACCESS DOOR INSULATION

⚠ WARNING

When handling ceramic fibre always follow the local regulations regarding such materials, including the use of breathing apparatus, suitable body protection and protective gloves.

The front access door is lined with end-on ceramic fibre leaving an air gap between the fibre and the boiler tube face plate.
The face of the boiler front tube plate is also insulated with end-on ceramic fibre, the insulation is positioned around the perimeter of the shell and over the area of tube plate above the water level.
The insulation is glued into position using a high temperature adhesive.
Inspection of the tube plate to shell weld will require insulation to be removed, it is important after inspection to replace with new high temperature end-on fibre, available with adhesive from Fulton.

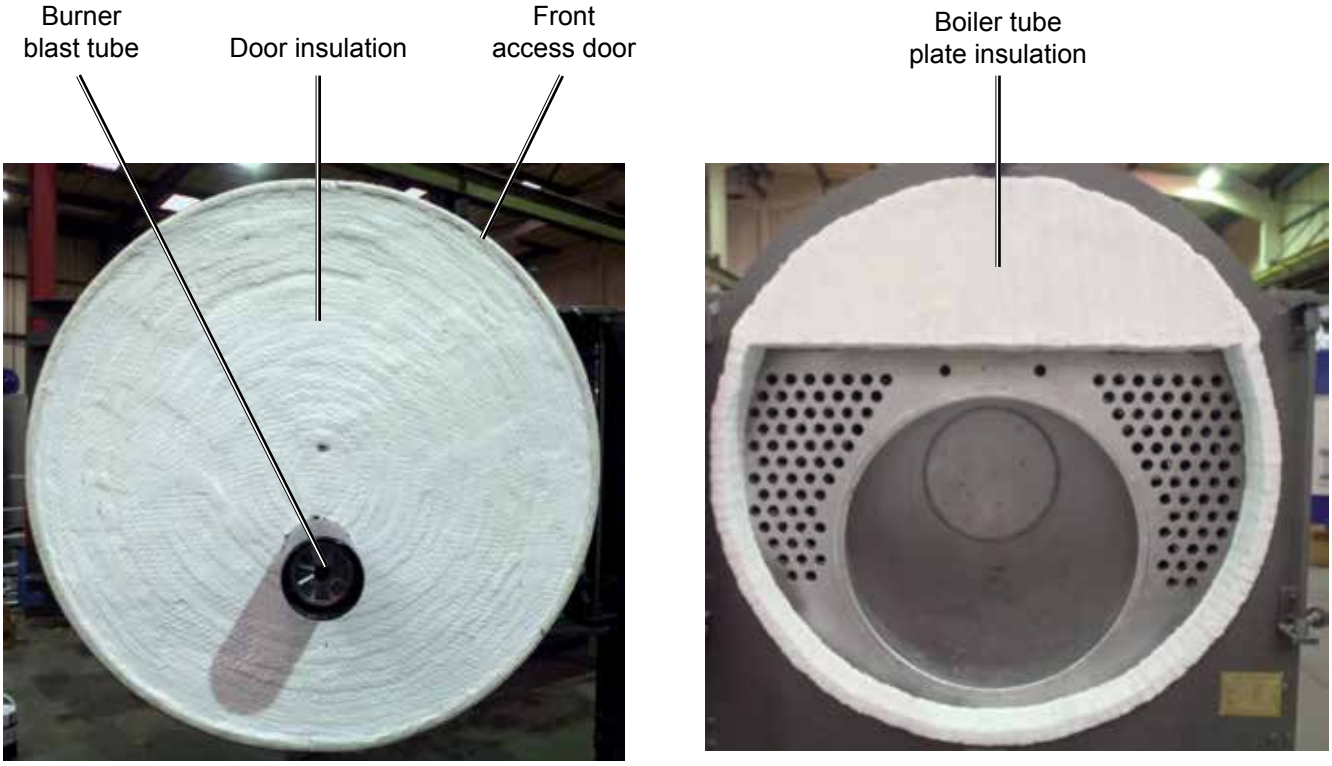


Figure. 26 - Front Access Door Insulation

4.9 FEEDWATER DISPERSER

⚠ CAUTION

DO NOT use unheated or untreated feedwater which can result in premature tube failure by oxygen corrosion.

RB Boilers are fitted with a feedwater disperser, removable for cleaning. The holes in the disperser are sized to give an exit velocity sufficient to ensure rapid mixing of the boiler water and the cooler feedwater, reducing temperature gradients within the water to a minimum.

In order to reduce oxygen corrosion to the tubes and prevent thermal shock, it is imperative that feedwater entering the boiler is heated to 80 °C - 85 °C. (The solubility of oxygen in water reduces to a minimum at 85 °C), on initial start-up this may not be possible.

As part of the water treatment programme chemicals will be dosed into the boiler feedwater line and/or the boiler feedwater tank. The nature of many of these chemicals is that they react when there is a rapid rise in temperature such that dissolved solids are precipitated and fall out of solution as a sludge.

The first major change in temperature to the feedwater is as it enters the feedwater disperser, as a result some solids will be precipitated within the disperser, the majority will be washed through, however some may remain as deposits.

The disperser should therefore be removed, inspected and cleaned at each inspection interval i.e. 6 monthly or before if the feedwater pump has difficulty in maintaining the boiler water level. To reduce the problems of possible disperser blockage, chemical dosage should always be applied as a slug into the feedwater pipe rather than into the feedwater tank.
By chemical slug method, precipitation of solids only takes place from the water either side and mixed with the dose.
By dosing the feedwater tank all of the feedwater becomes saturated with chemical causing all of the feedwater entering the boiler to release precipitates/sludge. The exceptions are Sulphite compounds used for oxygen scavenging which can be dosed directly into the feedwater tank.

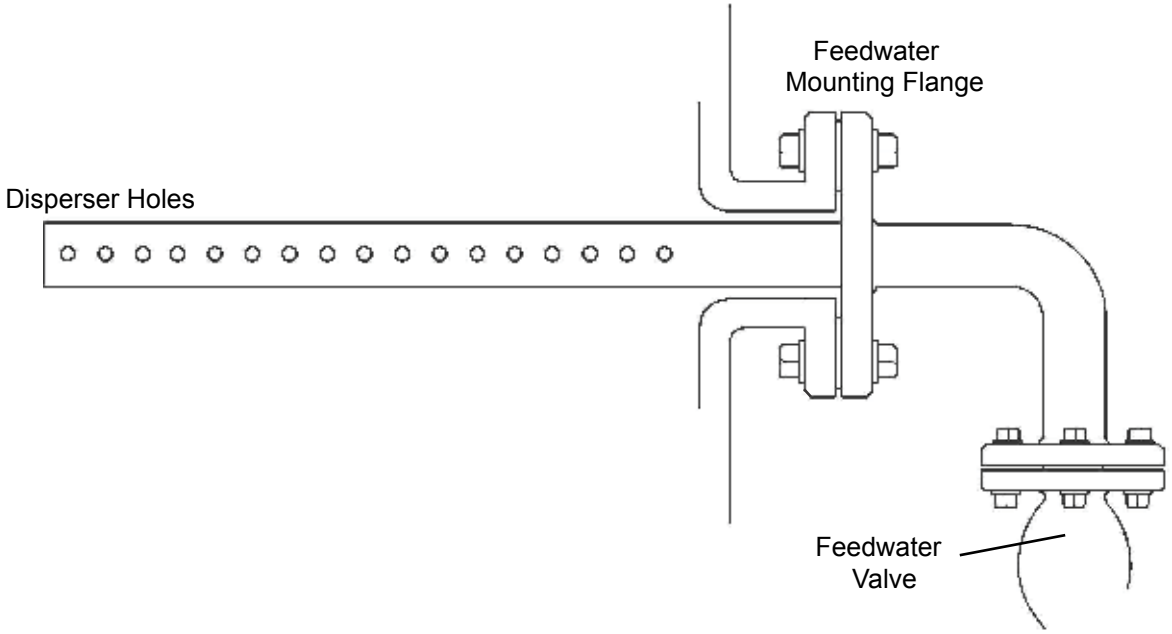


Figure. 27 - Feedwater Disperser

4.10 SERVICE INSPECTION OF WELDED JOINTS (UK ONLY)

The requirement for in-service inspection of the main welded joints of the boiler is calculated by the number of cycles since the last inspection.
Boilers running twenty four hours a day require the shell and furnace end plate welds to be inspected at five year intervals and the longitudinal seam every ten years.

Boilers that are continually heated and cooled require more frequent inspection.
During manufacture the major longitudinal and circumferential weld seams are subject to non-destructive testing by X-ray and/or Ultrasonic testing.
The boiler construction standard BS 2790 1992 class 1, specifies a minimum level of testing, in order to reduce down time during testing. RB/RBC boilers are fitted with removable cladding strips located above the main shell horizontal and circumferential weld seams. The purpose of the in-service weld inspections is to check for:-

a) Buried defects during manufacture that are outside acceptable limits. Because the boiler was 100% tested during manufacture none should be found, and upon proof of 100% manufacture testing these tests may be waived at the discretion of the ‘competent person’.

b) Cracks propagating from the region of the toe of the fillet weld on the shell to the tube plate weld, resulting from fatigue or corrosion fatigue cracking. These cracks would not be there after manufacture but can develop in service, they are caused by stress due to a combination of pressure loads, differential expansion, local temperature gradients, oxygen impurities in the boiler water/steam and inadequate pH (water chemistry) control.

Differential thermal expansion and local temperature gradients all result from continuous pressure/temperature cycling and heating from cold too quickly. Water treatment and in particular oxygen corrosion are covered in **Section 2.9 - Water Supply.** The importance of correct water treatment cannot be overemphasised.

To achieve long trouble free boiler life :

1. Maintain the boiler at working pressure as long as possible.

2. When heating from cold do so slowly.

3. Maintain water treatment within the prescribed limits at all times.

4.11 SCHEDULE OF OPERATOR TESTS AND CHECKS

The following schedule is the advice of Fulton Ltd. The frequency of tests and checks may vary according to site risk assessment and/or specific requirements of the country/territory that the boiler is installed in. Failure to maintain the boiler adequately may void the Fulton guarantee.

Maintenance on gas related parts of a boiler must be carried out by competent, trained personnel who are GAS SAFE/ACS registered, and who have the necessary equipment to check combustion.

If any fault is found during these operations, contact your Fulton representative.

⚠ WARNING

Prior to the commencement of any work requiring the removal of cover plates and the opening of the control panel box, the electrical supply to the boiler must be isolated.

Ensure any residual pressure within the boiler is completely vented before working on the pressure vessel.

⚠ CAUTION

It is essential that regular checks are made to ensure that scale build-up is not taking place within the boiler. Such checks will ensure that water treatment being applied to the boiler feedwater is effective.

Make sure that lifting equipment complies with all local regulations and is suitable for the job.
You can be injured if you use faulty lifting equipment.
Make sure the lifting equipment is in good condition.

⚠ IMPORTANT

If any fault is found during these procedures, shut-down the boiler immediately and consult Fulton Ltd.

The following procedures are designed to prevent the build-up of scale, silt or sludge in the bottom of the boiler and water level gauge (sight glass). Personnel involved in doing this work must have received the appropriate training in all aspects of maintenance and safety procedures.

In addition to these procedures, the advice of a water treatment specialist should be sought and followed.

4.11.1 DAILY

⚠ WARNING

All steam pipework, valves and fittings will be very hot.

1. Visually inspect for signs of leakage (see **Section 4.2 - Visual Checks**):
   a) Steam and feedwater pipework
   b) Valves and fittings
   c) Hand holes and man holes - If leak is detected shut down and replace the gasket.
2. 1st Low water level check (see **Section 4.4.2 - 1st Low Water Level Check)**.
3. 2nd Low water level check (see **Section 4.4.3 - 2nd Low Water Level Check).**
4. Blowdown the boiler (see **Section 4.3 –Main Boiler Blowdown**).

Note: *If the boiler is being operated automatically on a time clock, the blowdown may be done once during the working day and once at the end of the day when generating 10 psig or less, providing this is sufficient to control the TDS level within limits.*

5. Blowdown the Water Level Gauge (sight glass) (see **Section 4.5.2 – Water Level Gauge Blowdown**).

4.11.2 WEEKLY IN ADDITION

⚠ WARNING

Ensure the fittings around the steam safety valve(s) are secure.
The safety valve will be very hot, do not operate the safety valve without protection.

6. Ensure that the pipe from the safety valve outlet is not damaged and that it continues to a safe blowdown point.
7. Flame sensor test (see **Section 4.3 - Burner Flame Sensor Test**).
8. Feedwater pump test (see **Section 4.4.1 - Pump Test**).
9. Visually inspect the front door seal for leakage - If leak is detected shut down and replace the seal.
10. Carry out routine maintenance checks on the burner as recommended by the manufacturers Installation and Maintenance instructions.

4.11.3 THREE MONTHLY IN ADDITION

⚠ WARNING

The boiler should be completely cold before carrying out any of the following procedures.

11. Visually inspect the boiler interior (see **Section 4.6 - Boiler Internal Inspection**).

4.11.4 SIX MONTHLY IN ADDITION

12. Ensure the following valves are shut:
    a) Main steam stop valve
    b) Feedwater isolating valve
    c) Fuel (gas/oil) valves
13. Drain and isolate the boiler (see **Section 3.4 - Draining the Boiler).**
14. Remove the Feedwater Disperser, inspect and clean (see **Section 4.9 - Feedwater Disperser**).
15. Open the boiler front access door with the burner mounted on it as described below.
    i) Disconnect gas supply (authorised personnel only) from the gas train.
    ii) Disconnect oil supply from the oil lines.
    iii) Undo the four retaining nuts (the two on the hinge side by two complete turns) (see **Section 4.8**).
    iv) Open the door sufficiently to allow full access to furnace and tube ends.

⚠ WARNING

When handling ceramic fibre always follow the local regulations regarding such materials, including the use of breathing apparatus, suitable body protection and protective gloves.

16. Where retarders are fitted they should be removed - some burning of the retarders at the inlet end is normal.
17. Examine the internal surface of the door lining for defects. Small repairs may be carried out by cutting out the defective area and replacing with new fibre, ensure the correct adhesive is used.
18. Examine the end of the burner blast tube where it extends through the door into the furnace. Clean off any deposits, paying particular attention to the internal lip where deposits can cause irregular flame patterns.
19. Remove the rear smoke box access doors.
20. Brush through the tubes to remove any deposits from the products of combustion.

21. Using a wire brush, clean the internal surfaces of the furnace and the face of the front tube plate. Pay particular attention to the tube ligaments (the spaces between adjacent tubes).

22. Inspect the tube ends for any signs of splitting or burning.
    These are symptoms of gas reburning in the tube ends as a result of poor combustion, e.g. carbon monoxide carry-over. If the tube ends exhibit these signs, consult Fulton Ltd.

⚠ IMPORTANT
Ensure that the rear smoke box drain connections are clean and free from deposits. This is particularly important on oil fired boilers because of the acidic nature of the condensate formed.

23. Clean out the rear smoke boxes to remove the deposits brushed through from the tubes.

24. Inspect the rear smoke box door seals for deterioration and replace if necessary.

25. Remove the access panel from the economiser (where fitted), inspect the finned tubes of the economiser for clogging or blocking, clean as required. Extreme care should be taken not to damage or distort the fins. Maintenance instructions for control and safety devices fitted to the economiser system should be fully observed.

26. Refit the economiser access panel.

27. Close the boiler front access door by reversing the opening procedure.

    i) Close the boiler door.

    ii) Tighten the four retaining nuts (the two on the hinge side by two complete turns) (see **Section 4.8**).

    iii) Reconnect gas supply (authorised personnel only) to the gas train.

    iv) Reconnect oil supply to the oil lines.

28. Drain and flush the feedwater/hotwell tank, clean any filters and the strainer in the feed line before the pump.

29. Drain and flush out the blowdown separator.

30. Carry out routine maintenance to the burner as detailed in the manufacturers Installation and Maintenance instructions.

Note: Depending upon the mode of operation, it may be found that the six monthly interval can be extended, possibly to an annual service. It is strongly recommended, however, that the interval should be 6 months from initial start up until such times as a ‘pattern of use’ and the condition of the boiler after a typical 6 months can be established.

4.11.5 ANNUALLY IN ADDITION

It is a requirement of the Factories Act and Pressure Systems Regulations (UK only) that the boiler is internally inspected and re-certified at not more than 14 month intervals.

It is normal practice to carry out an annual service during which your insurance surveyor would attend to carry out the statutory inspection. The scope of a full insurance strip-down is such that it should only be attempted by persons competent to do so who have had the necessary training, and have the required test equipment. Fulton Ltd can offer this service if required.

The engineering surveyor may require the removal of the ceramic fibre insulation around the periphery of the front tube plate to facilitate inspection of the shell to tube plate weld.
The standard Fulton service kit includes replacement ceramic fibre material which must be glued in place with the adhesive supplied. It is vital the material is fitted ensuring the ends of the fibre face into the centre of the boiler.

For burner maintenance, refer to the burner manufacturer’s Installation and Maintenance instructions.

4.12 MAINTENANCE RECORD KEEPING

Boiler log sheets should be completed on a regular basis, this provides invaluable information in the subsequent investigation of the boiler history. Maintenance log sheets can be found in the Fulton boiler Log Books provided by Fulton.

To Purchase a Fulton Boiler Log Book, please contact training@fulton.co.uk.

Fulton

Model: _____ **Fuel:** _____

Horizontal Steam Boiler - Daily and Weekly Tests

Boiler Number: _____

DAILY TESTS		1	2	3	4	5	6	7
	Date							
1. **Visual Inspection** of pipework, fittings and hand holes for signs of leakage.		Y - N	Y - N	Y - N	Y - N	Y - N	Y - N	Y - N
2. **1st Low Water Level Check** - low water indicator illuminate, alarm sound and burner cuts-out.		Y - N	Y - N	Y - N	Y - N	Y - N	Y - N	Y - N
3. **2nd Low Water Level Check** - 2nd low water switch illuminates and alarm sounds.		Y - N	Y - N	Y - N	Y - N	Y - N	Y - N	Y - N
4. **Blowdown, Boiler**	Duration seconds.							
	Test Time.							
5. **Blowdown, Water Level Gauge**	Duration seconds.							
	Test Time.							
6. **Pressure gauge** reading for blowdown tests.								
Boiler water and water treatment values must be within known tolerances of the datum.								
7. **Boiler Water.**	datum value. TDS. reading							
	datum value. PH reading							
8. **Oxygen Scavenger Concentration**	datum value. reading							
9. **Brine level correct**		Y - N	Y - N	Y - N	Y - N	Y - N	Y - N	Y - N
WEEKLY TESTS								**7+**
10. **Flame Sensor Test**								Y - N
11. **Feedwater Pump Test** - Feedwater pump, start/stop								Y - N
12. **Safety valve outlet pipe** to safe blowdown point and free of damage								Y - N
13. **Evaporation Test**								Y - N

Test results and actions taken

Day			Day		
	1.	sig.		5.	sig.
	2.	sig.		6.	sig.
	3.	sig.		7.	sig.
	4.	sig.		7+.	sig.

Log examined by: _____ **Date:** _____

MAINTENANCE LOG

Date	Time	Operation Performed	Remarks	Operators Initials

4.12.1 TROUBLESHOOTING BOILER

Problem	Cause	Remedy
Starting	Power supply	Check fuses or circuit breaker.
	Gas supply	Check for gas pressure. Check main gas cock is open.
	Low water probe	Check low water probes.
	Loose wire connection	Check connections to all components.
	Control circuit dead	Door interlock microswitch.
Gas burner will not start	Gas supply	Check for gas pressure.
	Gas pressure switch(s)	Reset gas pressure switch.
	Air pressure switch	Check air pressure switch. Check fan and thermal overload switch.
Oil burner will not start	Oil supply	Check for oil in storage tank. Check oil feed line is open. Check oil solenoid valves
	Fuel pump	Check oil pump is de-aerated. Check oil strainer.
Burner will not start	Burner control locked	Reset.
	Ignition	Check ignition electrode and readjust or clean. Check transformer.
Flame failure	Flame sensor	Clean or replace.
	Burner programmer	Check functions or replace.
Poor combustion	Fuel flow	Check fuel pressure. Check fuel valves. Check fuel nozzle.
	Air adjustment	Readjust. Check air inlet. Check fan and thermal overload switch
	Off centre flame	Check diffuser alignment in the blast tube.
	Flue	Check flue for blockage.
Boiler will not maintain pressure	Gas supply	See above.
	Oil supply	See above.
	Steam pressure switch	Check steam pressure switch, readjust or replace.
	Scale build up in boiler	Check Water Treatment advisor.
	Steam traps	Check steam traps and replace as necessary.
	Dirty flue	Clean flue side of boiler.
	Steam overload	Reduce.

CONTINUED ON NEXT PAGE

4.12.1 TROUBLESHOOTING BOILER

Problem	Cause	Remedy
Wet steam, boiler primes	Too much boiler treatment chemical	Dump return tank, flush system or stop treatment for a week.
	Steam traps	See previous page.
Pump will not cut off	Earth connection	Check for tightness and clean.
	Probes connections	Check for tightness and clean.
	Dirty probes	Clean or replace.
	Water level relay	Replace.
Feedwater pump runs but does not put water into boiler	Air/steam lock in pump	Check for bad steam traps. Check for check valve in water feed line. Reduce temperature of the feedwater tank.
	Blocked water feed line	Check and clean if necessary.
	Impellers damaged	Replace pump.
Feedwater pump will not start in time	Probe connections	Check for tightness and clean the connections.
	Dirty probes	Clean or replace.
	Water level relay	Replace.
	Earth connection	Check for tightness and clean.
Low water alarm/burner shut-off will not act in time	Probe connections	Check for tightness and clean the connections.
	Dirty probes	Clean or replace.
	Water level relay	Replace.
	Earth connection	Check for tightness and clean.
Starting the boiler, the high limit steam pressure limit is illuminated and the burner stops	Boiler is completely filled with water.	Blowdown the boiler to a normal water level.
	On/off pressure switch has failed.	Check pressure switch replace as required.

Note: *For more detailed fault finding on the burner consult the burner manufacturers Installation and Maintenance instructions*

4.12.2 TROUBLESHOOTING FEEDWATER PUMP

Problem	Cause	Remedy
FEEDWATER PUMP Pump will not run	1. Supply failure.	Connect the electricity supply.
	2. Fuses/Circuit Breakers are blown.	Replace fuses/Circuit Breakers.
	3. Motor contactor overload has tripped out.	Reactivate the motor protection.
	4. Contactors not making	Check, the coil is faulty or wiring loose.
	5. Control circuit is defective.	Repair the control circuit.
	6. Motor is defective.	Replace the motor.
Motor starter overload, trips out immediately when supply is switched on.	1. One fuse/automatic circuit breaker is blown.	Replace the fuse, reset the circuit breaker.
	2. Contacts in motor contactor overload are faulty.	Replace motor starter contacts.
	3. Cable connection is loose or faulty.	Tighten or replace the cable connection.
	4. Motor winding is defective.	Replace the motor.
	5. Pump blocked.	Remove the blockage.
	6. Overload setting too low.	Set the motor starter correctly.
Motor contactor overload trips out occasionally.	1. Overload setting is too low.	Set the overload correctly.
	2. Low voltage at peak times.	Check the electricity supply.
Motor contactor has not tripped out but the pump does not run.		Check : Motor does not run when started: items: 1, 2, 4, 5, 6,
Pump capacity not constant.	1. Pump inlet pressure is too low (cavitation).	Check the suction conditions.
	2. Suction pipe/pump partly blocked.	Clean the pump or suction pipe.
	3. Pump draws in air.	Check the suction conditions.
Pump runs but gives no water.	1. Suction pipe/pump blocked.	Clean the pump or suction pipe.
	2. Foot or non-return valve blocked in closed position.	Repair the foot or non-return valve.
	3. Leakage in suction pipe.	Repair the suction pipe.
	4. Air in suction pipe or pump.	Check the suction conditions.
	5. Pump rotates in the wrong direction.	Change the direction of rotation of the motor.
	6. Boiler feedwater non-return valve letting water passed the valve seat,	Check and clean boiler feedwater non-return valve, ensure it is seating (normally and not allowing water passed. accompanied by banging in the feedwater tank).

CONTINUED ON NEXT PAGE

4.12.2 TROUBLESHOOTING FEEDWATER PUMP

Problem	Cause	Remedy
Pump runs backwards when switched off.	1. Leakage in suction pipe.	Repair the suction pipe.
	2. Foot or non-return valve is defective.	Repair the foot or non-return valve.
Leakage in shaft seal.	1. Shaft seal is defective.	Replace the shaft seal.
Noise.	1. Cavitation occurs in the pump.	Check the suction conditions.
	2. Pump does not rotate freely (frictional resistance because of incorrect pump shaft position.	Adjust the pump shaft.
	3. Frequency converter operation.	See Grundfos manual.
	4. Boiler feedwater non-return valve letting water passed the valve seat, (normally accompanied by banging in the feedwater tank).	Check and clean boiler feedwater non-return valve, ensure it is seating and not allowing water passed.
Water pump will not come on at times.	1. Scale on probes.	Check and clean probes, replace as necessary.
	2. Faulty pump contactor	Check the contactor has power. Check the contactor is pulling in. Replace if necessary.
	3. Faulty pump motor.	Check the pump has power. If the pump has power but is not running, replace it.
	4. Faulty Level Control Relay	Check the relay has power and is secure on it's base. Replace if faulty.
Low fuel pressure.	1. Gas pressure regulator	Check and replace.
Boiler flooding	1. Pump does not shut off.	Dirty probes. Clean or replace as necessary.
	2. Relay failed.	Ensure the relay is secure on its base. If so replace the water level relay.
	3. Earth connection.	Clean and tighten as required.
	4. Vacuum created with boiler off.	As the boiler cools, it pulls water from the system piping. To prevent this, add a check valve on the steam gauge assembly piping, which closes under pressure and opens under vacuum.

APPENDIX A - TI SHEETS

The Fulton boiler manual refers to a number of Fulton TI sheets. These TI sheets can be found in this Appendix.

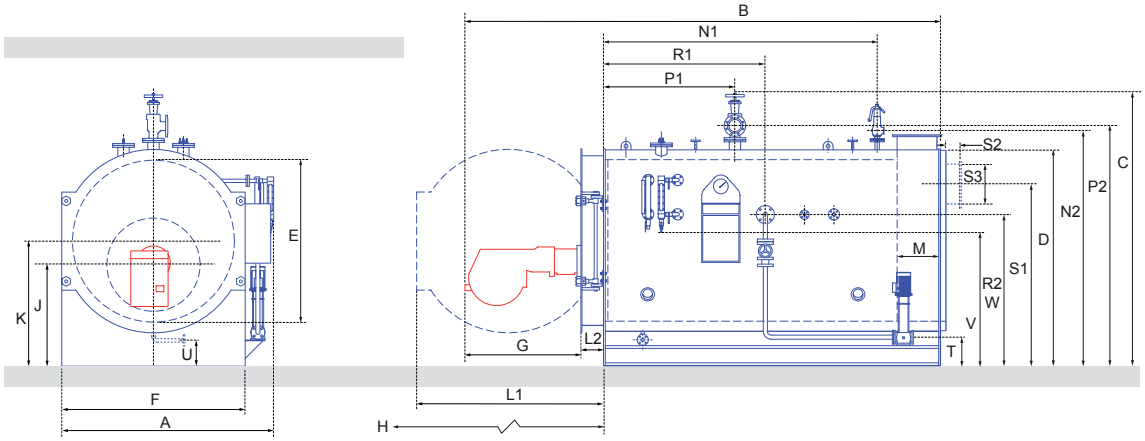
Note: *The TI sheets in this appendix can be updated/replaced without revising the manuals issue number. To check you have the most up to date TI sheet, please check the downloads section on the Fulton website (www.fulton.co.uk/support/downloads) or consult Fulton Ltd.*

Fulton Ltd

Technical Information
Sheet No. 135 Issue 1

RB Dimensions & Specification

Dimensions



MODEL: RB		1600		2600		3400	
		S	P	S	P	S	P
A	Overall Width	2000	2000	2175	2175	2350	2350
B*	Overall Length (With Gas Burner)	3575	3760	4650	4535	4965	4891
	Overall Length (With Oil Burner)	3322	3517	4407	4407	4722	4722
	Overall Length (With Dual Fuel Burner)	3615	3755	4645	4915	4960	5230
C	Overall Height	2465	2465	2750	2750	2970	1970
D	Boiler Height	2100	2100	2250	2250	2450	2450
E	Boiler Diameter	1500	1500	1650	1650	1800	1800
F	Base Frame Width	1700	1700	1870	1870	2020	2020
G*	Gas Burner Length	795	980	980	865	980	906
	Oil Burner Length	542	737	737	737	737	737
	Dual Fuel Burner Length	835	975	975	1245	975	1245
H	Tube Withdrawal Distance	2250	2250	2970	2970	3225	3225
J	Furnace Centreline Height	980	980	1035	1035	1150	1150
K	Boiler Centreline Height	1200	1200	1275	1275	1400	1400
L1	Door Opening Radius	1735	1735	1905	1905	2055	2055
L2	Front Door Depth	240	240	240	240	240	240
M	Rear Gas Chamber Depth	300	300	445	445	495	495
N1	Safety Valve Discharge to Front	2090	2090	2850	2850	3045	3045
N2	Safety Valve Discharge Height	2205	2205	2365	2365	2586	2586
P1	Steam Outlet to Front	860	860	1340	1340	1645	1645
P2	Steam Outlet Height	2245	2245	2275	2275	2620	2620
R1	Feedwater Inlet to Front	1550	1550	1675	1675	1695	1695
R2	Feedwater Inlet Height	1515	1515	1620	1620	1820	1820
S1	Rear Flue Outlet Height	1700	1700	1850	1850	2020	2020
	Top Flue Outlet Height	2170	2170	2330	2330	2525	2525
S2**	Flue Outlet Depth	150	150	150	150	150	150
S3***	Flue Diameter	300	300	350	350	450	450
T	Feedwater Pump Inlet Height	285	285	285	285	285	285
U	Main Boiler Blowdown Height	280	280	280	280	280	280
V	Water Level Gauge (Sight Glass) Blowdown Height	1340	1340	1420	1420	1590	1590
W	Water Sample Point Height	1460	1460	1540	1540	1740	1740
X	Water Level Gauge Stand Off	1050	1050	1135	1135	1270	1270

Note:

* *Dimensions given for Nu-Way burners. Other burners will vary.*

** *Flue may be rear or top mounted. N.B. Clearance must be left all round the boiler for maintenance access.*

*** *Details of flanges will vary with specification.*

Dimensions mm

Dimensions are approximate and only intended as a guide to aid installation.

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Specification

MODEL: RB	UNIT	1600		2600		3400	
		S	P	S	P	S	P
CE marked to PED, EMC, LVD & Machinery Directive, constructed to BS2790 as standard (other code specifications available).							
General							
Steam Output F & A 100°C	**kg/h**	1150	1600	1900	2600	2800	3400
kW Rating	**kW**	750	1100	1250	1700	1850	2250
Operating Pressure	**barg**	10.34	10.34	10.34	10.34	10.34	10.34
Weight							
Shipping Weight (ex. burner)	**kg**	4750	4800	7300	7350	8900	8950
Operational Weight	**kg**	6200	6250	9585	9635	11790	11840
Water Content	**L**	1450	1450	2285	2285	2890	2890
Efficiencies							
Gross	**%**	91	91	91	91	91	91
Net	**%**	82	82	82	82	82	82
Gas Pressures							
Min. Natural Gas Modulating	**mbar**	15.7	52.2	45.7	49.7	66.4	66.6
Min. Natural Gas On/Off	**mbar**	15.7	52.2	45.7	49.7	66.4	66.6
Max. Natural Gas	**mbar**	150	150	150	150	150	150
Firing Rate ****							
Gas	**m^3/h**	89	123	146	200	215	262
Oil	**L/h**	72	100	119	163	175	213
LPG/Propane	**m^3/h**	32	44	52	71	77	93
Ventilation Requirements for Combustion Purposes (Free Area)							
Low Level Inlet	**cm^2**	4020	5770	6520	8770	9520	11520
High Level Outlet	**cm^2**	2010	2885	3260	4385	4760	5760
Electrical Requirements							
FLC 400 V 3 ph 50 Hz	**A/ph**	16	16	19	19	21	21
Burner Fan, Light Oil Fired	**kW**	2.2	2.2	2.2	2.2	5.5	5.5
Burner Fan, Gas Fired	**kW**	2.2	2.2	4	4	4.5	4.5
Burner Fan, Dual Fuel	**kW**	2.2	2.2	4	4	4.4	4.4
Feedwater Pump	**kW**	2.2	2.2	2.2	2.2	3	3
Connection Sizes	**All threads BSP. All flanges to BS4504, PN16-A2 unless otherwise stated.**						
Steam Outlet (PN16)	**DN**	65	65	100	100	100	100
Safety Valve Discharge (PN16)	**DN**	40	40	50	50	65	65
Feedwater Inlet (PN16)	**DN**	25	25	32	32	32	32
Feedwater Pump Inlet (BSP)	**DN**	25	25	-	-	-	-
Feedwater Pump Inlet (PN16)	**DN**	-	-	32	32	32	32
Blowdown, Boiler (PN16)	**DN**	25	25	32	32	32	32
Blowdown, Water Level Gauge (Sight Glass) (BSP)	**DN**	15	15	15	15	15	15
Blowdown, TDS (PN16)	**DN**	25	25	25	25	25	25
Flue Outlet	**in.**	300	300	350	350	450	450
Water Sample Outlet (PN16)	**DN**	15	15	15	15	15	15
Gas Inlet, natural gas (BSPP)	**DN**	40	40	40	40	-	-
Gas Inlet, natural gas (PN16)	**DN**	-	-	-	-	80	80
Oil Connection	**in.**	Flexible hoses provided 1/2 in. BSP all models.					

Note:
**** *Figures based on gross cv figures from DUKES report 2010.*
***** *Gas booster not fitted.*

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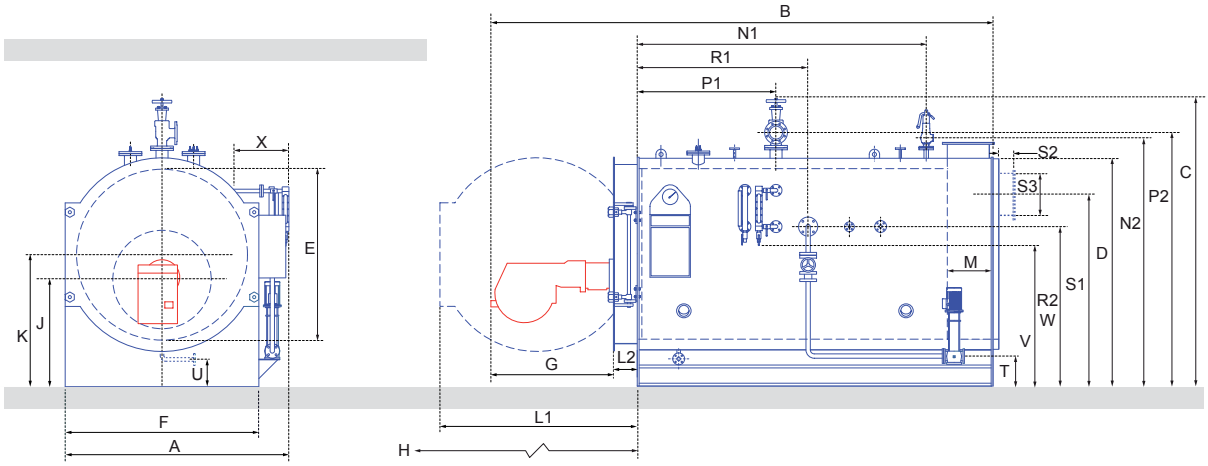
Technical Information

Sheet No. 109 Issue 4

RBC Dimensions & Specification

Dimensions



MODEL: RBC		600	750	1000	1250	1500	1850	2100	2500	3000
A	Overall Width	1960	1960	1960	2175	2175	2305	2305	2510	2508
B*	Overall Length (With Gas Burner)	3240	3325	4025	4415	4415	4725	4725	4830	4856
	Overall Length (With Oil Burner)	3310	3395	4103	4493	4493	4482	4482	4587	4860
	Overall Length (With Dual Fuel Burner)	3280	3365	4020	4410	4410	4720	4826	4931	5195
C	Overall Height	2495	2495	2545	2750	2750	2940	2940	3200	3200
D	Boiler Height	2100	2100	2100	2250	2250	2400	2400	2565	2565
E	Boiler Diameter	1500	1500	1500	1650	1650	1800	1800	2028	2028
F	Base Frame Width	1700	1700	1700	1870	1870	2020	2020	2248	2248
G*	Gas Burner Length	795	795	980	980	980	980	980	980	906
	Oil Burner Length	865	865	1058	1058	1058	737	737	737	910
	Dual Fuel Burner Length	835	835	975	975	975	975	1081	1081	1245
H	Tube Withdrawal Distance	2150	2185	2605	2945	2945	3205	3205	3205	3305
J	Furnace Centreline Height	980	980	980	1035	1035	1105	1105	1140	1175
K	Boiler Centreline Height	1200	1200	1200	1275	1275	1350	1350	1450	1450
L1	Door Opening Radius	1735	1735	1735	1905	1905	2055	2055	2285	2285
L2	Front Door Depth	240	240	240	240	240	240	240	240	240
M	Rear Gas Chamber Depth	250	300	395	445	445	495	495	550	550
N1	Safety Valve Discharge to Front	2090	2090	2520	2790	2790	3045	3045	3100	3200
N2	Safety Valve Discharge Height	2205	2205	2215	2365	2365	2250	2540	2755	2757
P1	Steam Outlet to Front	890	890	1040	1340	1340	1645	1645	1700	1750
P2	Steam Outlet Height	2245	2245	2245	2425	2425	2575	2575	2805	2809
R1	Feedwater Inlet to Front	1550	1550	1790	1650	1650	1710	1710	1855	1855
R2	Feedwater Inlet Height	1460	1460	1460	1540	1540	1695	1695	1700	1700
S1	Rear Flue Outlet Height	1700	1700	1700	1850	1850	1975	1975	2140	2140
	Top Flue Outlet Height	-	2405	2405	2555	2555	2715	2715	2875	2878
S2**	Flue Outlet Depth	152	152	152	152	152	152	152	152	152
S3***	Flue Diameter	250	300	300	350	400	450	450	500	550
T	Feedwater Pump Inlet Height	290	290	290	290	290	290	290	290	290
U	Main Boiler Blowdown Height	300	300	300	300	300	215	215	250	250
V	Water Level Gauge (Sight Glass) Blowdown Height	1330	1330	1330	1410	1410	1580	1580	1725	1725
W	Water Sample Point Height	1460	1460	1460	1540	1540	1710	1710	1863	1863
X	Water Level Gauge Stand Off	330	330	330	330	330	330	330	330	330

Note:

* *Dimensions given for Nu-Way burners. Other burners will vary.*

** *Flue may be rear or top mounted. N.B. Clearance must be left all round the boiler for maintenance access.*

*** *Details of flanges will vary with specification.*

Dimensions mm

Dimensions are approximate and only intended as a guide to aid installation.

Specification

MODEL: RBC	UNIT	600	750	1000	1250	1500	1850	2100	2500	3000
CE marked to PED, EMC, LVD & Machinery Directive, constructed to BS2790 as standard (other code specifications available).										
General										
Steam Output F & A 100°C	**kg/h**	957	1197	1596	1995	2393	2952	3350	3990	4787
kW Rating	**kW**	600	750	1000	1250	1500	1850	2100	2500	3000
Operating Pressure	**barg**	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34	10.34
Weight										
Shipping Weight (ex. burner)	**kg**	4310	4710	5350	7280	7380	8870	8970	10600	12170
Operational Weight	**kg**	5660	6160	6910	9566	9620	11758	11820	14020	16507
Water Content	**L**	1350	1450	1560	2286	2240	2888	2850	3420	4337
Minimum Gas Pressures										
Natural Gas Modulating	**mbar**	15.7	15.5	30	45.7	57.3	66.4	54.5	66	60.9
Natural Gas On/Off	**mbar**	15.7	15.5	30	45.7	57.3	66.4	54.5	66	60.9
LPG	**mbar**	50	50	50	50	50	50	50	50	50
Firing Rate ****										
Gas	**m^3/h**	67	84	112	140	168	208	236	281	337
Oil	**L/h**	64	80	106	133	159	197	226	267	321
LPG/Propane	**m^3/h**	28	35	46	58	70	86	98	117	140
Ventilation Requirements for Combustion Purposes (Free Area)										
Low Level Inlet	**cm^2**	3660	4510	5923	7336	8851	10435	11678	13444	15716
High Level Outlet	**cm^2**	1830	2255	2961	3668	4425	5217	5839	6722	7858
Electrical Requirements										
FLC 400 V 3 ph 50 Hz	**A**	6.2	7	7	8.4	8.4	8.4	10	12	12
FLC 230 V 1 ph 50 Hz	**A**	7.8	9.1	9.1	11.5	11.5	11.5	14.2	17.6	17.6
Burner Fan, Light Oil Fired	**A**	1.1	1.5	1.5	2.2	2.2	2.2	3	4	4
Burner Fan, Gas Fired	**A**	1.1	1.5	1.5	2.2	2.2	2.2	3	4	4
Burner Fan, Dual Fuel	**A**	1.1	1.5	1.5	2.2	2.2	2.2	3	4	4
Feedwater Pump	**A**	1.1	1.5	1.5	2.2	2.2	2.2	3	4	4
Connection Sizes	**All threads BSP. All flanges to BS4504, PN16-A2 unless otherwise stated.**									
Steam Outlet (PN16)	**DN**	65	65	65	100	100	100	100	125	125
Safety Valve Discharge (PN16)	**DN**	40	40	50	50	50	65	65	80	80
Feedwater Inlet (PN16)	**DN**	25	25	25	32	32	32	32	32	32
Feedwater Pump Inlet (BSP)	**DN**	25	25	25	-	-	-	-	-	-
Feedwater Pump Inlet (PN16)	**DN**	-	-	-	32	32	32	32	32	32
Blowdown, Boiler (PN16)	**DN**	25	25	25	32	32	32	32	40	40
Blowdown, Water Level Gauge (Sight Glass) (BSP)	**DN**	15	15	15	15	15	15	15	15	15
Blowdown, TDS (PN16)	**DN**	25	25	25	25	25	25	25	25	25
Flue Outlet	**mm**	250	300	300	350	400	450	450	500	550
Water Sample Outlet (PN16)	**DN**	15	15	15	15	15	15	15	15	15
Gas Inlet, natural gas (BSPP)	**DN**	40*****	40*****	40	40	40	-	-	-	-
Gas Inlet, natural gas (PN16)	**DN**	-	-	65*****	-	-	80	65	65	80
Oil Connection	**in.**	Flexible hoses provided 1/2 in. BSP all models.								

Note:

**** *Figures based on gross cv figures from DUKES report 2010.*

***** *Gas booster not fitted.*

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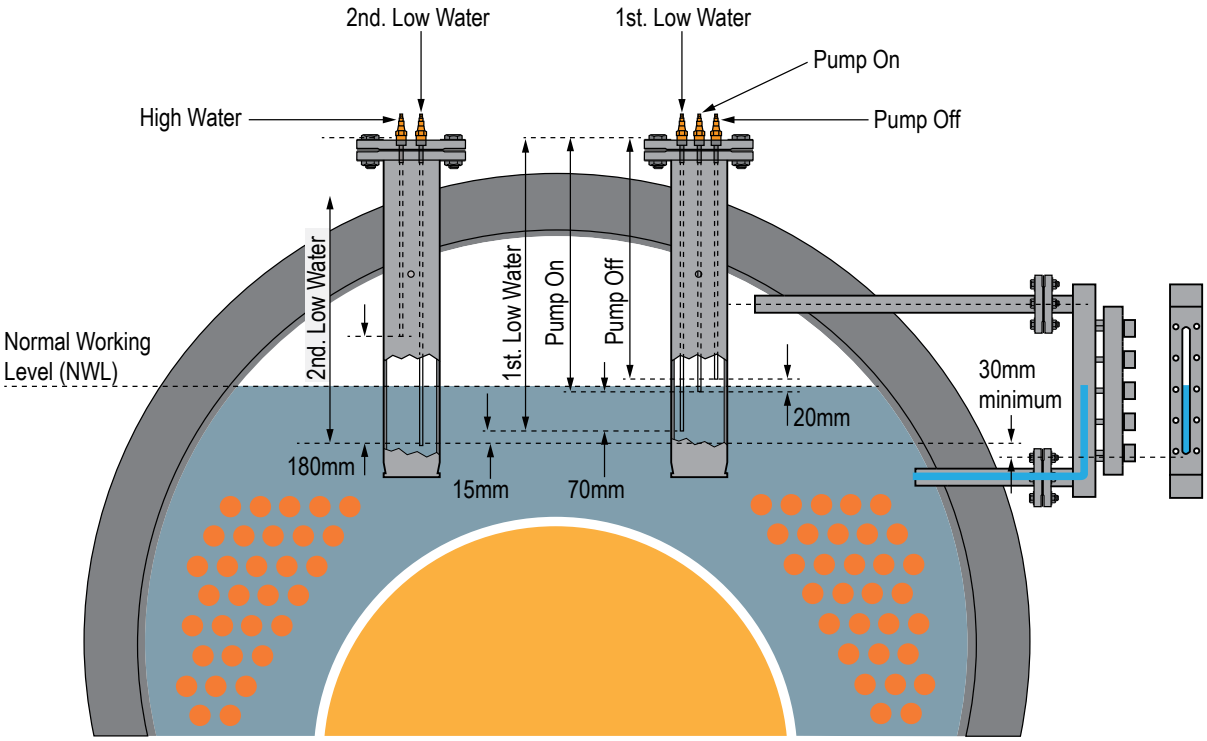
Technical Information

Sheet No. 136 Issue 1

Probe Lengths - RB Series



MODEL: RB SERIES	1600	2600	3400
Pump OFF	475	535	510
Pump ON	495	555	530
1st. Low Water	565	625	600
2nd. Low Water	580	640	615
High Water	400	460	435

Dimensions mm
Dimensions are approximate and only intended as a guide to aid installation.

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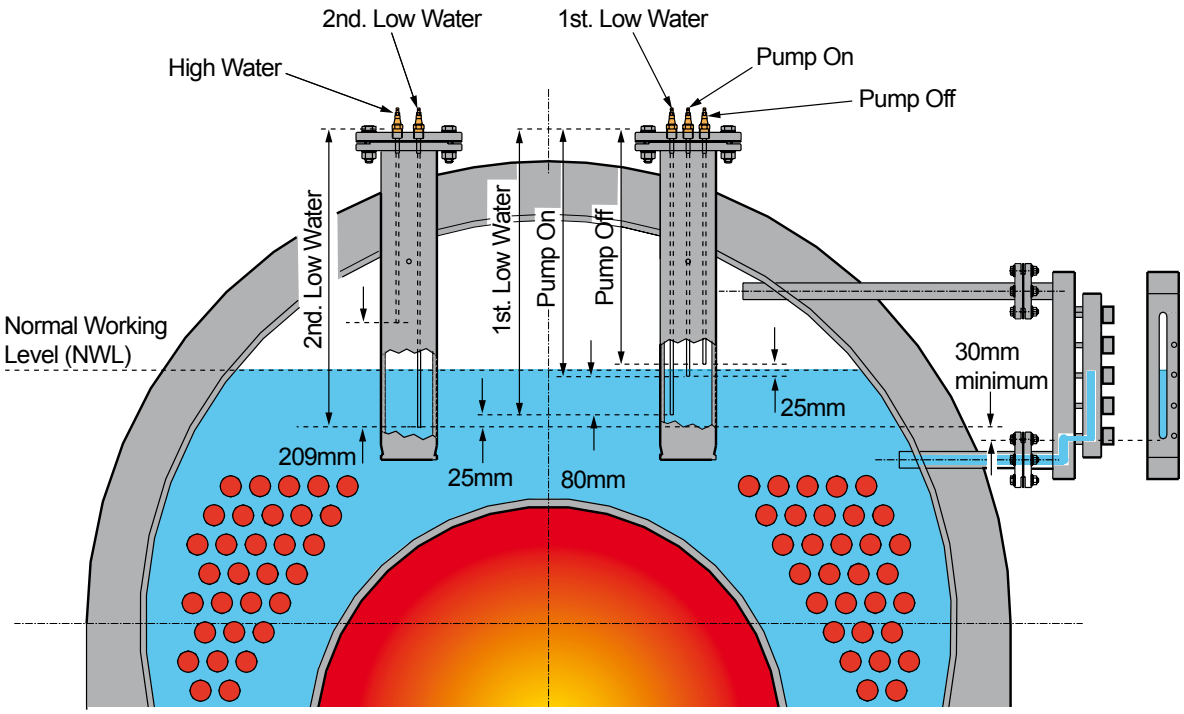
Fulton Boiler Works, (Great Britain) Ltd.

Technical Information

Probe Lengths - RBC Series

TI63



⚠ WARNING

The 2nd. Low Water at 30mm in the sight glass must not be changed.

Model	Pump OFF	Pump ON	1st. Low Water	2nd. Low Water	High Water
RBC600	415	440	520	545	336
RBC750	415	440	520	545	336
RBC1000	415	440	520	545	336
RBC1250	535	560	640	665	456
RBC1500	535	560	640	665	456
RBC1850	515	540	620	645	436
RBC2100	515	540	620	645	436
RBC2500	535	560	640	665	456
RBC3000	535	560	640	665	456

Note: Probe lengths are nominal and must be checked against the requirements of each individual boiler to achieve not less than 30mm of water in the sight glass at 2nd. low water.
All probe lengths are measured from the underside of the hex. nut.

January 2008

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Technical Information

Sheet No. 140 Issue 2

Horizontal Steam Boilers

Recommended Water Conditions

IMPORTANT

It is very important that a strict water management program is followed to ensure trouble free boiler operation.

The following are recommended for feedwater and for boiler water

FEEDWATER (water entering boiler)	
pH Value	8.5 to 9.5 tested at room temperature.
Hardness	Less than 2.0 ppm in the form of $CaCO_3$.
Suspended Solids	None
Chloride	Less than 50 ppm.
Organic Matter	Less than 5 ppm.
Oil	None
Minimum Temperature	85 °C
BOILER WATER (water inside boiler)	
pH Value	10.0 to 12.0 tested at room temperature.
Hardness	Not detectable.
Suspended Solids	Less than 200 ppm.
Chloride	Less than 500 ppm.
Oxygen Scavenger, Sodium Sulphite	30 to 70 ppm.
Tannin	30 to 70 ppm.
Phosphate	30 to 70 ppm, in the form of PO_4.
Total Alkalinity	Less than 1000 ppm.
Caustic Alkalinity	Minimum 300 ppm as $CaCO_3$.
Total Dissolved Solids (TDS)	Less than 3500 ppm.
Iron	Less than 1 ppm.
Silica	Less than 150 ppm, in the form of SiO_2.
Dissolved Oxygen	None

KEY		
mg/kg	=	Milligrams per Kilogram
$CaCO_3$	=	Calcium Carbonate
PO_4	=	Phosphate
SiO_2	=	Silicon Dioxide
PPM	=	Parts Per Million
1 Grain hardness	=	17.118 ppm
therefore 70 ppm	=	4.10 grains hardness
For practical purposes ppm	=	mg/kg

It is critical that the boiler water pH be alkaline in the range 10.0 - 12.0.

Daily boiler blowdown is essential to help prevent formation of deposits and reduce Total Dissolved Solids (TDS).

Consult your water treatment specialist to establish the frequency and duration of blowdown required to achieve the required conditions.

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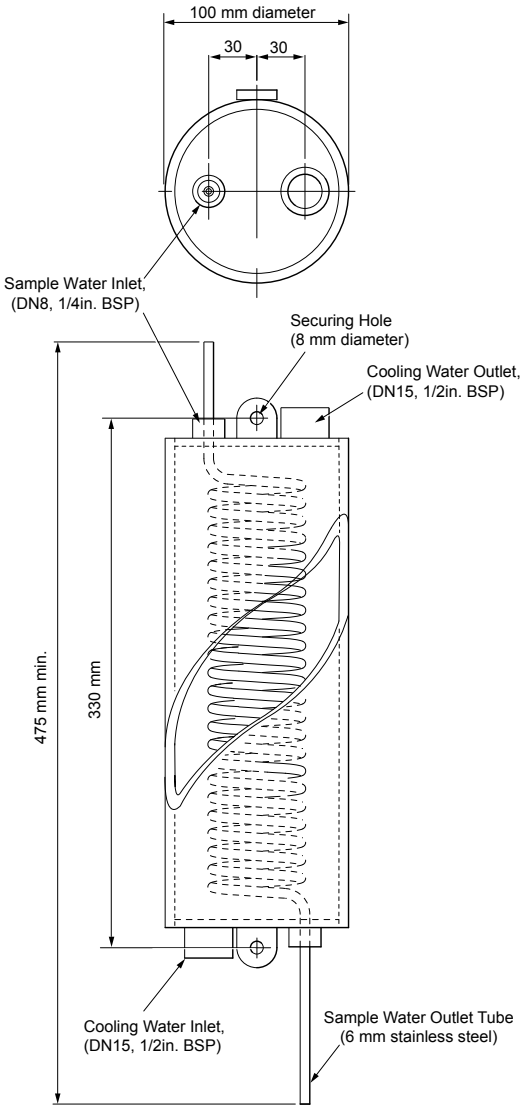
Technical Information

Sheet No. 122 Issue 5

Boiler Water Sample Cooler

Installation & Operation



The sample cooler is supplied complete with:
• Sample water inlet valve

WHY SAMPLE WATER?

In order to ensure the safe, efficient and economical running of boiler plant, it is imperative the boiler water is sampled for analysis at frequent and regular intervals.

The Fulton water sample cooler has been designed and manufactured to facilitate the safe monitoring of the boiler water.

OPERATION

Always assume the boiler sample water is capable of scalding until the sample is taken and has cooled down.

1. **Normal Boiler Operation** (sample not required)

   Ensure the valve at the boiler, feeding the sample cooler is closed.
   Ensure the boiler water sample valve and the cooling water inlet valves are closed.

2. **Taking a Sample**

   When a sample is ready to be taken, open the cooling water inlet valve and check the water is flowing through the cooler to drain.

   Provide a suitable receptacle to receive the sample.
   Open the boiler water sample valve adjacent to the boiler and slowly open the boiler water sample valve located on the sample cooler, allow the sample water to run for approximately 30 seconds to remove the standing water from the sample cooler feed line.
   Take a sample of the boiler water.

3. When the sample has been taken, close the boiler water sample valve and the cooling water inlet valve.
   Close the boiler valve feeding the sample cooler.

CONNECTIONS	
Cooling Water Outlet	DN15 (1/2in.BSP)
Sample Water Inlet	DN8 (1/4in.BSP) Valve Fitted to 6 mm O/D tube
Fitting kit	Available on request

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Technical Information

Sheet No. 103 Issue 3

Water Level Probes

Replacement

Standard Probes (brass)

Probes are supplied in a standard length and should be cut to the length required, (the length of the probe being replaced) ensuring measurements are taken from the underside of the probe hexagonal nut, remove any burrs caused by cutting.

⚠ IMPORTANT
Terminal and securing nuts must not be adjusted.
Only Angle Rajah are to be used to connect wire to the probes.

The Terminal & Securing Nuts are tightened to a specified torque during manufacture which causes the PTFE Insulation to seal against the probe body. Therefore these nuts must not be adjusted because the seal will be broken which may cause the probe to leak (see **Figure. 1**).

Angle Rajah **ONLY** must be used to connect wire to the probes because they clip directly to the Terminal Nut. Spade Connectors must **NOT** be used because the Terminal Nut would require adjustment and therefore cause the probe to leak (see **Figure. 2**).

N.B. The Probe Rod Grub Screw and Lock Nut are suitably tightened during manufacture, meaning the probe is ready to be installed without any adjustment.

The **ONLY** instance a spanner should be used, is to turn the Probe Body in order to remove or reinstall the entire probe.

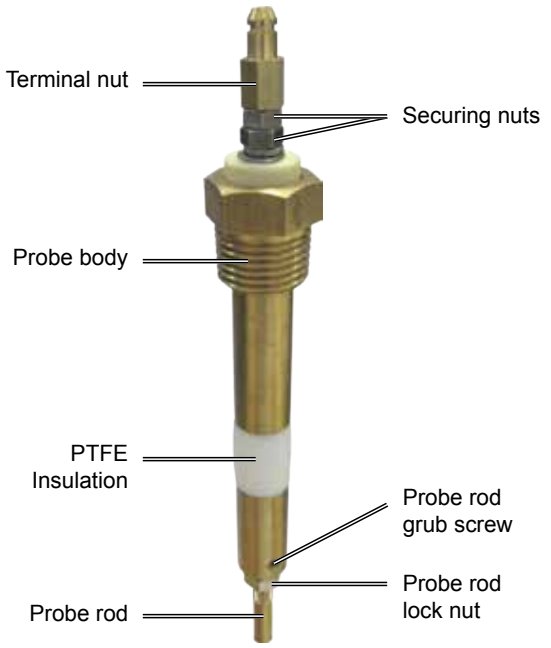

Figure. 1 - Water Level Probe Components

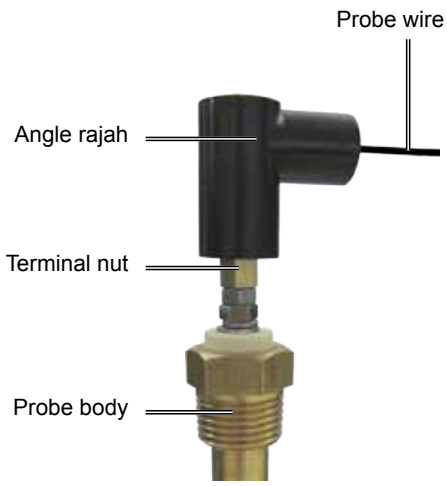

Figure. 2 - Angle Rajah Fitted to Probe

High Integrity Probes (stainless steel)

TI-103-WaterLevelProbes-2015-3

The probe is supplied in two parts, the head and the tip. The tip should be screwed onto the head aligning the slot in the top of the tip with the hole in the screwed shaft of the head.

Locate the pin provided into the slot/hole and secure with the lock nut.

Using the measurement from the old probe, cut the new probe to length and de-burr. Ensure both measurements are taken from the underside of the hex. nut on the probe head.

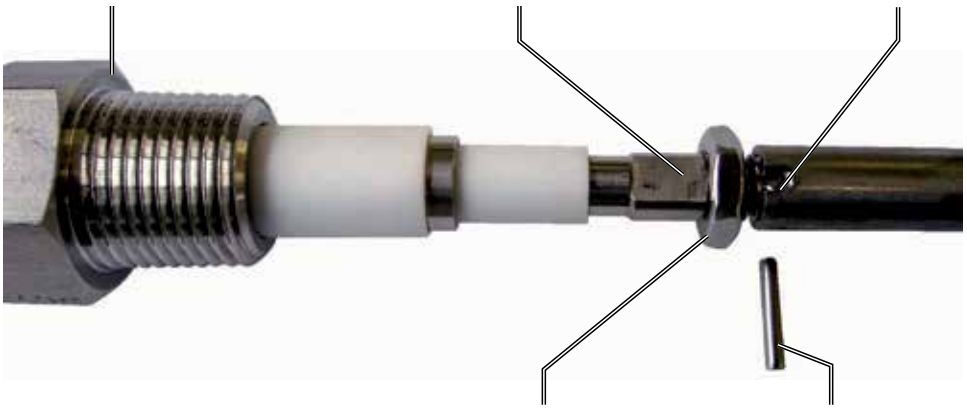

Figure. 3 - High Integrity Water Level Probe

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Technical Information

Sheet No. 30 Issue 3

Automatic TDS Blowdown Systems

The purpose of an Automatic, Total Dissolved Solids (TDS) Control Blowdown System, is to control the TDS level within the boiler around a set point. It is not a substitute for the main boiler blowdown, which must be used to control suspended solids, and prevent the build-up of sludge in the bottom of the boiler. The daily testing of boiler water level controls is a mandatory requirement as defined in the Health & Safety Executive Guidance Note BG01, Arrangement 3.

The method of operation is to take a sample of the boiler water at pre-set timed intervals, pass the sample over an electrode which measures water conductivity (which is proportional to TDS for a given water chemistry), and then compares the result with the control value (normally 2000 ppm), which is set when the unit is commissioned.

If the sample value is higher than the control value, the blowdown solenoid valve opens in a series of pulses until the measured value corresponds to, or is lower than, the set value. When this is achieved, blowdown finishes until the next timed sample is taken when the process is repeated. Should the sample value be lower than the set value, blowdown is deferred until the next timed sample.

For the system to function reliably, the control must be calibrated to a typical water sample that is representative of the water conditions that are likely to prevail during normal running of the boiler and system. Conductivity and as a consequence TDS, can vary significantly with water chemistry. Changes in condensate return rates, alkalinity, chemical dosage, and suspended solids can all affect the performance of an Automatic TDS Blowdown System.

Condensate return rates that vary greatly on a day to day basis can severely disrupt the reliability of the conductivity measurement.

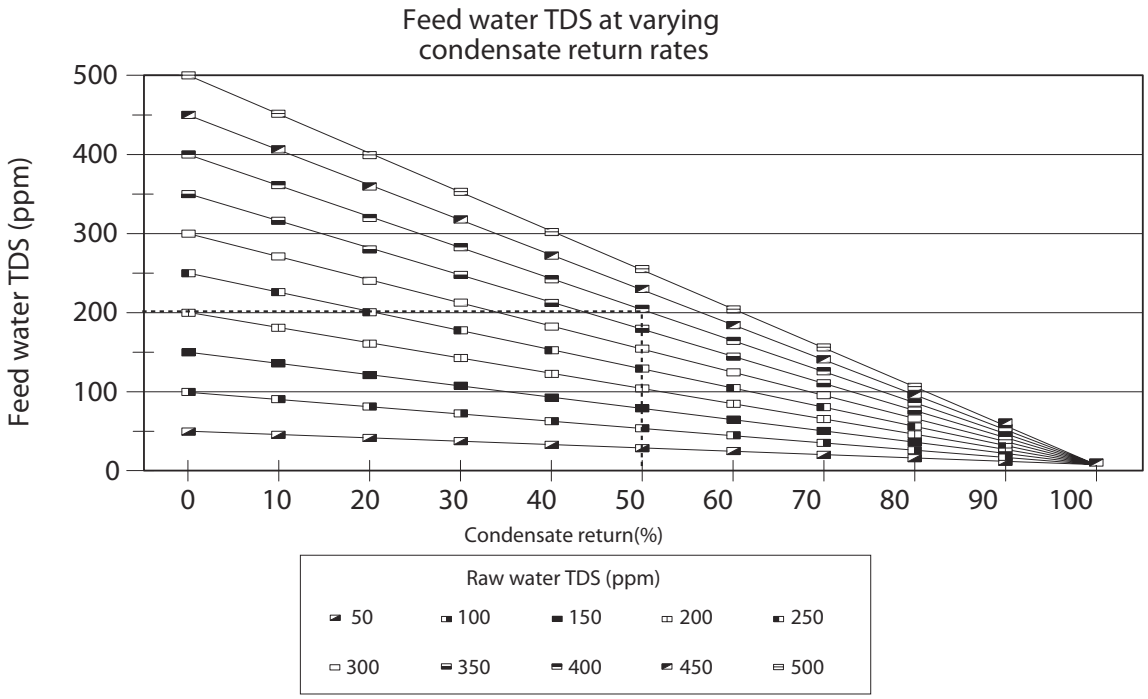

Figure. 1 - TDS Graph 1

e.g. A boiler with a 50% condensate return and a raw water TDS of 400 will have a boiler feed water TDS of 200 ppm.

TI-30-AutoTDSBlowdown-2015-3

Systems that return for example very little condensate during the day, but a high proportion at night, are almost impossible to control with any real accuracy. At best a compromise calibration will be achieved, where too much blowdown at times may be the penalty.

When installing and commissioning a new Automatic TDS Control Blowdown System, it must be accepted that the calibration will be a reiterative process, requiring continual sampling, testing, and re-calibration until stable system operating conditions are achieved.

When purchasing an Automatic TDS Control Blowdown System from Fulton, the equipment would normally be supplied with the controller wired and fitted to the boiler control panel, with all the other parts supplied loose for piping and wiring on site by others, unless agreed otherwise in our order acknowledgement.

The purchase price of the system supplied fully or part fitted includes for one single visit to commission the system once installed. Part of the commissioning process will be the initial calibration of the TDS sensor to the water conditions prevailing at the time.
Further re-calibration will be required until the water treatment regime has been established, and “typical” water conditions have been achieved. Routine calibration checks will be required as part of the site maintenance and water treatment monitoring.

The equipment and staff training required to carry out TDS sampling and calibration can be provided by Fulton. In order to achieve the maximum benefit from the installation of an Automatic TDS Blowdown System, it is strongly recommended that site personnel be provided with the necessary equipment, and training in order for them to fully understand the function of the system, and the possible consequences of their actions.

Note: *Where Automatic TDS Blowdown systems are provided as part of a skid mounted or packaged plantroom system, they will be fully installed piped and wired.*

For further details on the installation of Automatic TDS Controlled Blowdown Systems consult the Fulton Ltd **Technical Information Sheet 35. Automatic TDS Control Blowdown System Installation Guide.**

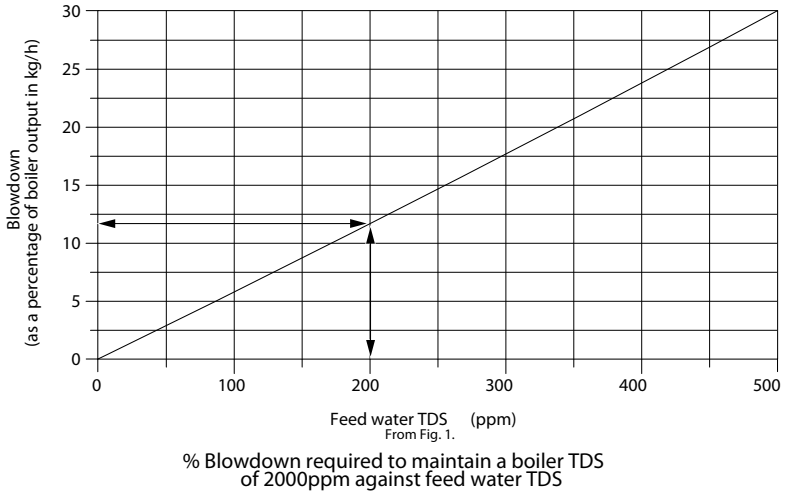

Figure. 2 - TDS Graph 2

e.g. Hourly blowdown rate required to maintain a boiler TDS of 2000 with a feedwater TDS of 200 = 12%

For a 1000 kg/h boiler 125 kg/h (125 l/h) of blowdown is required.

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On the Fulton Boiler Pressure Vessel

Fulton Ltd will repair or replace EXW factory any Fulton pressure vessel which within three (3) years of the date of delivery is found to be defective in workmanship, or material, provided this equipment is operated and maintained by the buyer for the purpose for which it was designed and in accordance with the manufacturer's handbook. This guarantee does not cover damage or failures that can be attributed to corrosion, scale or dirt accumulation or to low water conditions. This guarantee is good only in the United Kingdom of Great Britain and Northern Ireland. This guarantee does not include labour or delivery charges of any kind.

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