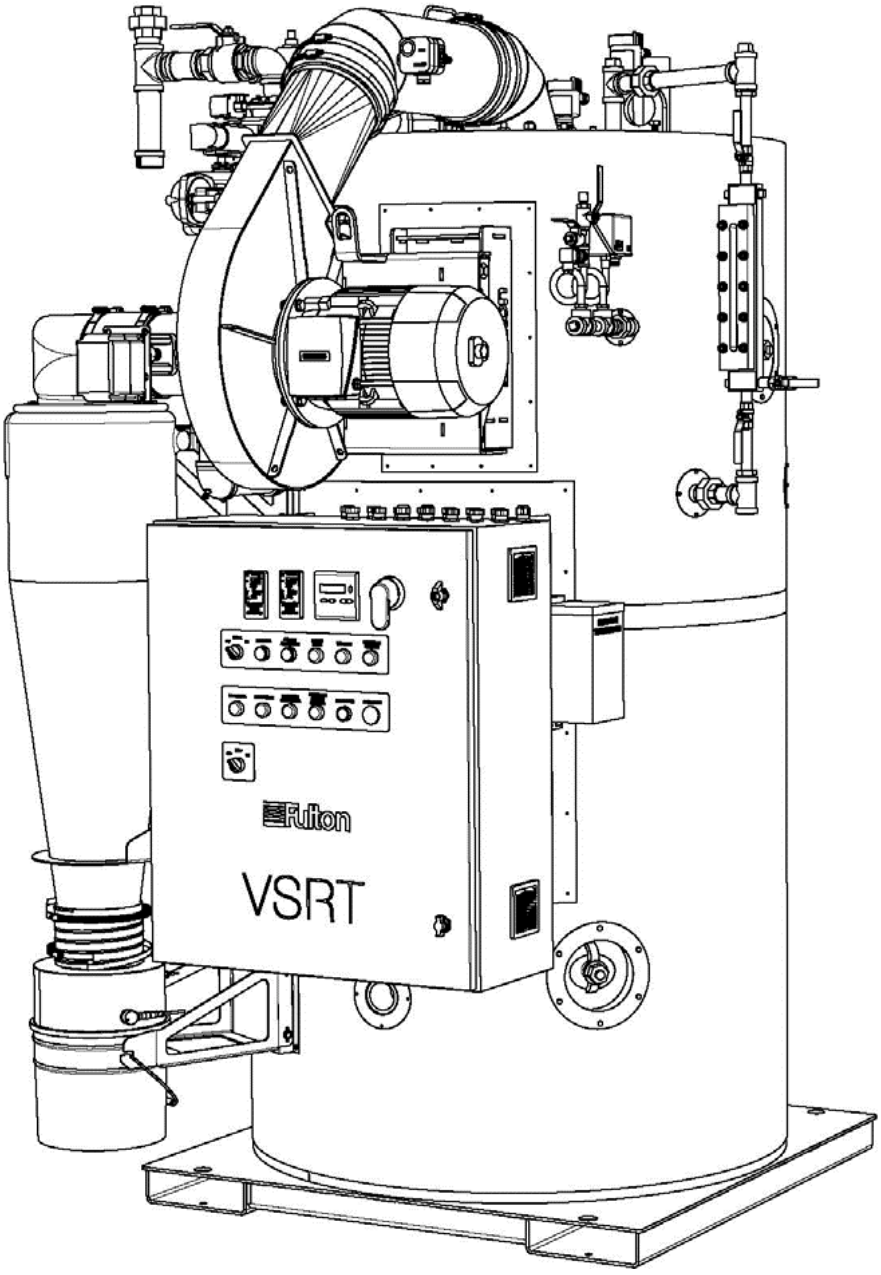
Fulton®
Improving life through heat transfer solutions

VSRT™

INSTALLATION, OPERATION AND MAINTENANCE MANUAL



VSRT Series

Gas Fired Steam Boilers

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I WARNINGS & CAUTIONS EXPLAINED

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.

II WARNINGS & CAUTIONS IN MANUAL

⚠ WARNING
Steam boilers are a potential hazard and are potentially 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.

Escaping gas can lead to explosions which may result in severe injury.

WHAT TO DO IF YOU SMELL GAS:

- Do not use matches, candles, flame, or other sources of ignition to check for gas leaks.
- Do not try to light the appliance.
- Do not touch any electrical switch; do not use any phone in your building.
- Immediately call your gas supplier from a safe location.
- Follow the gas supplier's instructions. If you cannot reach your gas supplier, call the fire department.

Flue Gas can lead to life threatening poisoning.

WHAT TO DO IF YOU HAVE A FLUE GAS LEAK:

- Shut down the heating system.
- Ventilate the boiler room.
- Close all doors leading to the space.

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 boiler 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.
The installation of gas appliances including the flue system should only be carried out by Gas Safe registered engineers.
Steam boilers have hot 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 flammable materials near the boiler.
The importance of correct boiler water and feedwater cannot be over emphasized, 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.
Boilers should always be drained through an approved blowdown vessel.
This boiler is equipped with an ignition device, which automatically lights the burner. Do not try to light the burner by hand.
Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation.
Never attempt to operate equipment that has failed to pass all the safety checks.
Follow proper lockout procedures for the electrical, gas and water connections.
If any “Manual Reset” limit device trips, DO NOT reset without determining and correcting the cause. (Manual Reset Limits may include flame safeguard, high or low gas pressure, high pressure limit.)
Never tamper with low water (liquid level) cut-off sensors or circuitry.
Before commissioning the equipment, verify with authorized personnel that gas lines have been purged and certified.
Check daily that the equipment area is free and clear of any combustible materials, including flammable vapours & liquids.
Do not store or use gasoline or other flammable vapours and liquids or corrosive materials in the vicinity of this or any other appliances. Cements for plastic pipe should be kept away from all sources of ignition. Proper ventilation should be maintained to reduce the hazard and to minimize breathing of cement vapours.
No shut-off of any kind shall be placed between the safety relief valve and the equipment or in the discharge pipe between such valve and the atmosphere. Doing so can cause an accidental explosion from overpressure.

⚠ WARNING

The discharge from the safety relief valve shall be arranged so that there will be no danger of scalding personnel or damage to equipment. Provisions should be made to properly drain safety relief valve discharge piping.

Fluids under pressure may cause injury to personnel or damage to equipment when released. Be sure to shut off all incoming and outgoing fluid shut-off valves and carefully decrease all trapped pressures to zero before performing any maintenance.

Do not attempt to start the equipment for any testing prior to filling and purging the vessel. A dry fire will seriously damage the equipment and may result in property damage or personnel injury and is not covered by warranty. In case of a dry firing event, shut off the fuel supply and allow the vessel to cool to room temperature before fluid is reintroduced to the pressure vessel. The boiler should be inspected by a qualified individual prior to commissioning the unit.

When opening any drains on the equipment or piping system, steps should be taken to avoid scalding/ burning of personnel due to hot fluids. Whenever possible, the system should be cooled prior to opening any drains.

Hot surfaces (over 49 °C) should be insulated or shielded for safety where practicable. See installation section.

Should overheating occur or the gas supply fails to shut off, manually shut off the gas supply external to the equipment.

Improper installation or maintenance of gauge glass and connections can cause immediate or delayed breakage resulting in bodily injury and/or property damage. Only trained personnel should install and maintain gauge glass connections. Wear suitable safety eyewear during installation. Be sure all parts are free of chips and debris.

⚠ CAUTION

WATER SOFTENER, SALT & 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 always available (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. To ensure the material/ pressure vessel does not suffer from brittle fracture, hydraulic testing should not be conducted below 7 °C.

The flue arrangement and draft conditions should be in accordance with the information in this manual for proper performance of the equipment.

Use appropriate leak-detection fluid. Clean all piping thoroughly after completing the leak check.

A temperature exceeding 32 °C* in the boiler room may cause premature failure of electrical components. Provisions should be made to maintain an ambient temperature of 32 °C* or less (the panel box interior should not exceed 32 °C*.
*Pumps, Programmable Logic Controllers (PLC) or sequence panels may require lower ambient temperatures or additional cooling.

Particulate matter or chemicals (example: per chloroethylene, chlorine, or halogenated compounds) in the combustion air supply to the boiler will cause damage or failure to the burner and is not covered under warranty. High-risk situations for particulate matter to be in the air include construction and maintenance activities.

For all systems containing boilers or unfired steam generators, the water chemistry in the boiler must be kept within the limits outlined in this manual. Failure to do so may cause premature pressure vessel failure and poor steam quality and will void the warranty.

Do not run the pump dry. Irreparable damage to the seal can result. Prime the pump in accordance with the manufacturer's instructions. Never operate the pump with a closed discharge valve.

Should you suspect that the boiler's flue passageways have become blocked, stop the boiler immediately and contact the Fulton office.

II REGULATIONS

Observe the following when working on this system:

- Work on gas equipment must only be carried out by a qualified gas engineer
- Work on electrical equipment must only be carried out by a qualified electrician.
- All legal instructions regarding the prevention of accidents,
- All legal instructions regarding environmental protection,
- The Code of Practice of relevant trade associations,
- All current safety regulations as defined by PED, DIN, EN, DVGW, TRGI, TRF, VDE and all locally applicable standards,
- Gas Safety (Installation & Use) Regulations
    - The appropriate Building Regulation either the building regulations, the Building Regulation (Scotland) or Building Regulations (Northern Ireland)
    - The Water Fittings Regulation or Water Bylaws in Scotland,
    - The current I.E.T. Wiring Regulations.

⚠ 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.

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.

a) Health and Safety Executive local office.

b) Your Competent Person.

SECTION 1 – INTRODUCTION

1.1 GENERAL

Prior to shipment, the following inspections and tests are made to ensure the highest standards of manufacturing for our customers:

- Material inspections
- Manufacturing process inspections
- Hydrostatic test inspection
- Electrical components inspection
- Documented Fire and Test (FaT)
- Packing, inspection and final check

This manual is provided as a guide to the correct operation and maintenance of your Fulton equipment, and should be read in its entirety and be made permanently available to the staff responsible for the operation of the boiler. It should not, however, be considered as a complete code of practice, nor should it replace existing codes or standards which may be applicable.

Fulton reserves the right to change any part of this installation, operation and maintenance manual.

Installation, start-up, and maintenance of this equipment can be hazardous and requires trained, qualified installers and service personnel. Trained personnel are responsible for the installation, operation, and maintenance of this product, and for the safety assurance of installation, operation, and maintenance processes. Do not install, operate, service or repair any component of this equipment unless you are qualified and fully understand all requirements and procedures.

1.2 TECHNICAL DATA

For a full specification refer to **Appendix A – VSRT Data Sheets.**

1.3 PRODUCT OVERVIEW

The VSRT fuel fired steam boiler is a vertical two-pass boiler of efficient design and construction. The VSRT uses Fulton's PURE technology to achieve higher efficiency and lower NOx levels with a smaller footprint than its Fulton J series equivalent.

VSRT connections and specifications are listed in Tables 1 and 2 and shown in Figures 1, 2, 3 and 4.

Table 1 – VSRT Customer Connections (See Figs. 1-4)

	10/15BPH		20/30 BPH		40/50/60 BPH	
Description	**Size**	**Type**	**Size**	**Type**	**Size**	**Type**
A. Feed Water Inlet	1"	B.S.P.T.	1"	B.S.P.T.	1"	B.S.P.T.
B. Blowdown Outlet	1¼"	B.S.P.T.	1¼"	B.S.P.T.	1½"	B.S.P.T.
C. Steam Outlet	1¼"	DN32	1½"	DN32	2"	B.S.P.T.
D. Flue	152.4	------	202	------	254	------
E. Auxiliary Water Column	1"	B.S.P.T.	1"	N.P.T.	1"	N.P.T.
F. Fuel Inlet	1"	B.S.P.T.	1¼"	B.S.P.T.	1½"	B.S.P.T.
G. Water Column	1"	B.S.P.T.	1"	B.S.P.T.	1"	B.S.P.T.
H. Surface Blowdown	¾"	B.S.P.T.	¾"	B.S.P.T.	¾"	B.S.P.T.
J. Combustion Air Inlet	101.6	-----	152.4	------	152.4	------
K. Safety Relief Valve	¾"	B.S.P.T.	¾"	B.S.P.T.	1"	B.S.P.T.
L. Steam Gauge Port	¼"	B.S.P.T.	¼"	B.S.P.T.	1/42	B.S.P.T.
M. Inspection Port	-----	-----	-----	-----	82.55	150#
N. Inspection Opening	-----	-----	-----	-----	50.8	N.P.T.

Table 2 – VSRT Specifications

Unit Size (BHP)	**10**	**15**	**20**	**30**	**40**	**50**	**60**
Maximum allowable working pressure (barg)	10.34 barg	10.34 barg	10.34 barg	10.34 barg	10.34 barg	10.34 barg	10.34 barg
Boiler input	120 kw	179 kw	239 kw	359 kw	478 kw	598 kw	718 kw
Boiler input (Natural gas); m3/hour	10.7 m3/hr	16.1 m3/hr	21.5 m3/hr	32.3 m3/hr	43 m3/hr	53.9 m3/hr	64.7 m3/hr
Boiler input (Propane); m3/hour	4.6 m3/hr	6.9 m3/hr	9.2 m3/hr	13.8 m3/hr	18.3 m3/hr	23 m3/hr	27.6 m3/hr
RATINGS* (Sea level to 914.4m)							
Boiler Output	98 kw	147 kw	196 kw	294 kw	392 kw	490 kw	589 kw
Steam Output - Minimum Service Capacity; kg/hr	156 kg/hr	235 kg/hr	313 kg/hr	470 kg/hr	626 kg/hr	782 kg/hr	939 kg/hr
Net Effective Heating Service (m2)	5.06 m2	5.06 m2	6.04 m2	6.04 m2	10.77 m2	10.77 m2	10.77 m2
Water Capacity (Operating)	356 litres	356 litres	424 litres	424 litres	1,306 litres	1,306 litres	1,306 litres
Burner Turndown	4:1	6:1	4:1	6:1	6:1	8:1	10:1
Minimum Draft Requirement	-0.25" W.C.	-0.25" W.C.	-0.25" W.C.	-0.25" W.C.	-0.25" W.C.	-0.25" W.C.	-0.25" W.C.
Minimum Incoming Gas Pressure	19 mbar	19 mbar	19 mbar	19 mbar	19 mbar	19 mbar	19 mbar
Weights (Approximate)							
Dry Weight; kg	876 kg	876 kg	1,284 kg	1,284 kg	2,654 kg	2,654 kg	2,654 kg
Operating Weight; kg	1,232 kg	1,232 kg	1,707 kg	1,707 kg	3,959 kg	3,959 kg	3,959 kg
Shipping Weight; kg	1,134 kg	1,134 kg	1,542 kg	1,542 kg	2,800 kg	2,800 kg	2,800 kg
Flooded Weight; kg	1,364 kg	1,364 kg	1,841 kg	1,841 kg	4,228 kg	4,228 kg	4,228 kg
Electric Power Requirements							
Voltage	400/50/3	400/50/3	400/50/3	400/50/3	400/50/3	400/50/3	400/50/3
Operating FLA (refers to boilers rated draw at high fire)	14.8 AMPS	14.8 AMPS	14.8 AMPS	21.6 AMPS	21.6 AMPS	21.6 AMPS	21.6 AMPS

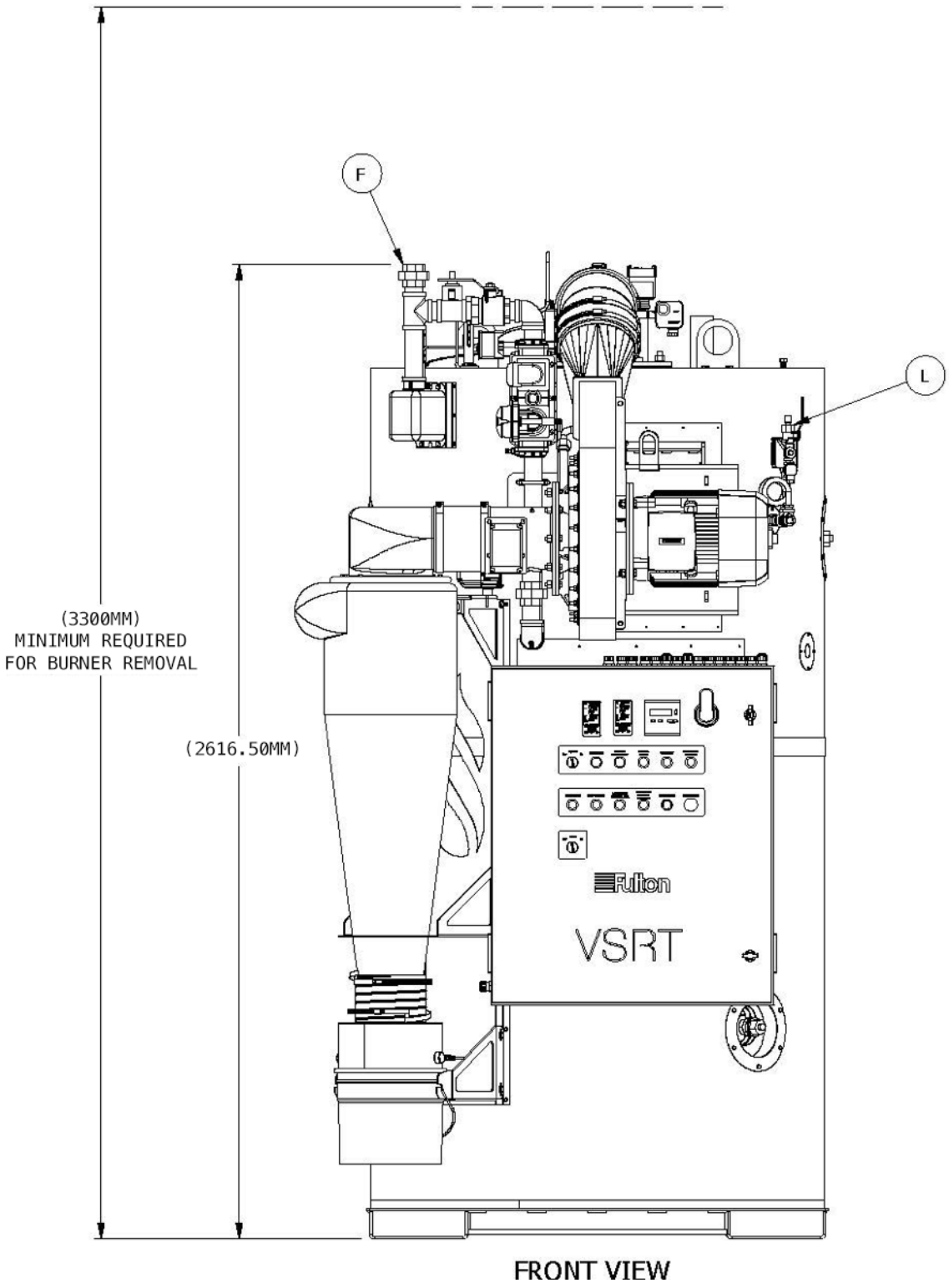


Figure 1 - Model VSRT-60 Dimensions – Front View

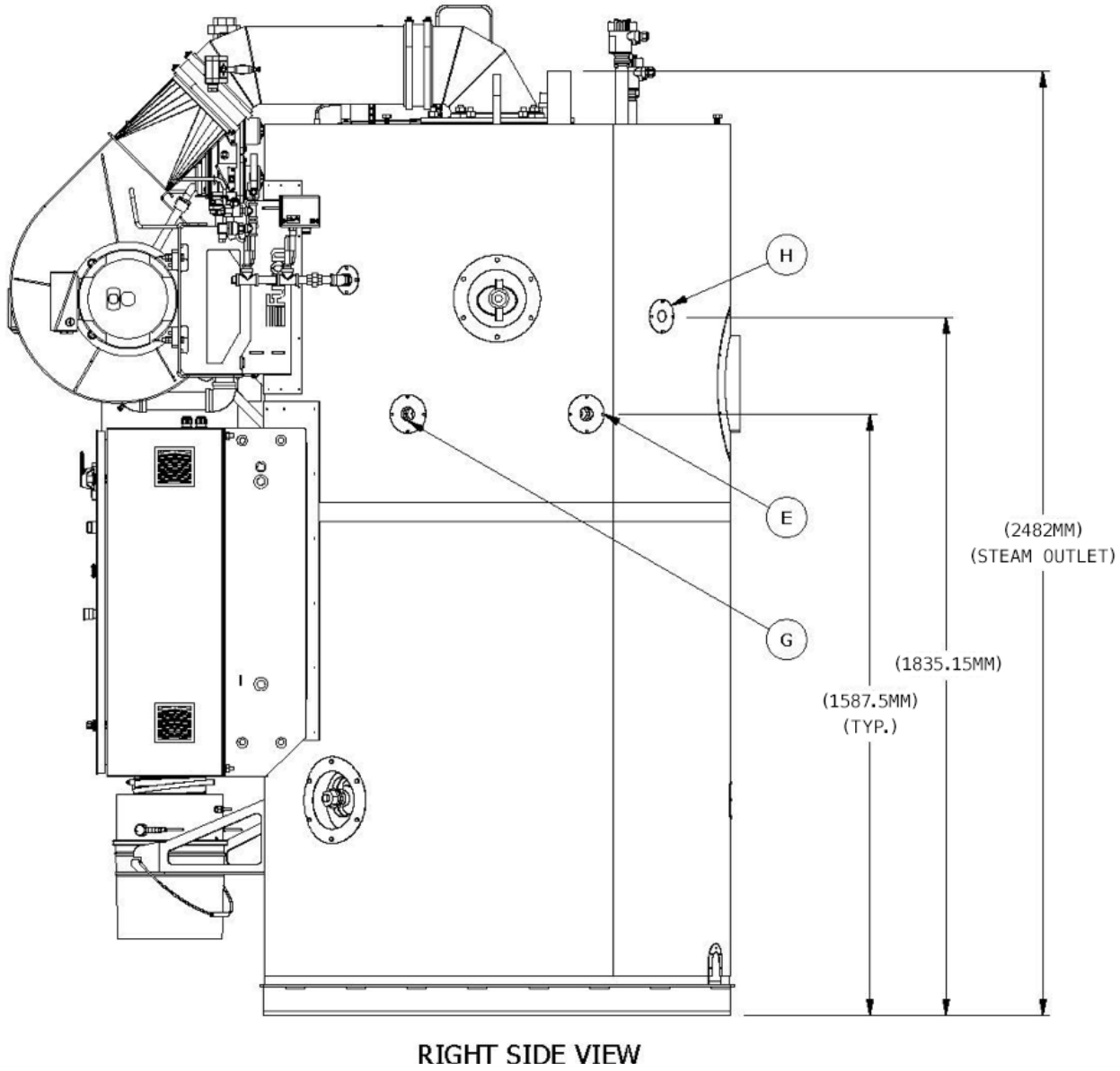


Figure 2 - Model VSRT-60 Dimensions

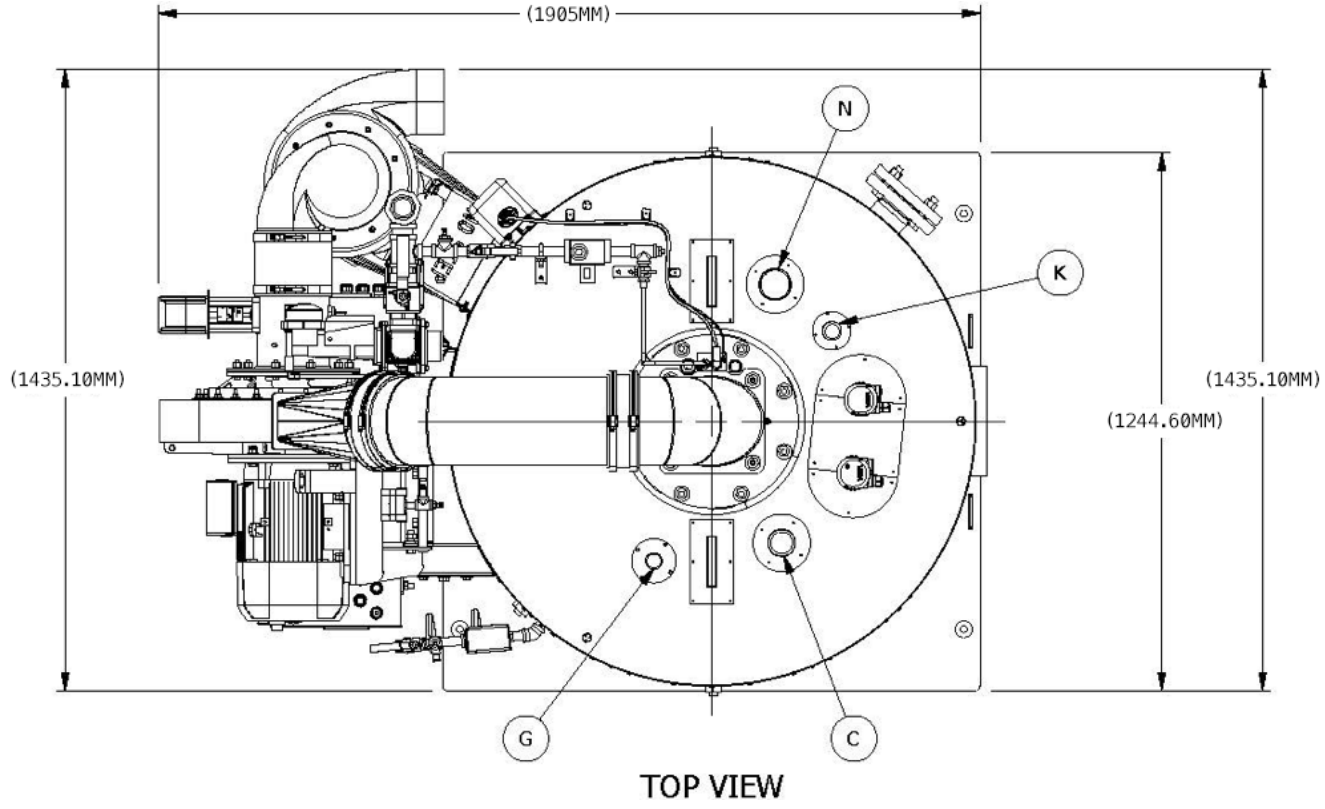


Figure 3 - Model VSRT-60 Dimensions – Top Side View

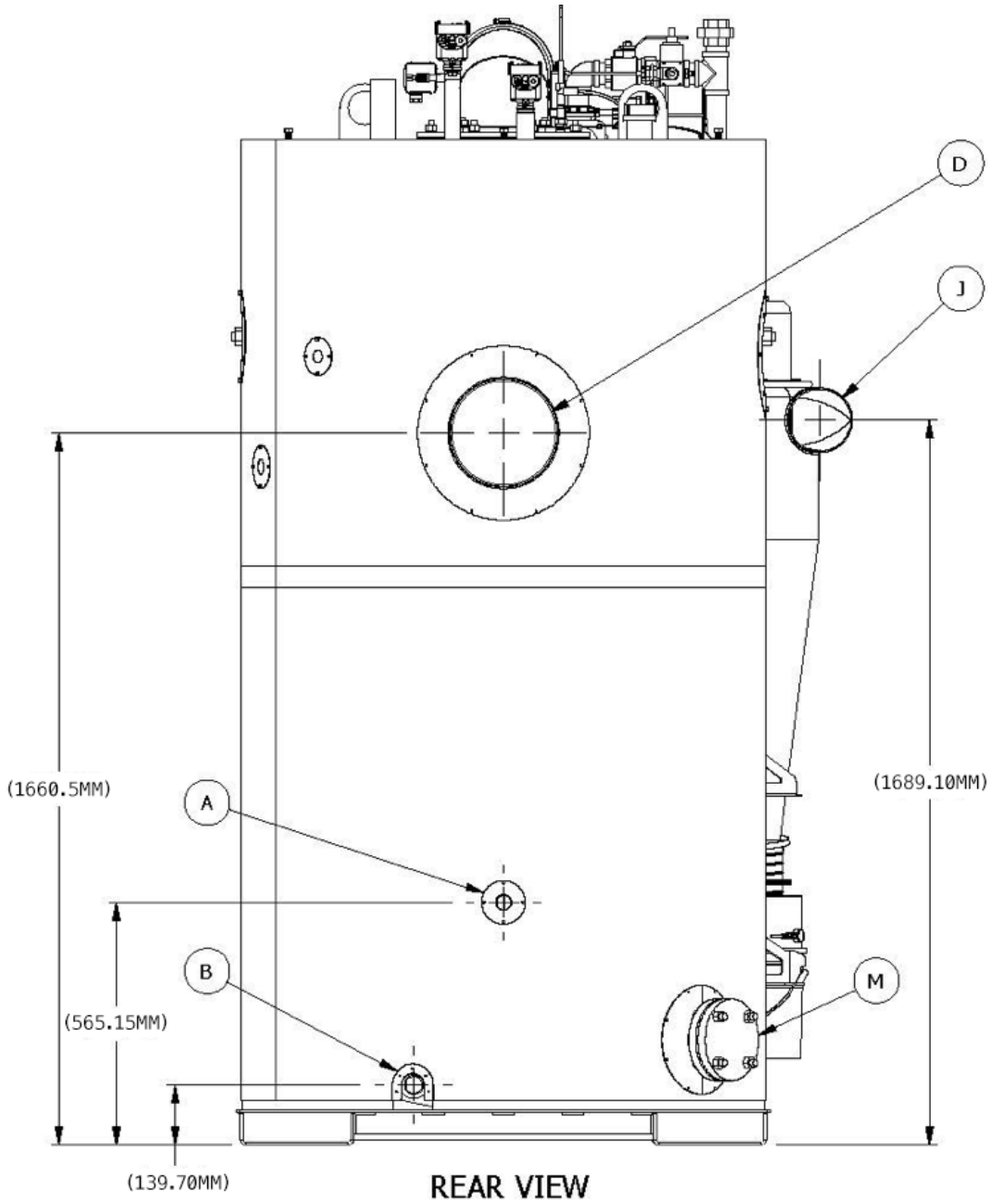


Figure 4 - Model VSRT-60 Dimensions – Rear Side View

SECTION – 2 INSTALLATION

2.1 GENERAL

The installation of a VSRT 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 non-combustible 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.

Table3 - Minimum Clearance Around Boiler

Unit Size (BHP	Front of Panel (mm)	Rear/Sides of Boiler (mm)	Vertical Clearance from Floor to Ceiling (mm)
10-15	915	610	2,713
20-30	915	610	2,800
40-60	915	610	3,350

Note: The vertical clearance from the floor to the ceiling is necessary for removal of the burner for servicing.

2.2.1 RECEIVING INSPECTION

The customer should examine the equipment for any damage. It is the responsibility of the installer to ensure all parts supplied with the equipment are fitted in a correct and safe manner.

2.2.2 SITING

⚠ WARNING

Failure to provide required and safe access to the equipment could impede commissioning and maintenance. Service technicians are instructed not to commence commissioning if hazardous conditions exist.

(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 – FBW203 – J-Classic Dimensions & Specification** to ascertain the relevant dimensions and weights, special note should be taken of the required vertical clearance required for maintenance.

⚠ WARNING
Maintenance on the burner assembly requires the area directly above and to one side of the boiler must not be obstructed with pipework or equipment which would interfere with the removal of the complete burner unit. Care should be taken on installation of the boiler to ensure this area remains clear of obstructions.

The flooring must be level, laid in a non-combustible material and be of sufficient strength to support the boiler.

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.

It is essential that only fresh air be allowed to enter the combustion air system. Foreign substances in the combustion system can create hazardous conditions. Particulate matter like lint, combustible volatiles, dust, smog or chemicals (example, perchloroethylene, halogenated compounds) in the combustion air supply to the equipment will cause damage or failure of the burner and is not covered under warranty.

Eliminate potential for high-risk situations for particulate matter to be in the air supply (e.g., as the result of construction or maintenance activities). If foreign substances can enter the air stream, the combustion air inlet must be piped to an outside location. Failure to do so will void the warranty.

Note: Ensure that there is adequate ventilation in the boiler room to correct standards. 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 forced vent interlocks.

Note: see **Appendix A – *VSRT Data Sheets*** *for low and high level values*, values.

⚠ CAUTION
Do not store chemicals such as perchloroethylene in the boiler house, the fumes may damage the boiler and flue and cause the burner to lock out on flame failure.
⚠ CAUTION
A temperature exceeding 49 C in the boiler room may cause premature failure of electrical components. Provisions should be made to maintain an ambient temperature of 49 C or less (the panel box interior should not exceed 52 C).
⚠ CAUTION
Recommended boiler HSE temperatures should not exceed: • **Floor Level (0-100mm): 25 C** • **Mid Level (1.5m above floor): 32 C** • **Ceiling Level (0-100mm from ceiling): 40 C**

2.4 CONNECTIONS

2.4.1 FLUE OUTLET

The height and type of flue will be subject to local planning regulations and approvals.

The following information is only intended to provide assistance for the installation of a simple flue. Where multi-boiler flues or difficulties are experienced, specialist advice should be obtained.

An appropriately sized flue should be connected to the flue gas outlet at the boiler. A 45° Boot Tee termination from the back of the boiler is recommended. The correct flue size and draft control is most important for correct burner operation. The flue must be as large as or larger than the outlet on the vessel. Avoid flue piping and elbows by placing the equipment as close as possible to the chimney."

The flue should rise continuously to the connection at the chimney and should contain no more than two bends at 45 degree angles or less.

There should be min 0.6m of straight, horizontal flue before any change in direction, fitting or draft regulator. This is to prevent potential pilot or main flame failures due to back pressure build-up during ignition.

The run in the total distance of flue ducting, as measured in a straight line from the outlet of the boiler to the outlet of the flue, should not exceed 70% of the rise. With the exception of the duct run previously described, horizontal sections of ducting must be avoided and should not exceed 1.5 metres total.

The flue, chimney, and any components must be constructed from material that is rated for a 300 °C operating temperature and sized for 280 °C operating temperature – Twin Wall construction, 316 Stainless Steel.

The flue and chimney material shall comply with all applicable codes. A condensate drain should be included at low point.

Adequate provision must be made for the support of the weight of the chimney and stack to avoid having a load imparted to the outlet connection of the equipment.

The installation of a draft regulator by the client/contractor will help maintain the required draft.

Where a chimney cowl is fitted, care should be taken to ensure that the distance between the lowest point of the cowl and the top of the flue is 1.5 x the diameter of the flue and that it is of the terminal stub type.

The VSRT requires a flue design that generates draft conditions of -0.25"W.C. – 1.5"W.C draft of the boiler.

Note: Ensure all flue pipes from the boiler to the main flue have a rising pitch.

⚠ WARNING

To maintain a reasonable temperature in the equipment area and ensure safety to personnel, the section of the chimney duct within the building should be insulated.

⚠ CAUTION

Concentration levels of only a few ppm of chlorine containing compounds in combustion air can produce serious corrosion of the flue over long periods of time. High chlorine containing compounds such as carbon tetrachloride or perchloroethylene would be prime suspects.

2.4.2 BLOWDOWN VALVES

There are three blowdown connections on the boiler, the boiler blowdown valve at the rear of the boiler, the water level gauge (sight glass) blowdown valve and the TDS blowdown connection.

Each connection 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 CEA Guidance Note Document BG03, which covers blowdown vessels and associated systems.

⚠ 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.

2.4.2.1 WATER LEVEL GAUGE SET (SIGHT GLASS)

Boilers are normally supplied with a water level gauge (sight glass). The water level gauge blowdown cock should be connected to the blowdown line by 12 mm soft copper tubing.

⚠ WARNING

Improper installation or maintenance of the water level gauge assembly can cause immediate or delayed breakage resulting in bodily injury and/or property damage.

2.4.3 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: It is recommended that the safety valve discharge pipework is installed to the requirements of BSEN 13480-1:2012.

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.

d) Ensure pipes and connections are clean and free of any foreign material.

e) Do not install using a pipe wrench. Use the appropriately sized wrench on the bonnet nut.

f) Install the valve vertically with no unnecessary intervening piping between the boiler and the valve.

g) Do not cap or plug the weep hole on the side of the safety valve.

h) A discharge pipe shall be of a pipe size equal to, or greater than, the outlet of the safety valve.

i) Minimize discharge piping fittings and overall piping run to avoid over pressurization of the piping, limiting safety valve discharge volume.

j) Do not support discharge piping with the safety valve. Discharge piping must be supported adequately by appropriate means.

k) Terminate the discharge pipe directly to atmosphere. Discharge pipe must not contain a shut off valve of any sort.

l) A drainpipe is to be fitted to the lowest point of the discharge pipework. Pipe size to be no greater than 10 mm.

2.4.4 MAIN STEAM VALVE

The main steam stop valve is fitted at the top of the boiler.

It is recommended to have a minimum of five pipe diameters of vertical rise out of the steam outlet. This is considered good piping practice and will allow for proper operation.

Steam outlet sizes should not be reduced until after the steam outlet and the end of the near boiler piping. Steam piping should be sized for appropriate velocities for the application and pressure.

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 5 - Main Steam Valve

2.4.5 STEAM PRESSURE GAUGE

The steam pressure gauge assembly should be assembled in accordance with **Figure. 6** using a suitable sealant on all joints.

Adhere to the following:

- Ensure pipes and connections are clean and free of any foreign material.
- Do not install using a pipe wrench. Use the appropriately sized spanner on the connection fitting.

Figure 6 - Steam Pressure Gauge

2.5 GAS SUPPLY

⚠ WARNING
Do not change the boiler fuel without consulting the boiler manufacturer.
A qualified installer, service agency or the gas supplier must perform installation and service on the fuel delivery system.
Do not use naked flames or other sources of ignition to check for gas leaks.

⚠ CAUTIOM
Some suitable leak-detection spray used for leak testing is corrosive to certain types of metals. Clean all piping thoroughly after completing the leak check.

Gas piping must be installed in compliance with all applicable codes. Adhere to the following for installation:

1. No changes shall be made to the factory fuel train.
2. The pipe and fittings used must be new and free of dirt or other deposits.
3. The piping must be of the proper size to ensure adequate gas supply to the gas head assembly without a pressure loss. Consult your gas company for specific recommendations.
4. When making gas piping joints, use a sealing compound resistant to the action of liquefied petroleum gases. Do not use PTFE tape on gas line threads, always use a suitable gas paste.

5. Piping must be installed such that no piping stresses are transmitted to the equipment. The equipment shall not be used as a pipe anchor.
6. Components may have vent connections which must be vented per local codes.
7. After gas piping is completed and before wiring installation is started, carefully check all piping connections (factory and field) for gas leaks.
8. All gas piping must be arranged so that it does not interfere with any cover or burner, inhibit service or maintenance, or prevent access between unit and walls or another unit.

Verify that the burner is suitable for the type of gas being supplied. Ensure that an appliance isolation valve is inserted in the line between the boiler and the meter. To avoid pressure drops, eliminate all unnecessary bends and elbows in the pipework between the gas meter and the boiler. A scale trap is provided on the gas train and should be used.

Burners suitable for operation on natural and manufactured gas are supplied with gas trains or a modular gas head.

A minimum working pressure of 18 mbar at the specified flow rate, is required at the gas train for natural gas installations.

If the gas supply is in excess of 35 mbar for Natural gas a suitable regulator is required before the main gas valve.

2.5.1 GAS VALVE WITH PILOT GAS LINE

The main gas valve is fitted with a bypass system (internal or external depending on the model) the bypass allows pilot pressure to be maintained whilst the flame is verified.

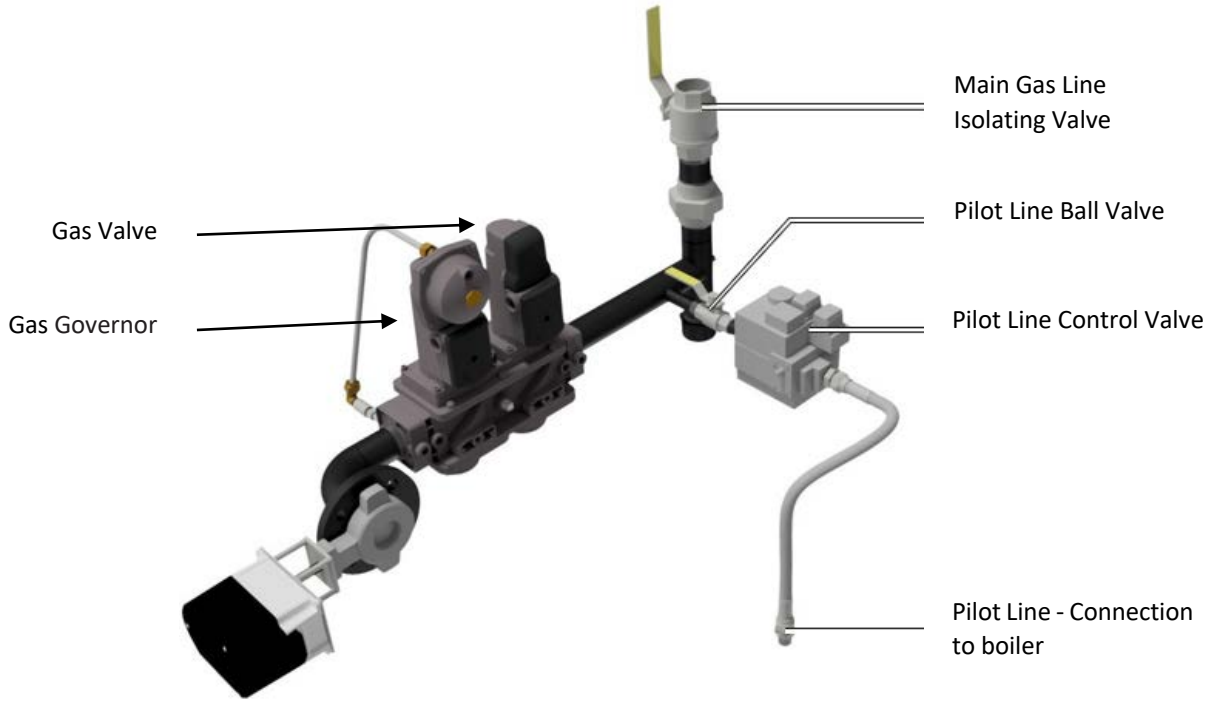


Figure 7 - Pilot Gas Line

2.5.2 MULTI BLOC GAS VALVES

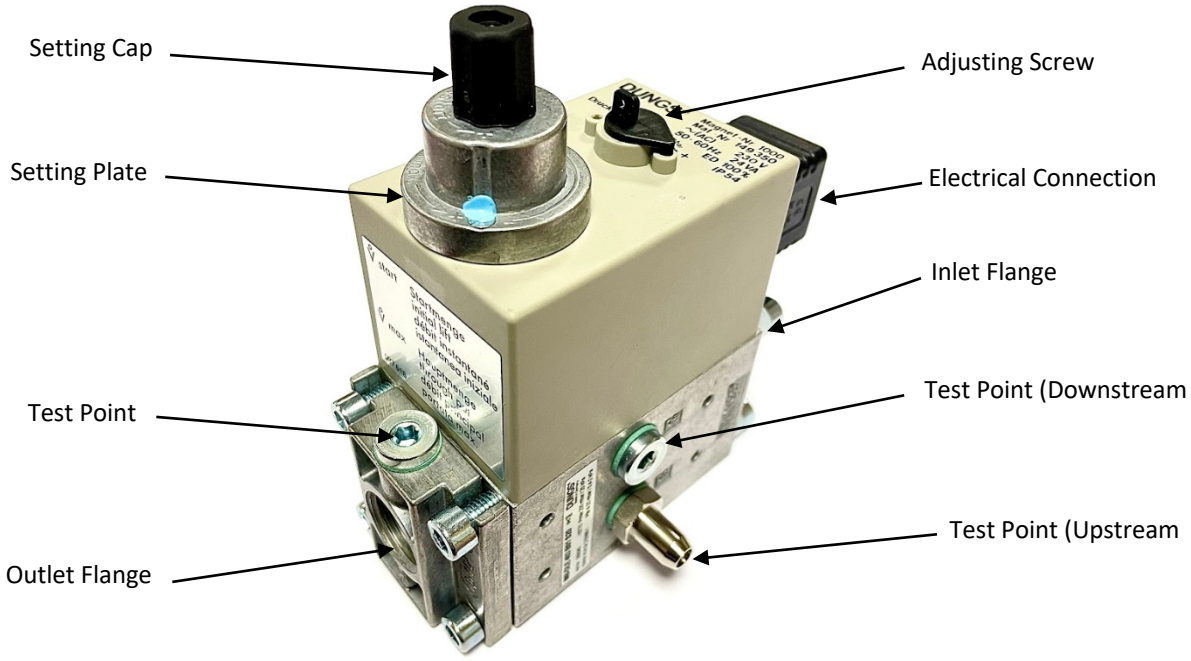
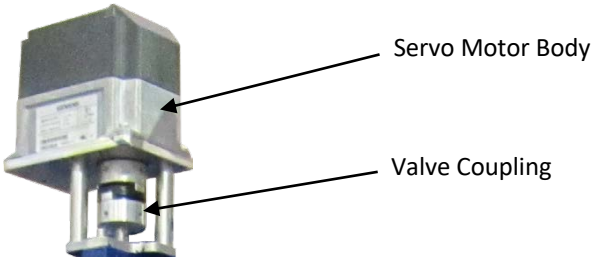


Figure 8 - Pilot Line Gas Valve

PRE-MIX (GAS & AIR) ACTUATOR



GAS GOVERNOR & VALVE

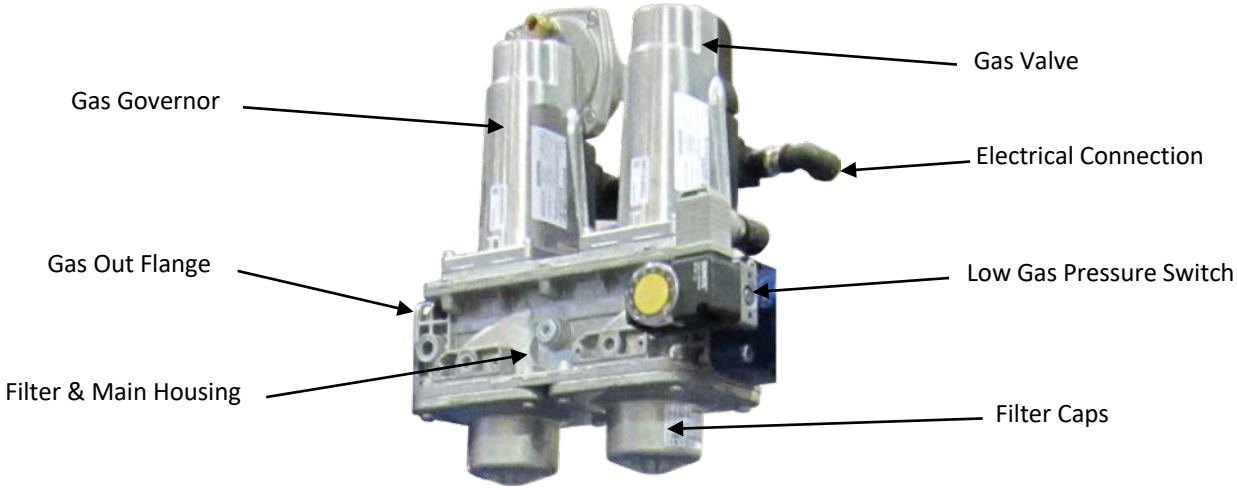


Figure 9 - Main Gas Valve (Siemens)

2.6 ELECTRICAL REQUIREMENTS

⚠ CAUTIOM

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

⚠ WARNING

Assure all electrical connections are powered down prior to attempting replacement or service of electrical components or connections of the equipment.

An individual wiring diagram for the boiler is located on the inside cover of the control box. Make sure the information on the electrical drawing corresponds to your voltage and frequency.

Check the supply voltage and make sure that there is no over-or under-voltage exceeding 10% of the nominal value.

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 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.

Unless otherwise specified, the alarms supplied will be mains voltage models. Unless otherwise specified all models are supplied with burner motors and feedwater pump motors arranged for operation on a three phase supply.

A wall-mounted, fused disconnect sized for the unit must be provided and fitted by the client/ contractor, if disconnect is not supplied on the panel.

Connect power to the terminal strip as supplied on the inside of the panel box. Note: Single skid systems are generally shipped completely pre-wired.

Note: *The power ratings and requirements are given in Appendix A - TI-153-VSRT Dimensions & Specification.*

2.6.1 ELECTRICAL CUSTOMER CONNECTIONS

There are terminals provided in the boiler control enclosure to allow the customer some extra functionality, there are descriptions below and a diagram to detail further.

Remote Stop.

The Remote Stop option allows the customer to fit a remote stop push button / contact. An open contact will stop the boiler. If a Remote Alarm panel is fitted, wire the remote stop between terminals 310 & 311.

Common Alarm Contact.

A Common Alarm Volt Free Contact is provided for giving a Remote Common Alarm signal or connecting to a site BMS system (Contact Rating 230V 5A).

Bottom Blowdown Valve.

Connect the Bottom Blowdown valve per the electrical drawing. A controller in the control panel will then allow automatic bottom blowdown to occur on a time basis. The contact gives feedback to the controller that the blowdown valve has opened and closed as required (Valve supply Max. rating 120V 6A resistive, 120V 2A inductive. Valve switch contact rating 230V 10A Max.).

TDS Solenoid Valve.

Connect the TDS Solenoid valve per the electrical drawing. A controller in the control panel will then allow automatic TDS blowdown to occur as required by monitoring the TDS in the boiler (Valve supply Max. rating 120V 6A resistive, 120V 2A inductive).

Fan Dilution Pressure Switch.

Depending on the installation, a Flue dilution system and/or a plant room ventilation system may be required. These are safety features to prevent a high contamination of flue gasses in the system. Pressure switches are fitted within the systems to ensure that the required fans are running, hence diluting the flue gasses. If the fans fail, a pressure switch will operate to stop the boiler and prevent further contamination occurring. A factory fitted link must be removed to use this option (110V).

Remote Alarm Panel.

A remote alarm panel to suit 1, 2 or 3 boilers can be fitted in a manned area. The panel will give an indication of a boiler alarm being triggered and also has the ability to remotely stop the individual boilers.

Water softener.

A water softener can be powered from the boiler control panel (230V, 2A Max.).

Feed Tank Level Control.

A Feed tank level control panel can be powered from the boiler control panel. It controls the level of feedwater in the feedwater tank if fitted (110V, 4A Max.). In the case of multiple, this panel must be fed from an independent suitable supply.

Feed Line Chemical Dosing.

A Feed line chemical dosing unit must be powered from a local fused spur supply (110V, 4A Max.).

2.7 WATER SUPPLY

⚠ WARNING

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 always available (including commissioning). Costly repairs could be required should the plant operate without chemicals or the wrong dosage of chemicals.

The Fulton Warranty does not cover damage or failure that can be attributed to excessive corrosion, scale, fouling or a poor water treatment regime.

The quality of the water used in the boiler will affect the life and performance of the boiler. Feedwater contains solids and dissolved gases, these may promote encrustations of scale; foaming, priming, surging; corrosion and pitting; or caustic embrittlement. To prevent this happening, it is strongly recommended that a reputable water treatment company is consulted prior to commissioning the boiler.

Note: See Appendix A - TI-139-Recommended Water Conditions.

Connect the feedwater pump discharge to the check valve inlet with 25 mm bore pipe. The pump suction pipework must remain at 25 mm minimum diameter and be as short as possible. Install the stop valve supplied between the pump and the check valve. The check valve must be positioned so that it is below the internal water level of the boiler and should

be installed at least 1 m after the feedwater pump. The reason for this placement position is that the check valve is designed to have water on both sides to enable it to function correctly.

It is essential to protect the feedwater pump from damage by foreign matter, a strainer must be fitted in the pump suction pipework.

Care should be taken to ensure the pipework is properly aligned and not placing any strain upon the feedwater pump.

Note: The boiler feedwater pump may contain an inhibitor, this should be flushed from the pump prior to fitting the pump to the boiler. Failure to do so may result in water bounce or foaming due to the inhibitor forming a seal in the boiler.

Note: If the boiler is to be operated with little or no condensate return, consideration should be given to pre- heating the feedwater. If in doubt consult Fulton Ltd.

2.7.1 GLOSSARY OF WATER SUPPLY TERMS

Dissolved Oxygen: Oxygen that is dissolved in the feedwater will cause the steel in the boiler and the feedwater system to be attacked by the water in a manner described as “pitting”. The pits that are produced can vary from tiny depressions to holes large enough to penetrate the boiler metal and are usually covered with tubercles of iron oxide. Once pitting starts, it may be extremely hard to arrest. Pitting can proceed at a surprisingly rapid rate and can occur not only in the boiler proper, but also in pre-boiler equipment such as economizers, feedwater tanks, and feedwater lines.

Suspended Solids: Suspended solids are the undissolved matter in water, including dirt, silt, vegetation, iron oxides, and any other insoluble matter. Normally suspended solids are expressed in terms of turbidity. Suspended solids may also deposit in low velocity areas and create fouling. In line filters, or various types of pre-treatments can be used to lower the suspended solids level. Periodic blowdowns will eliminate suspended solids.

Alkalinity: Alkalinity is the capacity of a water to neutralize acids. Common water alkalinities consist of bicarbonate, carbonates, hydroxide, phosphate, and silicate. These alkalinities, especially bicarbonates and carbonates, break down to form carbon dioxide in steam, which is a major factor in the corrosion on condensate lines. High alkalinity also causes foaming and carry over in boilers. Both foaming and carry over cause erratic boiler operation. The reason for the high alkalinity should be determined. It may result from lack of sufficient blow off. The source of alkalinity may be due to an overdose of alkaline internal water treatment chemical.

pH: pH is a measure of the degree of acid or base of solution. A pH range of 8.5-10.5 will have little influence on the corrosion rate of carbon steel. A low pH can result in corrosion of metals, while a high pH can result in scale formation or caustic embrittlement. To control boilers and equipment used for the external treatment of make-up water, it is essential that reliable pH measurements be made. RO/DI water will have a pH of 6.0 - 6.5 and will require neutralization if used in a carbon steel vessel. It is critical that the boiler pH be alkaline (8.5-10.5) whenever water is in the boiler.

Chlorides: If chloride levels are high enough to cause severe corrosion, they can be controlled by limiting the cycles of concentration and increasing boiler blowdowns. Corrosion from chlorides can also be controlled by increasing the amount of corrosion inhibitor or changing to a more effective inhibitor.

Oil: Oil is not a natural constituent of boiler water; still, it can frequently enter a system through leaks in a condenser or other heat exchanger. Oil can also enter a system through the lubrication of steam driven reciprocating equipment. Whatever the source, the presence of oil in boiler water is undesirable. Oil can act as a binder to form scale. In high heat-transfer areas oil can carbonize and further contribute to the formation of scale and low pH. Foaming is one indication of oil in boiler water. Its presence can also be confirmed by first shaking a bottle containing boiler water. If oil is present foam will result. Often oil in boiler water will originate in the condensate. This contaminated condensate should be directed to the sewer until the source of the oil is determined and corrective steps taken.

Iron (oxides): Iron in any of its oxide or complex forms is undesirable in boiler water. Iron in its various forms can originate in the raw water makeup, condensate return water, or form directly in the boiler as a result of corrosion. It can concentrate in the boiler, and it tends to collect in stagnant areas.

Water Hardness: Water hardness is the measure of calcium and magnesium content as calcium carbonate

equivalents. Water hardness is a primary source of scale in boiler equipment. Hardness is removed by softening. Periodically, the ion exchange resin bed requires regeneration by flushing through with a brine solution followed by rising with fresh water. The interval between regeneration is dependent upon the raw water hardness and flow rate.

In all cases the water hardness should be tested periodically and prior to starting the generator to ensure efficient operation of the softener. Unsoftened water should not be allowed to enter the steam generator unless sufficient scale inhibitor chemical is used.

Feedwater: Feedwater is the combination of fresh makeup and returning condensate that is pumped to the boiler.

Condensate: Condensate is condensed steam that is normally low in dissolved solids. Hence, it does not contribute to the dissolved solid content of the feedwater. In addition, condensate is very expensive to waste. It's been chemically treated, heated, pumped, converted to steam, and condensed.

Dissolved Solids: Dissolved solids are salts in the water that stay in solution. They are invisible to the naked eye. As the boiler generates steam, dissolved solids will concentrate. If the concentration becomes too high, they will precipitate, form a suspended solid, and concentrate in the vessel. Daily boiler blowdown is recommended to help prevent the formation of deposits. Consult Blowdown procedure in the Daily Maintenance Schedule section of this manual.

Chemical Dosing: In addition to softening the feedwater, it is also important to consider other factors such as dissolved oxygen and acidity. Depending on the results of an analysis, it may be necessary to inject appropriate amounts of corrective chemical into the feedwater system. This is usually achieved by means of a chemical compound solution and variable output metering pump mounted at the storage vessel. It is important that the chemicals and quantities are correct, and it is advisable to contact a water treatment company to arrange a feedwater analysis.

2.8 PIPING SPECIFICATIONS

For piping the basic considerations are the design temperature, the pressure retained by the pipe, the fluid in the pipe, the load resulting from thermal expansion or contraction, impact or shock loads imparted (such as water hammer, external loads, wind loads and vibration from equipment).

Adhere to the following:

1. The arrangement of the piping and its appurtenances must take into consideration the location of other structures and equipment adjacent to the piping. The potential for freezing interference and/or damage as a result of expansion, contraction, vibration, or other movements must be factored.
2. Valves are used in piping systems to stop and start the flow of fluids, to regulate flow, to prevent back flow, and to relieve excessive pressure build-up in the piping. Consideration should be given to the appropriate location and orientation of valves necessary for safe operation and isolation of the piping.
3. All piping and piping components used should be suitable for the design temperatures, pressure and fluid used in the system.
4. During the installation, ensure that no dirt, water, or residue from welding is left in the system.
5. Expansion joints or professionally designed and sited loops should be provided to accommodate thermal expansion. Thermal expansion should be calculated using the maximum possible utilization fluid temperature, regardless of whether the pipe considered is in the feed or return circuit. Steel pipe will expand approximately 1 mm per meter over 100 °C rise.
6. Supports and anchors must be provided for all pipes, as necessary, to prevent undue stresses from being placed on equipment, including pumps, valves, and the boiler. Supports and anchors which will not interfere with thermal

expansion should be chosen. The equipment should never be used or considered as an anchor. No additional loads should be applied to any factory connection.

7. Gaskets must be used to make all flanged connections. Gasket material must be suitable for use with the pressure, temperatures and fluids in the system. Ensure that all bolts are tightened evenly and to the torque recommended values provided by the gasket manufacturer.
8. High point bleeds/air vents are to be installed at all high points in the system piping.
9. All pipes should be installed with a pitch to facilitate draining and venting.

2.9 INSULATION

⚠ WARNING

After the appropriate system tests have been satisfactorily completed, all hot pipework and vessels must be adequately insulated with material suited to the temperature and application to prevent both heat loss and personnel injury.

Note: It is recommended that for inspection and maintenance, pumps, flanges, valves and fittings be left uninsulated but suitably shielded for safety.

Adhere to the following:

1. Return tanks, surge tanks and deaerators should be insulated. Insulation should be chosen with care such that the fluid in the tanks does not exceed the maximum operating temperature of the pump.

2. Blowdown vessels should not be insulated.

3. Equipment should be insulated with material suitable for the application and temperatures expected.

SECTION 3 – POST INSTALLATION

3.1 GAS PURGE

> ⚠ WARNING
>
> **Gas purging by qualified persons only.**

A purge of the gas lines must be carried out to remove air (oxygen) from the pipework and to ensure the pipework is flooded with gas.

3.2 PIPEWORK LEAK/PRESSURE TESTS

Upon completion of the installation, adhere to the following for system piping testing:

1. Perform a pneumatic test not exceeding 1bar (15psi).
2. Perform leak spray tests at all welds and joints to ensure that the system is free from leaks.

3.3 ELECTRICAL INSTALLATION TESTING

1. Earth bond test
2. Tighten electric terminals

3.4 FINAL INSTALLATION INSPECTION

1. Ventilation – to relevant standards
2. Gas Supply – supported by Test and Purge Certificate
3. Flue System – supported by Smoke test and Manufacturers Certificate
4. All installation pipework correctly sized, connected and supported.

SECTION 4 – COMISSIONING

⚠ WARNING

Commissioning by qualified persons only.

4.1 COMMISSIONING THE BOILER

It is essential that the commissioning procedures listed below are carried out by a Fulton service engineer who will have the necessary experience and testing equipment to ensure that the installation is not only correct but is operating safely and at optimum efficiency.

Flue Commissioning

Prior to initial firing of the boiler, the flue must be checked for leaks. This is done by BOTH of the following methods:

a) Visual Inspection Check joints between all flue sections for quality of seals. Where the flue passes through the structure of the building use your judgement as to the integrity of this section of the flue.

If this test fails or at any time during boiler operation, there is doubt about the integrity of the flue, shut down the boiler and contact Fulton Ltd immediately.

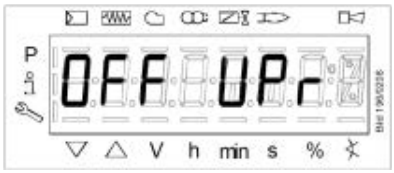
Note: Flues that are designed to operate with positive pressure should be tested to the latest regulations.

4.1.2 BOILER INSPECTION AND INITIAL FIRING OF GAS BURNER

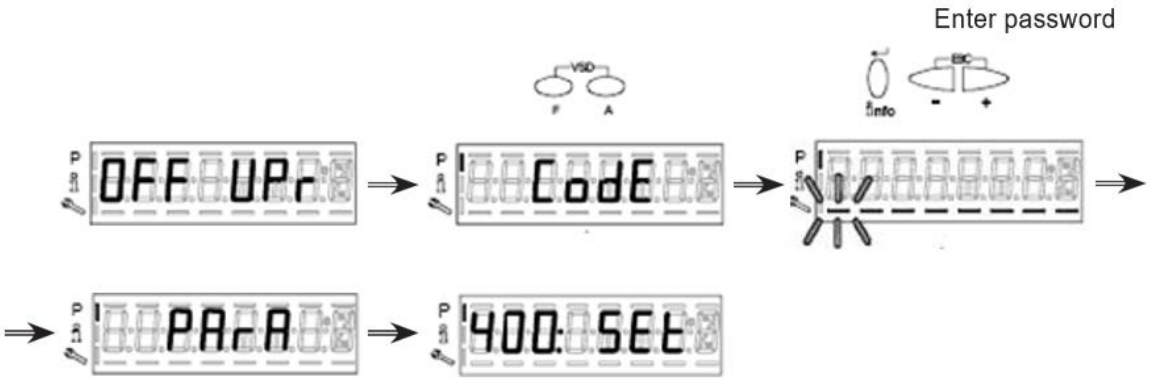
1. Ensure that the boiler has been washed out after installation. It is advisable to conduct a water analysis before operating the boiler.
2. Ensure that all wiring connections are correct and that all terminal screws are tight.
3. Open all of the valves in the feedwater line. Close the isolating valve on the discharge side of the feedwater pump. Remove the priming plug from the pump head and displace all air from the pump. Replace the priming plug and tighten securely.
4. Check the correct rotation of the feedwater pump on the motor fan cover. Start the feedwater pump and check the direction of rotation.
5. Check correct rotation of feedwater pump. Viewing through pump motor fan cowl.
6. Set up the load controller, see service information sheet SI012sheet.
7. Set the air pressure switch to its minimum setting. The gas pressure switch should be set at 10 mbar. The gas pressure switch is located on the gas train and the air pressure switch is located on the fan casing.
8. Fill the boiler (see Section 5.3 - Filling the boiler).
9. Test the pump controls (see Section 6.4.1 - Feedwater Pump Test).
10. Check water level limiters (see Section 6.4.2 - Low Water Level Check).

Figure 10 - Gas/Air Pressure Switch

11. Start the burner, the AZL2 control unit should be display the following screen.



On the AZL2 press F+A together, you will be prompted to enter the 5-character service code using the enter button and +/- to select characters, once complete press enter again to enter the parameter level;



12. (ASSUMING THE VSD CONTROLLER IS SET FROM THE FACTORY) Run speed standardisation;

Navigate to parameter group 600 using the +/- keys.

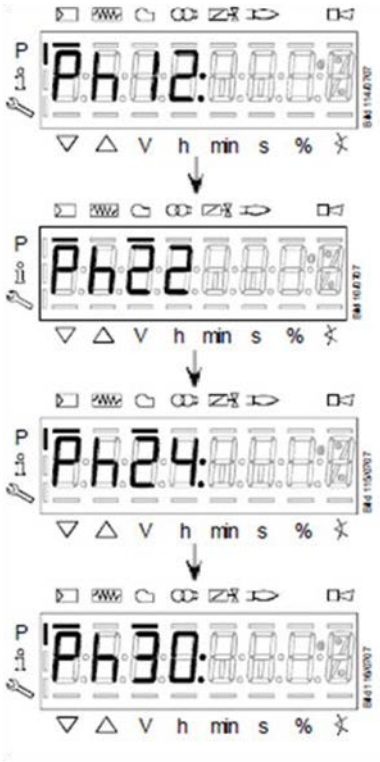
Press enter and navigate to parameter 641, press enter and edit value to 1, press enter again to save.

The LMV should now run speed standardisation procedure and the display should go back to.

Once speed standardisation is complete the value of parameter 641 should become 0 again if the standardisation was successful, navigate back to parameter 641 to confirm this.

13. Navigate to parameter group 400 used to set fuel air ratios by running the burner (manual control), press enter and the run screen should be displayed.

Press enter again and the burner will now run through its pre-ignition phases as follows.



Phase - Standby (stationary)

Phase - Fan ramp up
(fan motor = ON, extra valve = ON)

Phase - Traveling to pre-purge position

Phase – Pre-purge

Once Pre-purging is complete the system will pause in phase 36, the ignition position phase. Ratio values for P0 will be displayed and ignition will commence if the plus arrow is pressed. **DO NOT IGNITE THE BURNER BY PRESSING "+" UNTIL** the air and gas pressure switches and air valve values are adjusted to be correct.

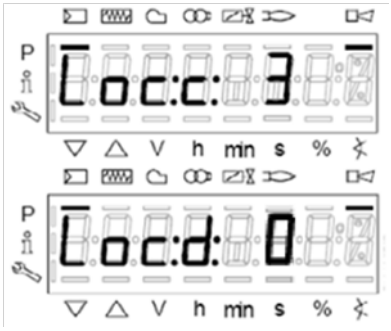
The screen below should be displayed.

The left number represents the current setting for fuel damper valve opening in P0 and the right number represents the same for the air damper valve. The fan will be running and the VSD speed can be viewed and adjusted by holding **F and A** and using **- or +** to adjust. The air and fuel damper valve values may be adjusted by holding **F or A** respectively and using **- or +** to adjust.

14. Air damper valve settings across the range P0-P9 are gathered by creating a negative pressure of 5 mbar in the intake chamber for each VSD speed corresponding to P1-P9. The LMV is factory set to the FaT document.

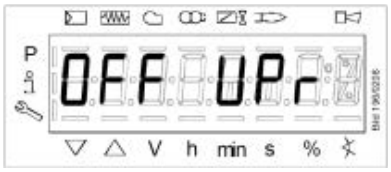
Fine Tuning for each boiler when being commissioned on site may be required. If required, use the controls illustrated in step 10 to adjust the air damper valve."

15. With the burner still running at P0 pre-ignition phase with the VSD speed pre-set, the air pressure switch may be set by slowly turning it up from its minimum setting until the switch output becomes low and the system fails, this should occur with the switch set to around 1mbar, the AZL2 should display alternating screens illustrated below,



determining an error code 3 diagnostic 0 meaning and air pressure switch failure off as expected. The switch should now be turned down by around 0.5 mbar to become its final setting. To dismiss the error code and unlock the LMV the enter key should be pressed and held for 2 seconds.

The below illustrated screen should be displayed again.



16. The gas pressure switch may be set by using the mono-meter and attaching it to the pressure tap on the gas line into the gas train. The low inlet gas pressure switch should be set to around 3 mbar lower than the normal working gas pressure (Minimum mandatory setting is 10mar).
17. Enter parameter group 400 again, when the run screen (illustrated below)

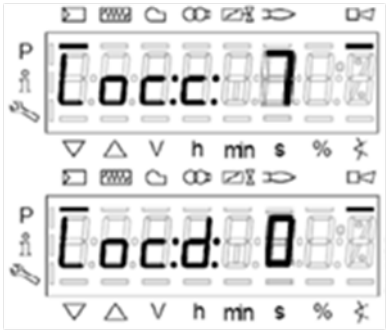
is displayed press **- and +** to escape into the "cold" setting function whereby the curve points for P1-P9 may be set without the burner running (LEAVE P0 AS FACTORY SETTINGS).

Use **- and +** to move through the set points P1-P9 and adjust the air damper valve openings, using the same procedure as described in step 10, to the values noted in step 11. Once the adjustments are made escape back to the parameter level.

18. Open any gas isolation valves.

19. Ensure that the boiler is still enabled. Enter parameter group 400 again and press enter on the run screen to start the burner. The burner will again cycle through the pre-ignition phases pausing on the screen illustrated below ready to ignite the pilot flame.

The **+** key may be pressed to commence pilot ignition phases. The pilot gas valves are tuned from the factory and should achieve a steady pilot flame for a wide range of input gas pressures. The pilot flame should ignite, do not be alarmed if the pilot does not ignite and the standard flame failure error is displayed (illustrated below).



This step may need repeating a few times to purge any air trapped in the pilot line and valve assembly, if this is the case press and hold enter for 2 seconds to reset the LMV and restart this step.

20. Once the pilot flame is lit look through the burner flame observation glass on top of the boiler to check the flame visually for stability. The flame should be steady and constant with no burn back past the burner brick. Use the mono-meter to measure the pilotline gas pressure while the flame is present by attaching the sensor to the output pressure tap of the pilot valve. The pressure here should be 17-20 mbar; 20 mbar is preferable to provide a strong pilot flame. If the pressure here is outside the desired range use the pilot valve pressure regulator adjustment to set the pilot pressure within range.

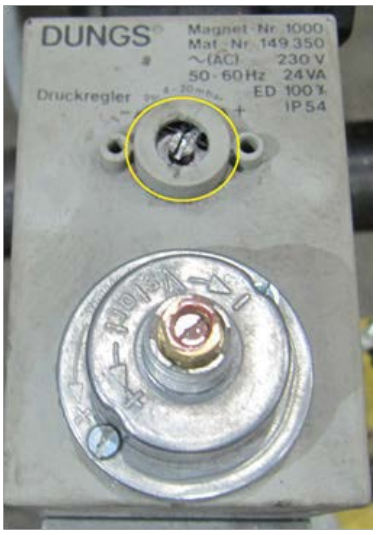


Figure 11 - Setting Pilot Valve Pressure

21. The burner may now be progressed to igniting the main flame on P0 by pressing the **+** key. If the flame fails to ignite and the standard flame failure error is displayed hold the enter key for 2 seconds to reset the LMV and repeat step

16. Again, this may need repeating a few times to purge the gas line and valve assembly. If the main flame still fails to ignite but shows an attempt to ignite when viewed through the burner flame observation glass, try increasing the opening of the fuel and air damper valves in small increments for P0 in the ratio2F:1A.

22. Once the flame is established use the burner flame observation glass to check stability. If the flame appears weak increase the opening of the air and fuel damper valves in the ratio 2F:1A until the flame appears strong. If any adjustments are made at this point repeat steps 16 and 18 to confirm ignition of main flame from pilot.

23. Use the **+** key to ramp the burner up through P1-P9 allowing the burner to stop at each set point long enough for the flame to settle to confirm stability. If the flame fails at any setpoint, reset the burner and return to the "cold" settings as described in step 14 and increase the fuel damper valve opening by 1° for that setpoint. Attempt to reignite the burner as described in steps 16 and 18 and ramp up through the set-points again. This process may need repeating for multiple setpoints and/or multiple times for a single set-point until the burner will run through all setpoints toP9.

24. Monitor the flue gas emissions with a flue gas analyser set up at an appropriate test point in the flue.

25. As the boiler pressure approaches 10 bar begin opening the steam valve partially and continue to make continuous adjustments as required to maintain the boiler pressure between 9 bar and 10bar.

26. Monitor the excess oxygen in the flue gas, with the factory fuel damper valve settings (shown alongside the VSD settings and factory air damper valve settings in the table in step 24) and a boiler pressure of 10 bar the flue gas should contain around O2 across every setpoint. Fine tuning of the main gas valve pressure regulator is likely required to obtain exactly 6.5% O2.

    This adjustment should be made while the boiler is maintained at 10 bar and firing at P9. Adjust the pressure regulator until a steady O2 is achieved. Check the output pressure of the main gas valve using the mono-meter, it should be 1.5-2 mbar. At 6.5% O2 there should be <30PPM NOx and <20PPM Co.

27. Use the **-** key to step the burner back to firing at P8 and monitor the emissions. Again, make continuous adjustments to the steam valve to maintain the boiler pressure between 9 and10 bar. The flue gasses should contain near 6.5% O2 some minor adjustments to the fuel damper valve may be required to achieve the exact value. Increasing the opening of the fuel damper valve reduces the excess oxygen and vice versa. Tune the fuel damper valve until a steady 6.5% O2 is achieved. Repeat this process for obtaining a 6.5% O2 value for each setpoint down to P1.

Table 7 - Steam Program for Siemens LMV3*

Par.No.	Parameter	Min Value	Max Value	Fulton Setting	Customer
000	Internal Parameters				
41	Password	0	65535		NB/SN
100	General				
102	Identification Date	0	255		
103	Identification Number	0	65535		
104	Pre-selected parameter set: Code	0	255	9	
105	Pre-selected parameter set: Vers.	0	0xFFFF	V.01.01	
107	Software version	0	0xFFFF	V01.80	
108	Software variant	0	255	1	
113	Burner identification	0	99999999		
121	Manual output Undefined=automatic mode	0%	100%	Undefined	
125	Main frequency 0=50hz 1=60hz	0	1	1	
126	Display brightness	0%	100%	100%	
127	Time out for menu operation	10min	120min	30min	
128	Fuel meter: pulse valency [pulses per volumetric flow unit]	0	400	0	
130	Delete display of error history: to delete the display, set to1then to2	-5	2	0	
141	Operating mode BACS 0=off 1=Modbus 2= reserved	0	2	1	
142	Setback time in the event of communication breakdown	0s	7200s	1s	
143	Reserved	1	8	1	
144	Reserved	10s	60s	30s	
145	Device address for Modbus	1	247	2	
146	Baud rate for Modbus 0=9600 1=19200	0	1	1	
147	Parity for Modbus 0=none 1=odd 2=even	0	2	0	
148	Performance standard at interruption of communication with building automation. For **modulation operation**… 0…19.9=burner off 20…100=20…100%burner rating for **multi-stage operation**… 0=burner off invalid=no performance	0%	100%	Undefined	
161	Number of faults	0	65535		
162	Operating hours resettable	0h	99999999h		

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+Out of Test Fire

Note: Customer settings should be recorded in the Customer column for reference.

Table 7 (cont) - Steam Program for Siemens LMV3*

Par.No.	Parameter	Min Value	Max Value	Fulton Setting	Customer
163	Operating hours when unit is live	0h	99999999h		
164	Number of start-ups resettable	0	99999999		
166	Total number of start-ups	0	9999999		
167	Fuel volume resettable	0	99999999		
200	Burner Control				
201	Burner operating mode (fuel train, modulating/ multistage, actuators, etc.) --=undefined (delete curves) 1=G mod 2=Gp1 mod 3=Gp2 mod 4=Lo mod 5=Lo2-stage 6=Lo3-stage 7=G modpneu 8=Gp1modpneu 9=Gp2modpneu 10=LoGp mod 11=LoGp 2-stage 12=Lomod2fuelvalves 13=LoGpmod2fuelvalves 14=Gmod pneu without actuator 15=Gp1modpneuwithoutactuator 16=Gp2modpneuwithoutactuator 17=Lo2-stufigwithoutactuator 18=Lo3-stufigwithoutactuator 19=G mod only gas actuator 20=Gp1mod only gas actuator 21=Gp2modonlygasactuator 22=Lo mod only oil actuator	1	22	3	
208	Program stop 0=deactivated 1=PrePurgP (Ph24) 2=IgnitPos (Ph36) 3=interval1 (Ph44) 4=interval2 (ph52)	0	4	0	
210	Alarm in the event of start prevention 0=deactivated 1=activated	0	1	0	
211	Fan ramp up time	2s	60s	5s	
212	Max time down to low fire	0.2s	10min	30s	10s
213	Min time homerun	2s	60s	2s	
214	Max time start release	0.2s	10min	20s	
215	Repetition limit safety loop	1	16	1	
217	Max time to detector signal	5s	10min	30s	
221	Gas: Active detector flame evaluation 0=QRB/QRC 1=ION/QRA	0	1	1	
222	Gas: Pre-purging 0=deactivated 1=activated	0	1	1	

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Table 7 (cont)-Steam Program for Siemens LMV3*

Par.No.	Parameter	Min Value	Max Value	Fulton Setting	Customer
223	Repetition limit pressure switch mini-gas	1	16	1	
225	Gas: Pre-purge time	20s	60s	30s	
226	Gas: Pre-ignition time	0.2s	60min	2s	
227	Gas: Safetytime1(TSA1)	0.2s	10s	5s	
229	Gas: time to respond topressurefaultsinTSA1	0.2s	9.8s	1.8s	
230	Gas: Interval1	0.2s	60s	5s	
231	Gas: Safetytime2(TSA2)	0.2s	10s	5s	
232	Gas: Interval2	0.2s	60s	2.0s	
233	Gas: Afterburn time	0.2s	60s	8s	
234	Gas: Postpurge time	0.2s	108mi,	15s	
237	Gas pressure switch-max/ POC input 0=deactivated, 1= pressure switch-max, 2=POC	1	2	2	
239	Gas: Forced intermittent operation, 0=deactivated, 1=activated	0	1	1	
240	Gas: Repetition limit loss of flame	1	2	1	
241	Gas: Execution leakage test 0=no leakage test 1=leakage test on start-up, 2=leakage test on shutdown, 3=leakage test on both	0	3	0	
242	Gas: Leakage test evacuation time	0.2s	10s	3s	
243	Gas: Leakage test time atm pressure	0.2s	60s	10s	
244	Gas: Leakage test filling time	0.2s	10s	3s	
245	Gas: Leakage test time gas pressure	0.2s	60s	10s	
246	Gas: Waiting time gas shortage	0.2s	60s	10s	
400	Ratio Curves				
401	Ratio control curve fuel actuator	0	90		
402	Ratio control curve air actuator	0	90		
403	Ratio control curve VSD	20%	100%		
500	Ratio Control				
501	No-flame positions fuel actuator Index0=no-load position. Index1=pre-purge position. Index2=post-purge position	0	90	0 0 0	
502	No-flame positions air actuator Index0=no-load position. Index1=pre-purge position. Index2=post-purge position	0	90	0 65 45	

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+Out of Test Fire

Note: Customer settings should be recorded in the Customer column for reference.

Table 7 (cont)-Steam Program for Siemens LMV3*

Par. No.	Parameter	Min Value	Max Value	Fulton Setting	Customer
503	No-flame speeds VSD Index0=no-load position Index1=pre-purge position Index2=post-purge position	0%	100%	0 65% 65%	
522	Ramp up	5s	20s	20s	
523	Ramp down	5s	20s	20s	
542	Activation of VSD/PWM fan	0	1	1	
544	Modulation Ramp	32s	80s	32s	
545	Lower load limit	20%	100%	20%	
546	Upper load limit	20%	100%	100%	
600	Actuators				
601	Selection of reference point Index0=fuel Index1=air 0=closed(<0) 1=open(>90)	0	1	1 0	
602	Actuator's direction of rotation Index0=fuel,Index1=air 0= counterclockwise 1=clockwise	0	1	0 0	
606	Tolerance limit of position monitoring	0.5	2.5	1.7	
641	Control of speed standardisation of VSD	-25	1	0	
642	Standardized speed Index0=uC1 Index1=uC2	650	6500	Undefined	
645	Configuration of analog output 0=DC0…10V 1=DC2…10V 2=DC0/2…10V	0	2	0	
700	Error History				
701	Error history:701-725.01. Code	0	255		
.	Error history:701-725.02.Diagnostic Code	0	255		
.	Error history:701-725.03.Error class	0	6		
.	Error history:701-725.04.Phase	0	255		
.	Error history:701-725.05.Startup counter	0	99999999		
725	Error history:701-725.06.Load	0%	100%		
900	Process Data				
903	Current output Index0=fuel Index1=air	0%	100%	0	
922	Incremental position of actuators Index0=fuel Index1=air	-50	150	0	
935	Absolute speed	0	65535	0	

Table 7 (cont)-Steam Program for Siemens LMV3*

Par.No.	Parameter	Min Value	Max Value	Fulton Setting	Customer
936	Standardized speed	-200%	200%		
942	Active load source	0	255		
947	Result of contact sensing(bit-coded)	0	255		
950	Required relay state(bit-coded)	0	255		
954	Intensity of flame	0%	100%		
960	Actual flowrate	0	65525		
961	Status for external modules and display	0	255		
981	Error storage: Code	0	255		
982	Error storage: Diagnostic code	0	255		
992	Error flags	0	0xFFFFFFFF		

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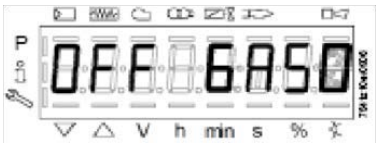
+Out of Test Fire

Note: Customer settings should be recorded in the Customer column for reference.

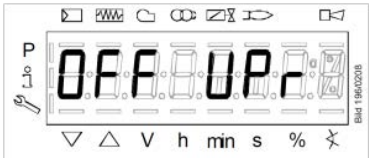
28. Once the commissioner is satisfied that the flue gas contains O2 across setpoints P1-P9 at a boiler pressure of 10bar use the**+** key to quickly ramp the burner up to P9, once at P9 use the

    - key to quickly ramp the burner down to P1 to confirm the flame is stable under transient load conditions.

29. Ramp the burner back up to P9, once settled press **- and +** to escape from the setpoint curve setting procedure and release automatic operation mode. Escape back to the home screen. It should now display



rather than



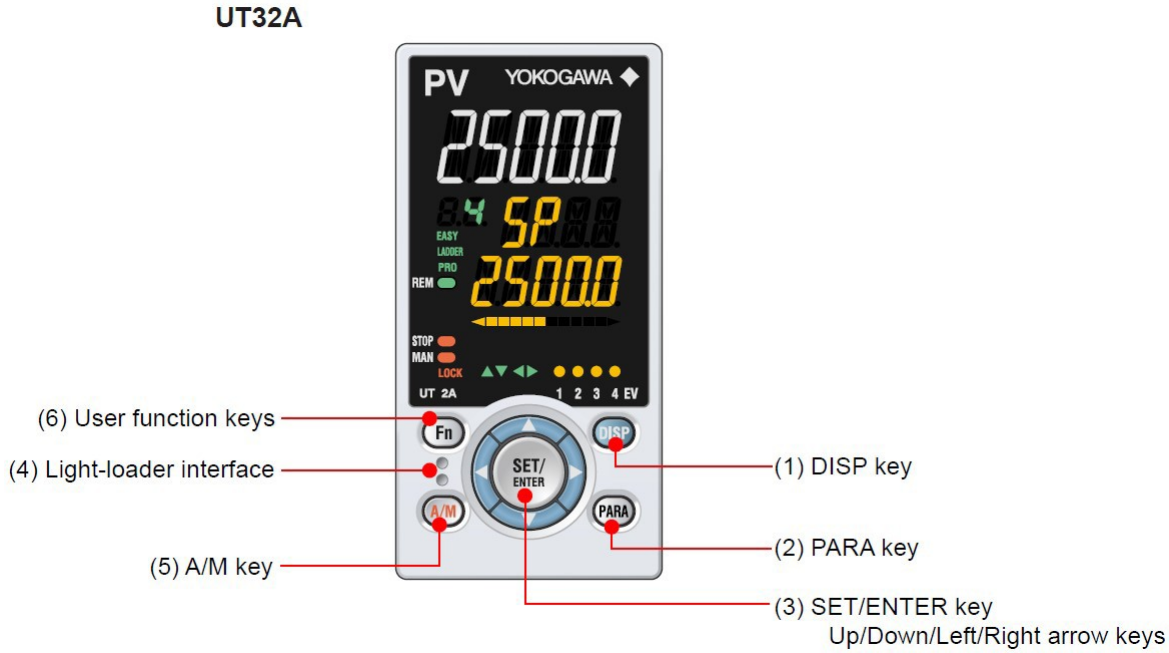
showing the setpoints are fully programmed and the burner is ready for automatic operation mode.

Note: *Before leaving the boiler unattended, the daily and weekly operating tests (see* **Section 6.8.1***) should be carried out to check the functions of all the safety interlocks.*

30. After commissioning, the boiler will need to be completely drained and refilled.

4.1.3 ADJUSTMENT OF THE YOKOGAWA UT-32A OPERATING CONTROLLER

Front panel keys are shown below and explained in the text that follows.



(1) DISP key used to switch the Operation Displays. Press the key in the Menu Display or Parameter Setting Display to return to the Operation Display.

(2) PARA key hold down the key for 3 seconds to move to the Operation Parameter Setting display. Hold down the key and the left arrow key simultaneously for 3 seconds to move to the Setup Parameter Setting Display. Press the DISP key in the Parameter Setting Display to return to the Menu Display. Press the SET/ENTER key once to cancel the parameter setting (set point is blinking)

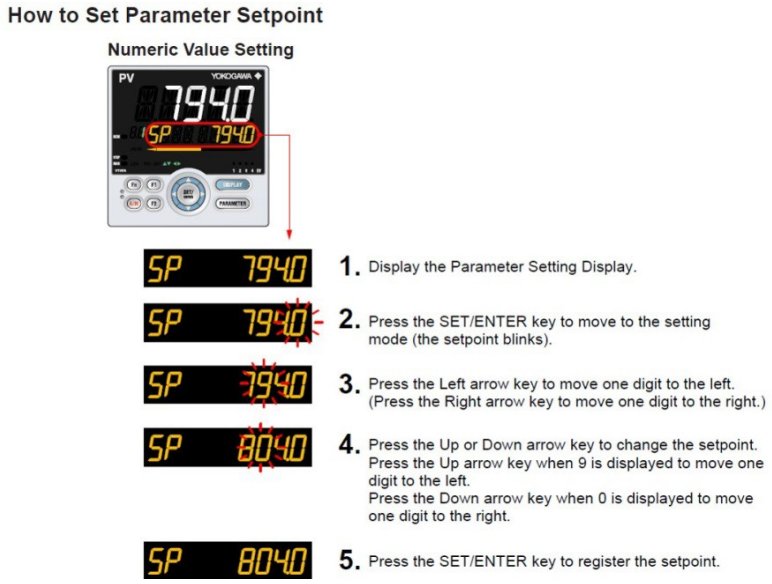
(3) SET/Enter key press the key in the Menu Display to the Parameter Setting Display of the Menu. Press the key in the Parameter Setting Mode to change the set point

(4) Light-loader interface is the communication interface to the adapter cable when setting and storing parameters via PC.

(5) A/M key used to switch between AUTO and MAN modes.

(6) Fn user function key defined by user. PID will display when Fn key is pressed.

Parameter set-point adjustments are shown in the figure on the next page and explained in the text that follows.



To adjust the "Boiler On" set point (A1): Press the "Display" key until A1 is shown on the controller. Press the "Set/Enter" key to adjust (the value will be flashing). Use the directional up and down arrows to change the value. With a negative setting for A1, the boiler will turn back on under the selected set point. For example, if the set point is 100 PSIG and the boiler burner is to turn back on at 80 PSIG, A1 would be set to (negative) - 20.

To adjust your "Boiler On" set point, you choose the negative number for how far under the set point you would like the boiler burner to turn back on. Press the "Set/Enter" key once the desired number is reached to lock in the set point. The value will now stop flashing to signify that it is set. Press the "Display" key to return to the Set Point (SP) home screen.

To adjust the "Boiler Off" set point (Hy1): Press the "Display" key until HY1 is shown on the controller. Press the "Set/Enter" key to adjust (the value will be flashing). Use the directional up and down arrows to change the value. With a positive setting for Hy1, the boiler will turn off over the selected set point. To adjust your "Boiler Off" set point, you have to calculate the difference between your "Boiler On" set point value and the "Boiler Off" set point value. Example: Boiler On at 100 PSIG and Boiler Off at 120 PSIG, the Hy1 setting is to be 20. Use the directional up and down arrows to change the value. Press the "Set/Enter" key once the desired number is reached to lock in the set point. The value will now stop flashing to signify that it is set. Press the "Display" key

to return to the Set Point (SP) home screen.

To adjust the PID settings, follow the steps below:

1. Pressing the "Fn" button will directly bring you to the PID parameters
2. "P" will be displayed
3. Pressing the ↓ will display "I."
4. Pressing the ↓ again will display "d."
5. Pressing DISP will return to SP
6. **"P" – Proportional Band**
7. Percentage of set point at which the burner begins to modulate down from 100% firing rate.
8. The smaller the number, the longer the unit will remain at 100% firing rate.
9. With Proportional only setting, the boiler typically will never reach set point.
10. **"I" – Integral Band**
11. How often the unit checks to adjust the firing rate.
12. The smaller the number, the faster the controller reacts. If it reacts too fast, it will oscillate.
13. Integral setting allows the boiler to reach the set point
14. Fulton standard Integral time setting is "minutes/ seconds per repeat"
15. **"D" – Derivative Band**

16. Proportional does the heavy lifting getting the temperature close to the set point and Integral gradually removes error. Most systems you will not need it.
17. D is used to compensate for dead (or lag) time.
18. The D term adds to, or subtracts from, the output an amount defined by the mathematical derivative or rate of change of the operating value.
19. PID Settings for a typical boiler system with the boiler correctly sized is P=20 / I=45 / D=0 To change the controllers from Automatic Mode to Manual Mode
20. Press the “A/M” button until the red light illuminates next to MAN and OUt is displayed.
21. Use the ⤒ /↓ to change the output from 0.0 to100.0.
22. To return to Automatic Mode, press the “A/M” key again and the red light will turn off.

SECTION 5 – 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.

5.1 GENERAL

The following instructions are given for the guidance of the competent operator in the use of the VSRT fuel 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.

5.2 CONTROLS

The following description of the controls used on the VSRT 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.

5.2.1 BOILER CONTROLS

Note: All the limiters are of the 'fail-safe' type and are wired in series; failure of anyone will automatically shut down the boiler.

Low Water Limiters, Feedwater Pump Relay and High-Water Level Relay

These limiters and relays operate in conjunction with probes suspended in the boiler and water bottle to automatically maintain the level of water in the boiler and to cut off the burner should the water level fall to an unsafe level, or if an unsafe water level is achieved.

Steam Pressure Controls

Located on a bracket above the control panel box and connected to the steam pressure gauge assembly by copper tube, the pressure transducer controls the modulation of the burner, shutting the burner off when maximum operating pressure is reached and switching it on when the steam pressure falls.

Burner Programmer

This is the main control in the panel box. The programmer in conjunction with a sensing device 'supervises' the ignition sequence, proves the flame is satisfactory and finally 'monitors' the established flame. Should any fault occur, either during the ignition sequence or during normal running, the programmer will immediately go to 'lockout' and the multi-bloc gas valve will be closed.

Air Pressure Switch

Mounted on the burner scroll, this switch is operated by the pressure of air entering the burner through the throat of the scroll. Lack of air, or insufficient pressure, will prevent the switch completing the circuit thus preventing the burner from operating.

Gas Head Assembly

Consists of a Multi-bloc incorporating an integral governor, pressure switch and gas valves or for larger boilers in addition to the internal components, an external pilot line with its own gas solenoid valves and governor. For boilers fitted with fully modulating burners, a gas actuator is fitted to the gas train.

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.

5.2.2 BOILER CONTROL PANEL

Indicator lights are fitted to the control panel as an additional aid to the operator. The meaning and operating sequence of these lights is as follows:

⚠ CAUTION
The power on light 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.

Power On

Indicates that power is being supplied to the control panel box.

Low Water Limiter 1

This light will energise when the boiler water is below low limiter 1. The light will illuminate, a continuous alarm will sound and the burner will go to lockout. Once the water in the boiler has been restored to a safe operating level, pressing the Common Alarm Reset button will reset the controls and allow the burner start sequence to initiate.

Low Water Limiter 2

This light will energise when the boiler water is below low limiter 2. The light will illuminate, a continuous alarm will sound and the burner will go to lockout. Once the water in the boiler has been restored to a safe operating level, pressing the Common Alarm Reset button will reset the controls and allow the burner start sequence to initiate.

Burner Alarm

This light will be illuminated when the burner has gone to a lock-out condition due to flame failure. The burner controller can be reset by pressing the Common Alarm reset button.

High Steam Pressure

This light indicates when the boiler exceeds the maximum allowable pressure. The high pressure limiter can be reset using the switch on top of the controller when the steam pressure has dropped below the set pressure.

VSD Fault

This light will illuminate when there is a fault with the variable speed drive (burner fan motor).

Common Alarm Reset

Pressing this button will clear rectified alarms. This light will extinguish when all alarms are rectified.

Alarm Mute

Pressing this button will silence the audible alarms but will not clear them. Alarms must be checked and rectified.

Collection Chamber Detached / Collection Chamber Full

Dependent on the age of the model, the control panel with have these lights to indicate if the dust collection chamber is fitted or full, respectively.

5.2.3 STEAM PRESSURE CONTROLS

Pressure controls are mounted on a bracket above the control panel.

Pressure controls are as follows:

Operating Pressure Switch (On/Off)

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 Pressure Limiter

Should the operating Pressure Switch fail, the steam pressure will raise above the pre-set limit causing the High Pressure Limiter (set at least 0.5barg higher than the Operating Pressure Switch) to switch off and lock out the burner.

A High Steam Pressure Indicator will illuminate, and an alarm will sound.

Should this happen, switch the Boiler OFF/ON switch to OFF and wait until the steam pressure is discharged. Check the connection to the pressure switch, replace as required.

5.2.3.1 SETTING PRESSURE CONTROLS

1. Set the boiler controller to the maximum pressure required (system pressure). Do not exceed the boiler operating pressure

5.2.3.2 TESTING STEAM PRESSURE CONTROLS

1. Start the boiler.
2. SHUT the main steam valve.
3. Set the Operating Pressure switch to its maximum.
4. Set the High-Pressure Limiter to 0.5barg 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 0.5barg below the safety valve lift pressure. If the pressure is incorrect, repeat steps 2, 4 and 5.
6. OPEN the main steam valve slowly to lower the steam pressure.
7. Reset the operating pressure switch to the required working pressure and the high/low pressure switch to 0.3barg - 0.5barg below the operating pressure switch setting.
8. SHUT the main steam valve.
9. Reset the high-pressure limiter 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 Operating Pressure switch.
10. Readjust if necessary to achieve the required settings.

Note: The requirement for a difference between the operating and high pressure limiter is to prevent unnecessary high steam pressure faults tripping the burner at no load conditions.

The residual heat in the furnace and the spiral rib flue way are capable of raising steam pressure slightly, causing the high limit to trip out.

5.3 FILLING THE BOILER - ALL MODELS

1. The door isolator should be in the OFF position.
2. Ensure the Boiler and Pump Switches are in the OFF position.
3. Ensure the following valves are OPEN:
   a) Main steam stop valve.
   b) Steam pressure gauge isolating valve.
   c) All valves in the feedwater line.
   d) Water level gauge (sight glass) isolating valves.
4. Ensure the following valves are SHUT:
   a) Main blowdown valve.
   b) Water level gauge blowdown valves.

⚠ CAUTION

The feed pump seals are water cooled. The pump must never be allowed to run whilst dry, irreparable damage may result. Ensure the pump is fully primed before energising the motor.

5. Vent the pump.
6. Turn the door isolator to the ON position.
7. Turn the Pump switch to the ON position.
8. The feedwater pump should start (check the pump direction of rotation) and fill the boiler to the correct working level and then automatically switch OFF.

Note: If the boiler water level is below its correct level, the feedwater pump will operate. When the water reaches the correct level (two thirds up the water level gauge), the pump will stop. If the water level is above the top of the level gauge, drain off until the level is in the middle of the water level gauge (sight glass).

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.

5.4 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. A low-level drain point is required in the blowdown pipework between the boiler and the Blow Down Vessel for both manual and automatic blowdown systems.
2. The boiler should not be under pressure/the boiler should be cold.
3. Isolate the boiler electrics at the isolator on the control box door.
4. Isolate the feedwater tank and the feedwater pumps.
5. Open the main steam valve and the boiler blowdown valve.
6. Open the blowdown vessel drain valve.
7. 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. Open the main blowdown valve.
3. Using the blowdown bypass valve to throttle the flow, drain the boiler.

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

If a blowdown bypass valve is not fitted then you can manually blowdown the boiler by using a flat-head screwdriver. Locate manual blowdown button (labelled as A in Figure. 17), push the Manual Blowdown Button up and make a quarter turn clockwise, this will lock the button in position and open the blowdown valve.

5.5 BOILER START-UP (FROM COLD)

1. Fill the boiler **(see Section 5.3 - Filling the Boiler).**
2. Ensure the main steam isolating valve is SHUT.
3. Open all the valves in the gas train. It is assumed that the fuel supply lines have been purged prior to attempting to start the boiler/burner.
4. Switch the Pump and Boiler switches to the ON position.
   The Low Water audible alarm will sound, the Low Water Limiter lights will illuminate.
5. Press the Common Alarm Reset button for two seconds maximum. The alarms will stop, and the alarm lights will extinguish.
   Reset high pressure switch.
   The burner start sequence will commence.
6. After a maximum of two minutes the burner should be firing, and the Main Gas light should illuminate.

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

When the boiler has achieved the required (set) pressure, the main steam isolating valve should be slowly opened allowing steam to enter the system distribution pipework.

This can be achieved by one of two methods:

a) Partially open the main steam valve and allow the system to heat up slowly (minimum 15 minutes) before fully opening the main steam valve.

b) Open the main steam valve when starting the boiler, allowing the boiler and system to heat up together.

Note: This can lead to water logging of the steam lines until full pressure is achieved.

If fitted, TDS Panel Mounted Controllers (BC3250) must be reset after any break in electrical supply to the unit.

Note: Before leaving the boiler unattended, the daily operating tests (see Section 6.8.1) should be carried out to check the functions of all the safety interlocks.

5.5.1 BOILER START-UP FOLLOWING SHORT TERM SHUTDOWN

If the boiler has been shut down for a short period of time (6 hours or less), it can be switched on and allowed to cycle to normal firing rates as the low thermal expansion of the boiler pressure vessel allows this. However, if the boiler has been shut down for extended periods of time, it should be brought up to normal operating temperature and pressure in a controlled manner.

5.6 BOILER SHUTDOWN

5.6.1 SHORT TERM SHUTDOWN (HOURS)

Switch Boiler switch to OFF on the boiler control panel switch.

The burner will stop firing, post-purge, and then stop.

5.6.2 MEDIUM TERM SHUTDOWN (DAYS)

1. Shut the main steam valve.
2. Leave Pump switch ON.
3. Switch Boiler switch OFF.
4. Shut off fuel supply.

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

5.6.3 LONG TERM SHUTDOWN (WEEKS)

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

1. Fully flood the boiler to exclude as much air as possible
   Increase chemical dosing (consult water treatment provider for guidance) Recommended maximum 3 month "water wedged"
2. Drain the boiler completely. Remove all handholes.

   Fit Silicone Gel moisture bags to the gas side and the water side of the boiler and seal all openings.

   Additionally, you could introduce a form of convection heating to the gas/oil and water side. A very effective solution is to install a small heater.

5.7 COLLECTION CHAMBER

Figure 12 - Collection chamber position.

⚠ CAUTION

The boiler should never be operated whilst the collection chamber is removed.

If the burner is running whilst the collection chamber is disconnected it will result in incorrect combustion and could affect the efficiency of the boiler.

There is also potential for debris, normally caught in the collection chamber, to get transported to the burner mesh instead, reducing its serviceable life.

SECTION 6 – MAINTENANCE

⚠ CAUTION

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

Tests should be conducted 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 conducted by trained, competent service personnel.

6.1 BOILER PLATFORM (IF FITTED)

Mobile platforms are recommended 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 ladders and working at height on the platform.

6.2 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.

6.3 FLAME SENSOR TEST

1. When the burner is firing under normal running conditions, turn switch (1) to BOILER OFF.
2. Ensure boiler is completely off – Siemens Display should read OFF GASO.
3. Close the pilot gas valve (2).
4. Turn switch (1) to BOILER ON.
5. The burner will cycle to pilot and should fail to light. The burner will lock out and the common alarm light (3) will illuminate, the sounder will trigger, and the Siemens Display will show Loc.d: 1 and Loc.c:2.
7. If the burner fails to lock out, turn off the boiler and contact Fulton or their appointed agents.
6. To reset the burner, reopen pilot gas valve (2), press the Common Alarm button (3) for 3 to 5 seconds. The Common Alarm Reset will automatically clear. The Siemens display will initially read OFF GASO, then the burner will begin a firing cycle.

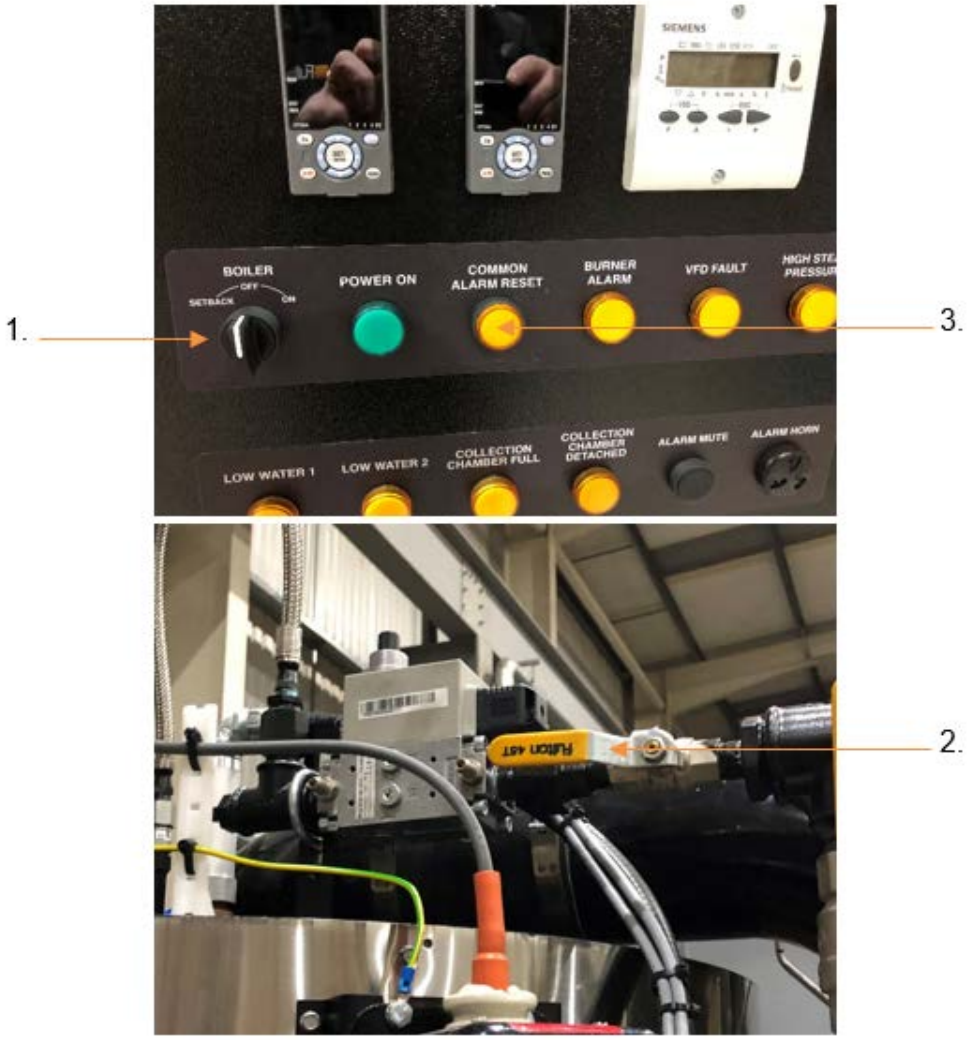


Figure 13 - Control details for flame sensor test.

6.4 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.

6.4.1 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.

6.4.2 LOW WATER LEVEL CHECK

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 the Pump switch to the OFF position.
3. Allow the water level to lower by natural evaporation below the Low Water level. Do not allow the water level to drop below the bottom of the water level gauge (sight glass).
4. Check:
   a) Low Water limiter lights illuminate
   b) Low Water audible alarm sounds
   c) Burner stops firing
   d) Feedwater pump does not start

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

5. Switch the pump switch to the ON position.
6. Check:
   a) Feedwater pump starts and refills the boiler
   b) Water level rises above the Low Water level
   c) Burner does not start
   d) Low Water audible alarm continues to sound

7. Press the Common Alarm Reset switch for 2 seconds maximum
8. Check:
   a) Low Water Limiter lights extinguish
   b) Low Water audible alarm silences
   c) Burner automatic fire sequence starts
9. Verify that the pump continues to run until the Pump Off level is reached and then switches off.

6.4.3 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 6.4.2 - Low Water Level check allowing water to lower by natural evaporation and not by manual blowdown.

6.5 BLOWDOWN PROCEDURES

Keep the boiler, water level gauge (sight glass) and interconnecting pipework free from sludge and scale build-up by blowing down in the following manner:

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

6.5.1 MAIN BOILER BLOWDOWN

1. Start the boiler and generate 10 psi of steam pressure.
2. Turn OFF both the burner and the pump.
3. Fully OPEN the boiler main blowdown valve for 5 seconds, or as recommended by the water treatment specialist.
4. CLOSE the main blowdown valve.

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

Note: Where Auto blowdown is fitted, this blowdown will be carried out automatically on a daily basis.

6.5.2 WATER LEVEL GAUGE (SIGHT GLASS) BLOWDOWN

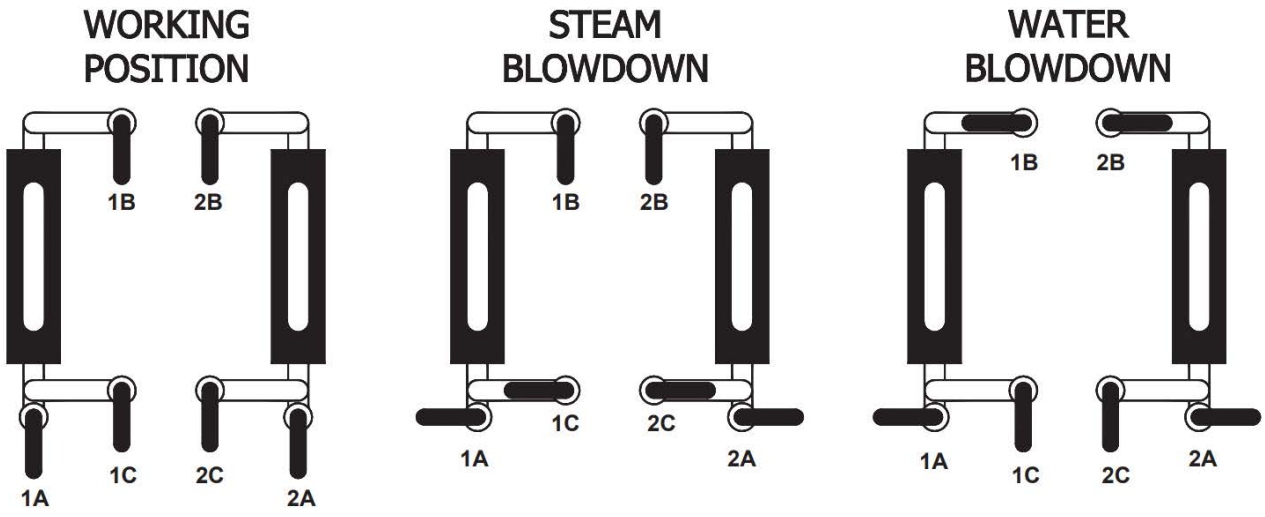


Figure 14 - Water Level Gauge Operating Positions

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 (B and C) are OPEN, and all blowdown valves (A) are CLOSED.

The level gauge isolation valves are equipped with an internal ball check. If a sight glass should break, the ball will set, preventing discharge of steam and water. The valve stem must be opened fully to enable this feature. If the valve is in any other position, the ball will not seat.

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

Note: If your boiler is fitted with Clifton Reflex Gauges instead of Klinger, then handles 1B and 1C will open away from the gauge instead of towards the gauge.

6.6 BOILER INTERNAL INSPECTION

The lower hand hole doors should be removed after one month of operation and the interior of the boiler thoroughly examined. If scale or sludge build-up is observed, it should be removed, and the water treatment supplier advised.

New gaskets must be fitted every time a hand hole door is removed **(see Section 6.7 - 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 conducted at three monthly intervals.

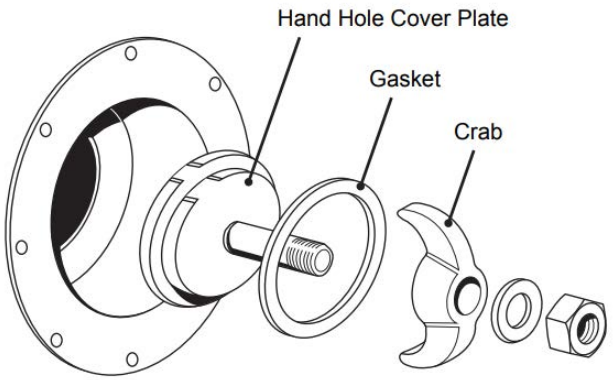


Figure 15 - Hand Hole

6.7 FITTING NEW GASKETS TO BOILER INSPECTION HOLES

6.8 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 VSRT boilers are fitted with Topog-E gaskets in all the steam and water side inspection openings 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.

6.8.2 FITTING PROCEDURE

Blowdown the boiler completely **(see Section 6.5.1 - Main Boiler Blowdown)** and examine all inspection holes in the boiler. If any leakage is evident, proceed as follows:

1. Disassemble the crab 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 crab 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 shutdown 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.

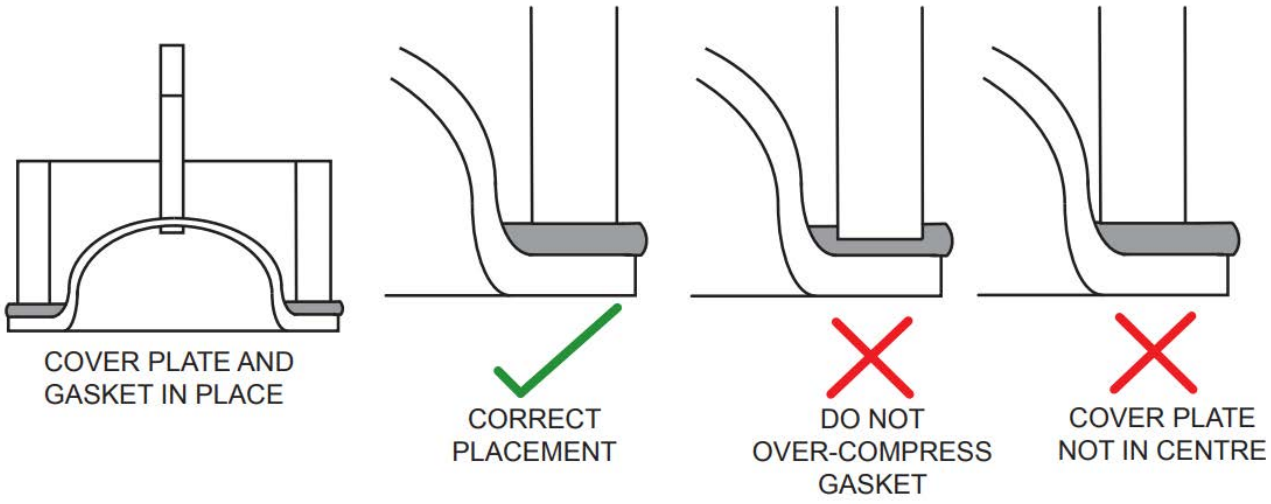


Figure 16 - Fitting a new Topog-E Gasket

6.9 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 conducted 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, water level gauge (sight glass) and water bottle pipework. 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.

6.9.1 DAILY

⚠ WARNING

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

1. Visually inspect for signs of leakage:
   a) Steam and feedwater pipework.
   b) Valves and fittings.
   c) Handholes

If leakage is evident, the gasket needs replacing.

If leaks are suspected, shut down and evacuate the system to atmospheric pressure before attempting to repair the leaks.

2. Low Water Level Check **(see Section 6.4.2).**
3. Blowdown the Boiler **(see Section6.5.1).**

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.

4. Blowdown the Water Level Gauge (sight glass), **(see Section6.5.2).**

6.9.2 WEEKLY - IN ADDITION TO DAILY

⚠ 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.

5. Ensure that the pipe from the safety valve outlet is not damaged and that it continues to a safe blowdown point.
6. Feedwater Pump Test **(see Section 6.4.1).**
7. Evaporation Check **(see Section 6.4.3).**
8. Flame Failure Check **(see Section 6.3).**

6.9.3 MONTHLY – IN ADDITION TO WEEKLY

Note: Must be carried out after 1ST Month following commissioning.

⚠ WARNING

Ensure the main electrical supply is isolated before starting work.

9. Visually inspect the internal water space (see Section6.6).
10. Visually inspect the flanged joint covering the rear inspection port in which the blowdown valve is fitted, if any leakage is evident, the gasket needs replacing.
11. Clean any water traps and strainers fitted in the feedwater line.

Check feedwater and boiler water quality against the values given in **Appendix A - TI-139- Recommended Water Conditions.**

Note: Use only genuine Fulton replacement parts.

6.9.4 SIX MOTNHLY – GAS SAFE ENGINEER ONLY

⚠ WARNING

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

The boiler must be drained and isolated before the following maintenance procedures are carried out (see Section 5.4 - Draining the Boiler).

12. Drain and flush the feedwater tank. Clean any filters in the tank, in the feedwater line or in the feedwater pump.
13. Clean the water level probes. When replacing the probes, the copper sealing washer should be replaced. After replacement of the probes, check the operation of the low water cut-off relay and of the feedwater pump.
14. Test the flue using the following procedure:

Visual Inspection

Check joints between all flue sections for quality of seals. Where the flue passes through the structure of the building use your judgement as to the integrity of this section of the flue.

Smoke Test

With the flue capped and a smoke generator inserted into the flue, there should be no smoke visible. If either of these tests fail, shut down the boiler and contact Fulton Ltd immediately.

15. Check the burner combustion to ensure that excess air and carbon monoxide values are within normal limits (see combustion values in Appendix A-TI-151-VSRT Dimensions & Specification).
16. Check the condition of the gas valve filter (if fitted), renew as required.

6.9.5 ANNUALLY - GAS SAFE ENGINEER ONLY

⚠ WARNING

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

17. Inspection of the pilot assembly

Your boiler is equipped with an interrupted pilot. This pilot uses gas from the pilot gas train, and air from within the combustion chamber to run. The pilot is ignited via a spark from the ignition electrode.

Remove the pilot line assembly – This can be done with the burner in place See “Figure. 23 - Pilot Removal” on page 53.

- Shut the manual ball valve in the pilot line, and ensure that the boiler is unpowered
- Disconnect the pilot gas hose from the pilot assembly
- Remove the ignition cable from the ignition electrode
- Remove the bolts holding the pilot assembly down
- Remove the pilot line assembly by lifting straight up, taking care not to lose the o-ring seal

Inspect the pilot line assembly

- Ensure that the pilot orifice is not clogged.
- Inspect and ensure that there are no signs of overheating, these would be visible as burner or scaling metal, or distortion of the pilot parts
- Inspect the gap from the ignition electrode to the sparking notch in the pilot sleeve.

- Electrode should be centred vertically in the notch, and the minimum gap from electrode to sparking surface should be 2.4mm.
- Ensure that the ceramic on the ignition electrode is not cracked or damaged

If any parts of the pilot assembly or the dead-zone of the burner are overheated, this could indicate a failure in the seal at the burner plate, or the premix transition, which allows combustion to flow upward. Inspect all seals if this is the case.

Note: Removing the burner plate will require replacement gaskets.

18. Inspection/Cleaning Of The Burner Assembly

Most of the particulate matter in the combustion air stream should be caught by a pre-filter or cyclone. However, it is necessary to pull the burner head once a year, and inspect and clean it

Remove Burner

- Remove the bolts holding the air duct to the burner plate and the fan.
- Lift the air duct straight up. Be mindful not to lose the gasket that seals the transition to the burner plate.
- You should now be able to lift the burner straight out of the burner plate.

Inspect and Clean the Burner

- The burner should be clean and free of dust.
- This can be accomplished using compressed air. Blow compressed air through the mesh from the outside in, then empty any contaminates inside the burner can.
- Inspect the burner signs of local overheating or soot. If soot is present, either the pilot or the main burner has incomplete combustion. The combustion controls should be checked, while local overheating will result in discoloured mesh or possible detachment or sagging. The condition of the insulting heat barrier should also be checked.

19. Flush boiler if necessary. More extensive cleaning may be required; consult a local water chemistry expert for recommendations.

6.9.6 AFTER 5 YEARS

23. Fulton Ltd recommend replacement of all threaded stub pipes on the boiler OR to your inspector's satisfaction.

6.9.7 AFTER ANY REPAIRS OR MAINTENANCE – IN ADDITION

1. Complete all safety checks in the daily and weekly maintenance section.

2. Fire the boiler and perform combustion safety checks.

3. Analyse combustion throughout the range and verify proper operation of safety devices.

6.10 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 Logbooks provided by Fulton.

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

Fulton

Model: _____ Fuel: _____

Vertical 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. **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. **Blowdown, Boiler**	Duration seconds.							
	Test Time.							
4. **Blowdown, Water Bottle**	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

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

SECTION 7- INSPECTION

7.1 INSPECTION

1. Provide annual inspection by a qualified boiler inspector, as required by local codes

SECTION 8 – TROUBLESHOOTING

8.1 TROUBLESHOOTING

Problem	Cause	Remedy
1. Ignition Failure	1. Gas supply	Check for gas pressure and intermittent supply problems.
	2. Power Supply	Check fuse or circuit breaker. Reset or Replace as required.
	3. Ignition Electrodes	Check for cracks in porcelain, if found replace the electrode. Check electrodes for carbon build-up. Clean as required. Check settings, adjust if required.
	4. Transformer	Check voltage between transformer leads at terminal block to be sure transformer is live.
	5. UV Detector	Check for ignition interference.
	6. Burner Control	Check voltage between ignition terminal and neutral, this check must be made before the control locks out. If no power, replace the control.
	7. Air Settings	Check air servo motor operation and setting.
	8. Faulty Air Switch	Check for faulty air switch.
	9. Gas Valve	Check filters in the valve block. Clean as required.
	10. Loose wire connections	Check connections to all components.
2. Flame Failure During Start-up	1. Gas supply	Check for gas pressure and intermittent supply problems.
	2. Power Supply	Check fuse or circuit breaker. Reset or Replace as required.
	3. Air Settings	Check air servo motor operation and setting.
	4. Ignition Electrodes	Check for cracks in porcelain, if found replace the electrode. Check electrodes for carbon build-up. Clean as required. Check settings, adjust if required.
	5. UV Detector	Check the detector is located correctly and clean.
	6. Burner Control	Check voltage between ignition terminal and neutral, this check must be made before the control locks out. If no power, replace the control.
	7. Loose wire at fuel valve circuit.	Tighten wiring connections.
	8. Contact open on Air Switch	Adjust to the correct setting.
	9. UV Detector wiring reversed at control box.	Change to the correct terminals.

Problem	Cause	Remedy
3. Flame Failure During Normal Run	1. Power Supply	Check fuse or circuit, reset or replace as necessary.
	2. Gas Supply	Check gas pressure coming into the gas train, if low contact the gas supplier. Check the setting on the gas valve regulator, adjust as required.
	3. UV Detector	Check the detector is located correctly and clean.
	4. Faulty Air Switch	Check for faulty air switch.
	5. Bad Combustion	Check combustion readings.
4. Boiler fails to start	1. No Power	Check fuse or circuit breaker. Reset or replace as necessary.
	2. Pressure Control	Disconnect all power to the controller. Disconnect the wires from the controller. Connect an ohmmeter between the switch terminals. Lower the set point of the controller, the switch should make. Raise the set point and re-check, switch should break. if the controller operates improperly, replace it.
5. Burner Cut-off	6. Gas supply	Check gas pressure coming into the gas train, if low contact the gas supplier. Check the setting on the gas valve regulator, adjust as required.
	7. Power Supply	Check fuse or Circuit breaker. Reset or replace as required.
	8. Ignition Electrodes	Check for cracks in porcelain, if found replace the electrode. Check electrodes for carbon build-up. Clean as required. Check settings, adjust if required.
	9. UV Detector	Check the detector is located correctly and clean.
	10. Faulty Air Switch	Check for faulty air switch by jumpering the two air switch leads at the terminal block. If the boiler starts and runs with the jumper in place, the air switch should be replaced.
	11. Faulty Level Control	Check the level control relays are securely mounted on their bases. Check the power supply to each. The relays may be checked by swapping positions and checking they are both functioning.
	12. Weak Pilot	Adjust to larger pilot by adjusting pilot gas pressure regulator.
	13. Transformer	Check voltage between transformer neutral at terminal block to be sure transformer is being powered.
	14. Burner Control	Check voltage between pilot terminal and neutral and ignition terminal and neutral. Check must be made before the control locks out on safety. If no power replace control.
	15. Pressure Control	Disconnect all power to the controller. Disconnect the wires from the controller. Connect an ohmmeter between the switch terminals. Lower the set point of the controller, the switch should make raise the set point and re-check, switch should break. If the controller operates improperly, replace it.

Problem	Cause	Remedy
6. Poor Combustion	1. Main Air Adjustment	Check air and gas servo motors and check CO2 and O2 combustion levels.
	2. Draft	Check draft with a gauge. Draft should be -.05 to -.10 mbar with the burner off, or -.10 to -.15 mbar when operating. A barometric damper may need to be installed.
	3. Dirty Flue	Check draft complies with min/max parameters (Technical Data Sheet Appendix A).
	4. Negative Room Pressure	Ensure there are no exhaust fans running in the boiler room.
	5. Dirty Fan	Check fan for obstructions, clean as required.
7. Burner Back Fires	1. Ignition Electrodes	Check for cracks in porcelain, if found replace the electrode. Check electrodes for carbon build-up. Clean as required. Check settings, adjust if required.
	2. UV Detector	Check the detector is located correctly and clean.
	3. Draft	Check draft complies with min/max parameters (Technical Data Sheet Appendix A).
	4. Negative room pressure	Ensure no exhaust fans are running in the boiler room.
	5. Air Settings	Check Air servo motor operation and setting.
	6. Gas Supply	Check gas pressure coming into the gas train, if low contact the gas supplier. Check the setting on the gas valve regulator, adjust as required.
	7. Dirty flue	Check flue Carbon build up and or obstruction.

Problem	Cause	Remedy
8. Boiler will not maintain pressure	1. Gas Supply	Check gas pressure coming into the gas train, if low contact the gas supplier. Check the setting on the gas valve regulator, adjust as required. If possible meter the flow rate.
	2. Dirty flue	Check flue for Carbon build-up or blockage.
	3. Pressure Control	Disconnect all power to the controller. Disconnect the wires from the controller. Connect an ohmmeter between the switch terminals. Lower the set point of the controller, the switch should make raise the set point and re-check, switch should break. If the controller operates improperly, replace it.
	4. Scale build-up in boiler	Clean the pressure vessel – heavy build up may require an acid clean – consult water treatment specialists.
	5. Steam traps blowing through.	Check steam traps, clean or replace as required.
	6. Boiler size.	Boiler may be under sized for the application. Consult Fulton.
9. Boiler is Surging (Widely fluctuating water level in sight glass)	1. Steam traps blowing through.	Check steam traps, clean or replace as required.
	2. Contamination in boiler.	Empty boiler and feed tank. Flush out and refill, if system operates but progressively deteriorates, there is probably a leak somewhere in the system.
	3. Scale build-up or lime deposits.	Consult Fulton or call a water treatment specialist.
	4. Too much compound (water treatment over dose).	Dump contents of the return tank and flush the system. Test the water.
	5. High Alkalinity (high pH).	Have a water treatment specialist test the water.
	6. Load exceeds boiler capacity.	Check total system load against the output of the boiler. Decrease the load required at any one time.
10. Boiler rumbles and pulsates	1. Poor Combustion	Check combustion readings.
	2. Draft	Check draft complies with min/max parameters (Technical Data Sheet Appendix A).
	3. Too much main air.	Adjust air/gas ratio.
11. Boiler carrying over water with the steam	1. Steam Traps.	Check steam traps, clean or replace as required.
	2. Too much compound (water treatment over dose) in the system.	Dump contents of the return tank and flush the system. Test the water.
	3. Contamination in boiler.	Empty boiler and feed tank. Flush out and refill, if system operates but progressively deteriorates, there is probably a leak somewhere in the system.
Low fuel pressure.	1. Gas pressure regulator	Check and replace.

Problem	Cause	Remedy
1. 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.
2. 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.
3. 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.
4. 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.
5. 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).
	7. Vapour locking of pump.	Allow system to cool down, check steam traps of pump and check to be sure return lines are not insulated. Check return tank temperature, if it is above 82 °C vapour locking of the pump will occur. Inspect check valves. Clean and replace as needed. Replace pump with multi-stage centrifugal pump able to cope with 121 °C.

Problem	Cause	Remedy
6. 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.
7. Leakage in shaft seal.	1. Shaft seal is defective.	Replace the shaft seal.
8. Noise.	1. Cavitation occurs in the pump.	Check the suction conditions and the feed water temperature into the pump is not exceeding 90°C.”
	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 feed water non-return valve (NRV) and replace if damaged or faulty
9. Water pump runs intermittently	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 its base. Replace if faulty.
10. 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:

Document Library | Support (fulton.co.uk) or consult Fulton Ltd.

Improving life through heat transfer solutions

VSRT FUEL-FIRED STEAM BOILER
Dimensions & Specification

TECHNICAL INFORMATION
Sheet No. 153 Issue 12

TECHNICAL DATA

Standard Features & Devices

- Vertical tubeless heat exchanger
- Thick wall construction (9.27 mm minimum)
- Never needs re-tubing
- Fully wetted design – no refractory
- Operating efficiencies up to 86% (typically 82%)
- Variable speed high pressure combustion air blower
- 10.34 barg maximum allowable working pressure
- Stainless steel jacket
- Fully modulating burner, offering up to 10:1 turndown
- Industrial pilot ignition
- Operating and high pressure limit switches
- Two low water cut off probes with manual reset
- Low NOx emissions <20 ppm
- Media free cyclonic combustion air intake filter
- Gas train
- Safety interlock contacts for external device
- Remote boiler enable contacts
- Emergency-stop contacts
- Combustion air inlet adapter
- Safety relief valve

Control Options

- Automatic surface blowdown (TDS)
- Control panel with non-fused disconnect
- High water protection
- Boiler alarm package
- Boiler gauge package
- Auto bottom blowdown
- High integrity 1st and 2nd low water level limiters
- Optional modbus interface (BACS)
- Optional PC interface

Listings & Compliance

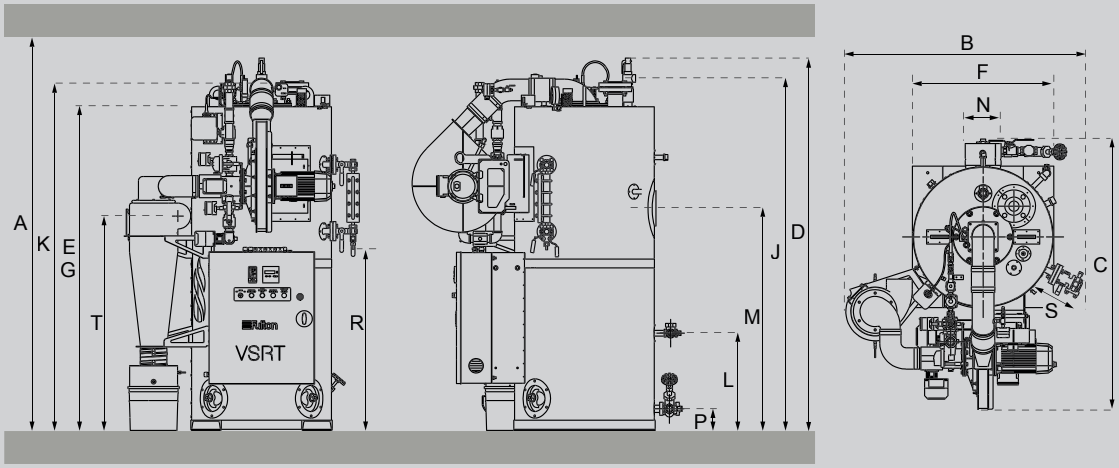
- CE Marked to PED, EMC and LVD
- Constructed to BS EN 12953 as standard

Trim Kit Items (Shipped Loose)

- Installation and Operation Manual
- Feedwater pump
- Automatic blowdown and TDS pipework (for level 3 boilers only)

Information provided in this document is based on standard boiler configurations. Alternate or custom configurations may result in deviations. Fulton practices continuous product improvement and reserves the right to change specifications and/or dimensions without notice.

DIMENSIONS



MODEL: VSRT		10	15	20	30	40	50	60
A	Minimum Clearance*	2713	2713	2800	2800	3350	3350	3350
B	Overall Width	1480	1480	1525	1525	1711	1711	1711
C	Overall Depth	1400	1400	1575	1575	2140	2140	2140
D	Overall Height	1939	1939	2210	2210	2648	2648	2648
E	Boiler Height	1868	1868	2015	2015	2473	2473	2473
F	Boiler Diameter	825	825	830	830	1244	1244	1244
G	Gas Inlet Height	1868	1868	1880	1880	2553	2553	2553
J	Safety Valve Discharge Height	1820	1820	2055	2055	2538	2538	2538
K	Steam Outlet Height	1879	1879	2035	2035	2500	2500	2500
L	Feedwater Inlet Height	567	567	570	570	562	562	562
M	Flue Outlet Height	1094	1094	1295	1295	1660	1660	1660
N	Flue Diameter	150	150	200	200	250	250	250
P	Main Boiler Blowdown Height	126	126	130	130	130	130	130
R	Water Level Gauge (Sight Glass) Blowdown Height	1100	1100	1260	1260	1700	1700	1700
S	Water Level Gauge Stand Off	280	280	280	280	280	280	280
T	Air Inlet Height	1264	1264	1250	1250	1686	1686	1686

* Minimum height required for service & maintenance. If skid mounted an additional 200mm height required.

Note: Dimensions mm.
Note: Dimensions are approximate and only intended as a guide to aid installation.
Note: Electrical enclosures are rated IP54.
Note: Minimum flue draught.

SPECIFICATIONS

MODEL: VSRT	UNIT	10	15	20	30	40	50	60
CE marked to PED, EMC & LVD, constructed to BS EN 12953 as standard.								
GENERAL								
Steam Output F & A 100 °C	kg/h	160	240	320	480	640	800	960
kW Rating	kW	100	150	200	300	400	500	600
Operating Pressure	barg	10.34	10.34	10.34	10.34	10.34	10.34	10.34
WEIGHT								
Shipping Weight	kg	1050	1050	1542	1542	3052	3052	3052
Dry Weight	kg	876	876	1284	1284	2654	2654	2654
Operational Weight	kg	1232	1232	1707	1707	3959	3959	3959
Flooded Weight	kg	1364	1364	1841	1841	4228	4228	4228
Water Capacity	L	356	356	424	424	1306	1306	1306
EFFICIENCIES								
Gross	%	82	82	82	82	82	82	82
Net	%	91	91	91	91	91	91	91
NOISE LEVELS dBA (MAIN NOISE GENERATOR)								
At 1m from fan	dBA	82.5	82.5	82.5	84.5	84.5	84.5	84.5
GAS PRESSURES (WORKING)								
Min.	mbar	19	19	19	19	19	19	19
Max.	mbar	35	35	35	35	35	35	35
FIRING RATE								
Natural Gas - Group H	m^3/h	11.18	16.77	22.36	33.54	44.72	55.9	67.08
Propane Gas	m^3/h	4.72	7.05	9.39	14.06	18.68	23.45	28.13
Burner Turndown		5:1	5:1	5:1	6:1	6:1	8:1	10:1
BOILER ROOM VENTILATION REQUIREMENTS FOR COMBUSTION PURPOSES (FREE AREA) **OPEN FLUED** (TYPE B)								
Low Level inlet	cm^2	440	660	880	1200	1760	2200	2640
High Level Outlet	cm^2	220	330	440	600	880	1100	1320
ELECTRICAL REQUIREMENTS (INCLUDES BURNER FAN MOTOR, FEEDWATER PUMP & 6A STANDARD CONTROL UNIT)								
FLC 400 V 3 ph 50 Hz	A/ph	14.8	14.8	21.6	21.6	21.6	21.6	21.6
ELECTRICAL REQUIREMENTS (INCLUDES BURNER FAN MOTOR & 6A STANDARD CONTROL UNIT EXCLUDES FEEDWATER PUMP)								
FLC 400 V 3 ph 50 Hz	A/ph	11.5	11.5	11.5	11.5	17.2	17.2	17.2
CONNECTION SIZES								
Steam Outlet	IN	1 1/4	1 1/4	1 1/2	1 1/2	2	2	2
Safety Valve Outlet	IN	1	1	1	1	1 1/4	1 1/4	1 1/4
Feedwater Inlet	IN	1	1	1	1	1	1	1
Feedwater Pump Inlet	DN	25F	25F	25F	25F	25F	25F	25F
Blowdown, Boiler	IN	1	1	1 1/4	1 1/4	1 1/2	1 1/2	1 1/2
Blowdown, Sight Glass	IN	1/1	1/1	1/1	1/1	1/1	1/1	1/1
Blowdown, TDS	IN	3/4	3/4	3/4	3/4	3/4	3/4	3/4
Flue Outlet	IN	6	6	8	8	10	10	10
Gas Inlet	IN	1 1/4	1 1/4	1 1/4	1 1/4	1 1/2	1 1/2	1 1/2
Air Inlet	IN	6	6	6	6	6	6	6

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TI-153-VSRT-DS-12

Technical Information

Sheet No. 139 Issue 5

VSRT, J Series & Electric 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 100 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 2000 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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Guided Wave Radar

Measuring principle

High-frequency radar pulses are coupled onto a rod and guided along the probe. The pulse is reflected by the product surface. The instrument calculates the level from the running time of the radar pulses. A controller limits the burner at a set low water level position. The analogue signal is also available for external controllers to make decisions about controlling the water level or providing warnings.

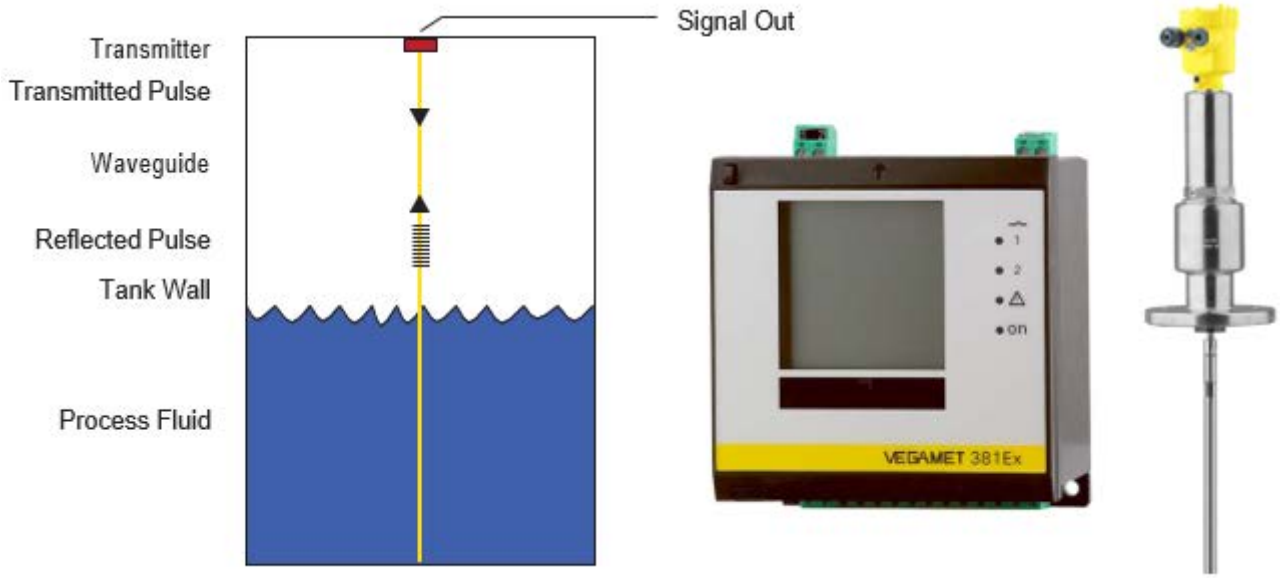

Figure 17 - Guided Wave Radar (VEGAFLEX 86)

Advantages

GWR sensors operate independently of noise, pressure or temperature fluctuations and are also completely unaffected by changes in density, foaming or steam. Build-up on the probe or on the container wall does not affect the measurement either. GWR probes detect the physical presence of the water rather than the conductivity of the fluid. This allows the device to operate in boiler water with very low or varying conductivity such as RO or

De-mineralised water. No polarising electrical connection is made through the probe so scale build-up is significantly reduced.

Integrity

The GWR unit that Fulton supplies is certified to provide SIL2 level of protection against low water level.

Vibrating Fork TI-149-High Integrity Water Limiters-2017-2

Measuring principle

The vibrating fork type level switch working principle is based upon detecting the change in harmonic vibration frequency of the sensing element as a result of the presence of the water between the forks. Typically there are two Piezoelectric elements or crystals. When these crystals are compressed or pulled under tension they generate an electric signal. Conversely when electricity is applied to these crystals they produce motion. This motion is attached to the fork sensing element and vibration at the natural resonant frequency of the mechanical fork is created. The second piezoelectric crystal is used to transform the motion received from the first crystal back into an electric signal. When the fork sensing element vibrates free in air (or steam) the measuring system sees this as one state (water not present). When the water covers the forks, the frequency of the vibration is changed and the second crystals electric signal changes, thereby detecting the material or fluid presence.

The vibrating fork type level switch working principle is simple, effective, reliable and a cost-effective means to measure or detect the presence and absence of water level.

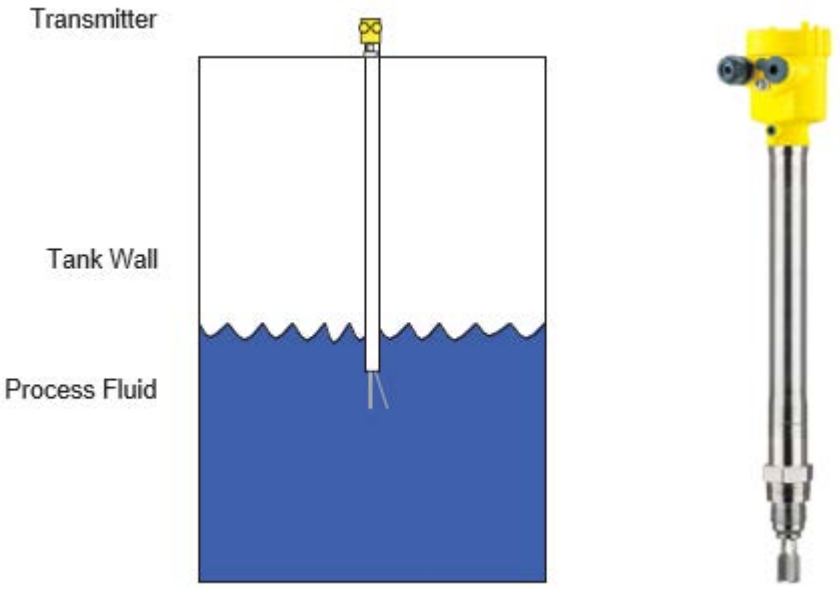

Figure 18 - VEGASWING 63

Advantages

Vibrating fork sensors operate independently of pressure or temperature fluctuations and are also completely unaffected by changes in density, foaming or steam. Build-up on the probe or on the container wall does not affect the measurement either. Vibrating Fork probes detect the physical presence of the water rather than the conductivity of the fluid. This allows the device to operate in boiler water with very low or varying conductivity such as RO or De-mineralised water.

Integrity

The Vibrating Fork unit that Fulton supplies is certified to provide SIL2 level of protection against low water level.

	Pros	Cons
GWR	• Works with RO and DeMin Water • SIL2 low water limiter function • Doesn't mistake foam for water level Provides an analogue signal • Doesn't attract scale • Function not affected by low level scale or debris build-up.	• Probe lengths need to be ordered to size within a range
VF	• Works with RO and DeMin Water • SIL2 low water limiter function • Doesn't mistake foam for water level	• Probe lengths need to be ordered to size (can't be cut to length)
Conductive	• Probes can be cut to length • SIL2 low water limiter function • Detects water tracking across insulation	• Mistakes foam for water level. • Function affected by low level scale or debris build-up.
GWR & VF	• Two separate technologies to reduce probability of undetected double failure. • SIL3 low water limiter function	
2 x Conductive	• SIL3 low water limiter function	• Two probes of the same technology increase the probability of undetected double failure.

Glossary of terms:

SIL2:

Safety Integrity Level 2 – Applied to a system or part of a system to indicate that the Probability of Failure on Demand (PFD) is in the region 10-2 to 10-3.

SIL3:

Safety Integrity Level 3 – Applied to a system or part of a system to indicate that the Probability of Failure on Demand (PFD) is in the region 10-3 to 10-4.

PFD:

Probability of Failure on Demand. The likelihood that a safety device or system will fail if the system needs to act to prevent a dangerous occurrence.

GWR:

Guided Wave Radar level measuring and limiting probe device.

VF:

Vibrating Fork Level limiting probe device

Limiting device:

A device that stops a machine if the machine enters an unsafe state or if the limiting device detects a fault with itself.

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APPENDIX B – SPARE PARTS

1.1 ORDERING SPARES

Note: Spare and wearing parts which have not been tested together with the system can compromise its function. Installing non-authorised components and non-approved modifications/conversion can compromise safety and may invalidate your warranty.

For replacements, use only original spare parts from Fulton or those which are approved by Fulton.

Using the appropriate information as completed below, order spare parts using the Fulton Spare Parts section in this manual.

To order spare parts please contact Fulton spares department at spares@fulton.co.uk or call the Fulton Ltd main number.

In order to ensure spare parts are correct, please complete the details below and have them at hand when ordering parts or making enquires regarding the boiler.

1. Boiler serial number: _____
2. Boiler model and size: _____
3. Fuel type used: _____
4. Wiring Diagram No. _____
5. Commissioning Date: _____
6. Boiler design pressure (on the boiler data plate) _____
7. Make and type (e.g., fig no.) of safety valve fitted _____

⚠ WARNING

The type, size and lift pressure of the safety valve fitted to a boiler is specific to that boiler.

When ordering new safety valves, it is important that the boiler design pressure and make ant type are given.

MATERIAL & WORKMANSHIP GUARANTEE

On the Fulton Boiler Pressure Vessel

Fulton Ltd will repair or replace EXW factory any Fulton pressure vessel which within ten (10) 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.

Fulton

General Guarantee

The Fulton general guarantee is given in lieu of and in exclusion of any warranty expressed or implied, statutory, or otherwise, as to the state, condition, performance, quality, or fitness of the goods. Save thereunder we shall be under no obligation or liability of any kind to you in regard to the goods. In the case of new goods manufactured and supplied by us we will make good any defect developing there in under proper use within 12 months of delivery, provided that after investigation in our sole discretion we are satisfied that the defect arose from faulty design, materials, or workmanship and from no other cause whatsoever. Defective goods or parts must be returned to us as soon as possible after discovery of the defect. Costs of carriage and of detaching and incorporating parts will be borne by you. In all cases at the termination of such 12 months all liability on our part will cease. No liability whatsoever is to be incurred by us in respect of gauge or sight glasses, packing glands or electric motors or any goods or accessories not of our manufacture. But so far as we are able, we shall let you have the benefit of any guarantee or warranty given to us in respect thereof.

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