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PLEASE NOTE - Throughout this manual this cautionary symbol is used to describe a potential damage or injury that might occur if the safety considerations are verlooked. This symbol denotes CAUTION, WARNING or DANGER.
General Instructions

These installation and operating instructions are an essential part of the burner and must be kept permanently on site with the burner:

- Are supplemented by installation and operating instructions for electrical, gas and oil systems that are used to operate this burner.
- Contain information for the safe assembly, commissioning and servicing of the burner.
- Are for the attention of all personnel responsible for the safe and efficient operation of the equipment.
- Must be read and before operating the equipment for the first time.

Explanation of notes and symbols

- This symbol is used to mark instructions, which, if not followed, could result in serious injury or loss of life.
- This symbol is used to mark instructions, which if not followed, could result in damage or destruction of the equipment or any surrounding equipment and pose a severe risk to personnel.
- This symbol is used to mark instructions, which if not followed, could result in life threatening electrical shock.
- This symbol is used when a test should be done.
- This symbol indicates detailed information.

Hand over and operating instructions

Commissioning of the equipment and all other ancillaries must be performed by qualified personnel with approval from Forbes Marshall Pvt. Ltd.

The equipment is said to be commissioned only when the post-commissioning checklist, handover report and logbooks are duly completed and signed by both parties.

Guarantee and liability

Forbes Marshall Pvt. Ltd will not accept liability or meet any claims for personal injuries, damage to property arising as a result of but not limited to one or more of the following:

- Improper assembly, commissioning, operating or servicing of the equipment.
- Failure to use the equipment as intended.
- Operating the equipment with defective safety devices, or with non-recommended safety devices.
- Failure to follow instructions in this user manual.
- Any alterations to the construction of the equipment by the plant operator.
- Fitting additional components not tested or approved by Forbes Marshall Pvt. Ltd.
- Alterations made to combustion chamber which hinders the predetermined flame structure.
- Inadequate monitoring of parts liable to wear and tear.
- Improperly performed repairs.
- Damage due to continued use despite occurrence of fault.
- Use of fuels not conforming to specifications given in this manual.
- Use of non-original spare parts.
- Operation of the equipment in manual operation without approval from Forbes Marshall Pvt. Ltd.
2 Safety Instructions

Dangers when using the equipment

Forbes Marshall Pvt. Ltd products are manufactured in accordance with relevant existing standards and guidelines and relevant safety laws. However, improper use of the burner could result in loss of life or damage to the equipment or plant.

To avoid dangerous operating conditions, the equipment should only be used:

- under ideal safety conditions
- for its intended purpose
- with reference to all the instructions in this manual
- in conformance with regular inspections and service work
- in conformance with changes in current guidelines as and when they are updated

Faults, which could affect the safe operation of the equipment, should be corrected immediately.

Personnel Requirements

Only qualified personnel may work on the appliance. Qualified personnel are persons familiar with the installation, mounting and commissioning of this product and have necessary qualifications such as:

- Instruction, training and authorization to install, modify and mark electrical circuits in accordance with relevant standards.
- Instruction, training and authorization to install, modify and maintain fuel fired plants.

Organizational Requirements

All personnel operating the equipment must follow plant safety regulations and local and national safety codes as applicable.

Safety requirements for operating the equipment

- Only use equipment when all safety devices are fully functional.
- Any moving parts should not be touched during operation.
- All safety devices must be checked regularly for visible signs of damage.

Pipe thread connections

Only tested and approved sealing material should be used. Please observe the prevailing user instructions.

Electrical safety requirements

- Before starting work - isolate the plant and protect against reactivation, check voltage is isolated; the unit is earthed and protected from adjacent equipment that might still be under voltage.
- Work on electrical circuit must be performed by qualified personnel.
- Electrical components must be checked for loose connections and heat damage during commissioning and service.
- Access to the control panel must the restricted to authorized personnel only.
If it is necessary to make changes to live parts, tools conforming to local regulations must be used. A second qualified person should be present to switch off the mains in case of emergency.

Ensure that the system is properly earthed to protect from voltage fluctuations in supply

**Maintenance**

- Necessary installations, inspections and servicing should be carried out at required times.
- Operator must be informed before any service work is undertaken.
- For all service work, electrically isolate the equipment and cut-off the fuel supply.
- If during service any sealed components must be removed, they must be thoroughly cleaned before replacement. Damaged seals must be replaced. Leakages must be traced and eliminated.
- All safety devices must be commissioned by Forbes Marshall Pvt. Ltd and cannot be replaced by any other agent.
- Screwed connections that have been loosened, must be re-tightened properly to ensure rigidity.
- Following any service work, all safety devices must be checked for functioning.

**Alterations to the construction of equipment**

- No alterations to the equipment are to be made without the approval of the manufacturer. All fuel conversions require the written approval of Forbes Marshall Pvt. Ltd.
- Any parts not in perfect working order must be replaced immediately.
- No additional components may be fitted which have not been tested for use with the equipment.

**Alterations to the furnace**

No alterations should be made to the furnace, which may hinder the flame structure.

**Noise of the equipment**

The noise a combustion system makes is a result of combination of components and factors, such as:
- Burner
- Combustion chamber
- Flue gas exhaust
- Location

Depending on these conditions, noise could be of a level that can lead to hearing damage. If this is so, operators must be equipped with suitable protection.

**General information for gas operation**

- When installing a gas combustion system, regulations and guidelines must be observed.
- The agent responsible for setting up the gas system must inform the gas supplier of the type and extent of the installation planned. The agent must ensure that the gas supply conforms to requirements.
- Underground installations must be performed by agents approved by the supplier.
- Pipe work must be subjected to a preliminary and main test. Additionally, soundness tests must be performed.
Safety measures when gas can be smelt
- Avoid spark generation and open flames
- Open any windows and doors
- Power Off the control panel and shut the main gas line valve
- Evacuate the building and inform the gas supplier
- Restart only when equipment is certified to be safe to operate

Gas specifications
A certificate from the gas supplier must be obtained detailing the following:
- Calorific value in MJ/m³ or kWh/m³ (GCV, NCV)
- Max. CO₂ content of flue gas
- Gas supply pressure
- H₂O content
- Density (at specified Pressure and Temperature)

Conversion to other gases
When converting to another gas, a conversion or re-commissioning is required.

Gas valve train
Observe sequence and flow direction. To ensure trouble free start conditions, the distance between MBC and burner should be kept to a minimum.

Gas Commissioning Requirements
Prior to start of gas commissioning, it must be ensured that following instruments are available:
- Gas Flow Meter
- Flue Gas Analyzer
- Pressure Gauge (at inlet/outlet of PRV and Outlet of MBC)

Note: To ensure the gas line is completely flushed before the ratio controller before installation on the line.
3 Introduction
3.1 Nomenclature

AIR SUPPLY

Punker plate
The plate placed in air path to improve turbulent mixing of air and fuel, also known as diffuser plate, flame retention head

Suction hood
Provides passage for suction air and performs regulation of air quantity through internal damper assembly

OIL SUPPLY

Hydraulic lance
Element which holds atomizing nozzle. It has ports for supply and return. Contains the plunger-piston actuating mechanism. Also known as oil gun, sprayer body

Preheater
A reservoir which contains the heating element, it ensures adequate heating of oil

Thermostat
It controls the sequence by ensuring that oil is at set temperature before proceeding. Also known as checkstat (Thermostat consists of inbuilt temperature gauge)

Oil pressure switches
Control elements which ensure that oil is between set pressures and initiate lock-out when deviation occurs

Inlet pressure relief valve (IPRV)
Responsible for delivering oil at required pressure and diverts excess oil

Back pressure relief valve (BPRV)
Controls the oil throughput through atomizing nozzle by variable restriction opening

Safety solenoid valve
Ensures that oil does not enter into the lance if there is no demand or if oil temperature is not met
GAS SUPPLY

Ratio controller
A pressure regulator and two shut-off devices integrated into a multibloc package they isolate gas supply and control the gas quantity for modulation

Gas pressure switches
Control elements which ensure that gas is between set pressures and initiate lock-out when deviation occurs

Valve proving system
Checks the effectiveness of the shut-off solenoid valve during every cycle and initiates lockout in case of leakage

Safety Blow-off valve
Checks whether supply gas pressure is exceeding maintained pressure. If so then it will open to control required pressure. (Part of high pressure gas train)

CONTROLS

Flame detector
A UV sensor or a photocell - along with a flame relay, ensures that flame, is present and initiates lock-out if flame is not detected

Servomotor
Regulates the air and/or fuel openings according to signal from boiler control system and thus controls the air/fuel quantity

Pressure troll/pressure transmitter
Primary sensing elements which sense boiler pressure and accordingly control burner firing rate to achieve modulation

Controller
Takes various inputs and initiates all control phases (lockouts, shut-downs and start-ups)

Lockout
A stall condition caused by controller due to abnormal readings of various metrics like oil temperature, fuel pressures, flame signals etc.

Pre-purge/post-purge
Phases in which combustion chamber is purged with air from the blower to remove any combustible materials

Ignition time
The time duration for which spark is allowed

Safety time
Duration of fuel is supplied in absence of flame.

3.2 Basic function

Modulation
The burner modulates its output automatically to match the heat demand from the appliance. The heat demand is sensed and processed by the burner control system. Accordingly, the fuel and air quantities are varied.

The burners are classified according to the control:

- Electronic compound regulation
  - In electronic compound regulation (ECR) the air and fuel quantities are modulated using separate servomotors.
  - The control is performed by a PLC-based controller.

The PLC-based controller
- controls the sequence of operation
- monitors the safety loop and flame
- monitors the flame
- regulates the servomotors
- gives feedback to aid troubleshooting

Optional equipment:
- online efficiency monitoring
- O2 trim
- VFD

- Mechanical compound regulation
  - In mechanical compound regulation (MCR) air and fuel quantities are modulated by a single servomotor.
  - The air-fuel ratio can be varied by a drum fitted to the servomotor. The control is performed by a hard-wired controller

NOTE:
This manual explains procedures pertaining to ECR.
3.3 Fuel system for oil

Shutoff:
One safety solenoid is provided in the nozzle supply line. Additionally, two solenoids provide direct fuel shut-off at the nozzle.

Oil regulator:
The oil regulator is a back pressure relief valve (BPRV). It has a variable opening. By varying the size of the opening, the quantity of oil atomized can be changed.

The opening size is controlled by the servomotor.
There are two sizes of the BPRV used.

Size | Oil throughput [kg/hr]
--- | ---
3/8"  | upto 325
3/4"  | above 325

The BPRV comes preset at highest opening from the factory.
Oil Nozzle

Forbes Marshall Pvt. Ltd Modulating burners are fitted with a spill-back nozzle. This nozzle has a supply path and a return path. By varying the quantity of oil in the return path, the oil throughput is adjusted.

**Forbes Marshall Pvt. Ltd burners are designed for a specific nozzle:**

Fluidics Instruments W1 type, 50 degrees spray angle

This nozzle gives desired atomization quality with supply pressure of 20 bar (gauge).

Care must be taken that the supply pressure does not fall below the rated 20 bar.

Each burner capacity has a rated nozzle capacity. The required nozzle capacity is given in the technical specifications of each burner.

**NOTE:**

If any change in nozzle size is required, it must be done only after permission in writing is obtained from Forbes Marshall Pvt. Ltd Pvt. Ltd. Under no circumstances should a change in the nozzle type be allowed.

Under **NO** circumstances should a different nozzle be substituted for the specified nozzle.

Using any nozzle other than the one specified can:

- Cause extensive physical damage to the combustion chamber and the burner.
- Pose a life-threatening risk to anyone in the vicinity of the equipment.

In these circumstances, Forbes Marshall Pvt. Ltd will not accept any liability for the product.
Atomiser 12
W(R) 1-“Size” - 50°
Supply Pressure 20 bar
Viscosity 5 cSt

OUTPUT CHARACTERISTICS

The size of the atomizer is shown at the end of each curve.
Atomiser 12
W(R) 1-"Size" - 50°
Supply Pressure 20 bar
Viscosity 5 cSt

OUTPUT CHARACTERISTICS

The size of the atomizer is shown at the end of each curve.

12-DSGM-DG-E

22-07-15
Atomiser 12
W(R) 1-“Size” - 50\degree
Supply Pressure 20 bar
Viscosity 5 cSt

OUTPUT CHARACTERISTICS

The size of the atomizer is shown at the end of each curve.

Output [kg/h]

Spill [kg/h]

Supply pressure [Bar]
Output Characteristics

- Atomiser 12
- W(R) 1-"Size" - 50°
- Supply Pressure 20 bar
- Viscosity 5 cSt

The size of the atomizer is shown at the end of each curve.
The size of the atomizer is shown at the end of each curve.
Atomiser 12
W(R) 1-"Size" - 50°
Supply Pressure 20 bar
Viscosity 5 cSt

OUTPUT CHARACTERISTICS

The size of the atomizer is shown at the end of each curve.

Output [kg/h]

Spill [kg/h]

Supply [kg/h]
**Operation:** (Refer Fig. Below)

At burner shutdown solenoid valve 8 and the nozzle shut-off valve 9 are closed and nozzle shut-off valve 10 is open.

The valve 5 is a manually operated pressure relief valve (IPRV). When pressure inside the circuit exceeds the value set by the handle of the IPRV, it releases oil to the bypass.

When the heat demand exists and the thermostat 4 senses temperature below its set point, the pump 1 and preheater 2 start. Oil is circulated via the bypass line of IPRV. When the set oil temperature is reached at thermostat 4, the solenoid 8 opens and pre-purge begins. At this stage, nozzle shut-off solenoid 9 is still closed.

The pressure gauges 7 and 14 show the oil pressure in supply and return respectively. The oil pressure switch 6 supervises the oil atomizing pressure. If pressure rises above the set point, the burner shuts down.

The oil pressure switch 13 supervises the oil in the return. If the pressure rises above the set point the burner shuts down.

**NOTE:**

a) The circuit shown is for residual fuel oils (also known as furnace oil). For light oils like HSD, the heater and the thermostat are removed and rest of the circuit remains the same.

b) For burner with separate OPH, pump, IPRV and heater are part of OPH and a Normally Open solenoid valve is added to burner oil circuit. (Ref. fig. 4)

---

1. Oil Pump
2. Pre-heater
3. Temp Gauge
4. Thermostat
5. IPRV
6. High oil pressure switch- supply
7. Supply oil pressure gauge
8. Safety solenoid value NC
9. Actuation solenoid value NC
10. Actuation solenoid value NO
11. Atomizer
12. BPRV
13. High oil pressure switch Return
14. Return oil Pressure Gauge
15. Safety solenoid - NO
After pre-purge time has elapsed, the solenoid 9 opens and simultaneously the solenoid 10 closes. Oil is released for combustion. At this stage, the oil regulator 12 (BPRV) is in initial fire position. Due to low return pressure only a small quantity of oil is atomized. The rest of the oil flows through the BPRV and to the return header. The measured oil pressure at ignition load is approx. 7-9 bar. Full load operation is achieved by reducing the opening size of the BPRV. This is done by rotation of the cam, which pushes the follower. This increases oil throughput through the nozzle.

With a controlled shutdown, shut-off devices 9 and 10 close simultaneously, thus stopping oil flow out of the nozzle. During post-purge, solenoid 8 is kept open. After post-purge, this solenoid also closes.

During installation and repairs, the voltages of the valves must be rechecked. Failure to use rated valves will cause damage to equipment and render the burner non-functional.

**Attention!!**

a) The shutoff devices 9 and 10 are connected electrically in series. The voltage of the solenoid coil is therefore 110 V.

b) With separate OPH shut off devices 8 and 15 are connected electrically in series. The voltage of each solenoid coil is therefore 110V.

On solenoid valves the directional arrow on the solenoid valve’s body must point towards the nozzle.
3.4 Oil Supply

Reliable operation of the burner to a large extent depends on the oil supply. The pipe system and sizing can be obtained from relevant technical worksheets.

Ring main systems

Ring main systems are recommended and often essential.

A typical ring main system is shown. (Right side Fig.)

**Note**

The factory pre-set burner pressures are for systems without ring mains.

**Filter:**

Between the day oil tank and the burner inlet connection, a duplex filter set must be connected. This filter prevents dirt particles from the oil and pipework from reaching the burner. Operating without the filter is not recommended can have the following consequences:

- Seizing of oil pump gears
- Blocking of solenoid valves and nozzle
- Mesh Size for Burner strainer Filter 140 or 120 mesh size, and Duplex Filter 100 or 80 mesh size.

Pressure regulating valve in the ring main:

A ring main system is kept under pressure by its own IPRV

Ring main pressure 2 … 3 bar

Oil supply to the burner:

The oil supply pipes must allow tension free connection of the flexible oil hoses. The hose connections must allow the burner to swing open.
ATTENTION!
Failure to comply with these instructions and those provided in the technical instruction sheets will cause:

- Inadequate oil supply
- Impure oil supply

NOTE:
For residual oil applications, line tracing should be provided wherever possible
3.5 Oil Specifications

Oil specifications for both light and residual fuel oils are given below. Forbes Marshall Pvt. Ltd requires a certificate from the supplier, detailing the conformance of the oil supply to these requirements on a regular basis.

ATTENTION!

If fuel supplied to the burner does not conform to the specifications listed below Forbes Marshall Pvt. Ltd. will not accept any warranty or liability for either the safety or efficiency of the system.

<table>
<thead>
<tr>
<th></th>
<th>Furnace Oil</th>
<th>High Speed Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity @ 50°C (cSt)</td>
<td>125 - 180</td>
<td>1.8 - 5.0</td>
</tr>
<tr>
<td>Density @ 15°C (kg/m³)</td>
<td>960 - 980</td>
<td>820 - 845</td>
</tr>
<tr>
<td>Water content (% by volume), Max.</td>
<td>0.5</td>
<td>0.05</td>
</tr>
<tr>
<td>Ash (% by weight) Max.</td>
<td>0.1</td>
<td>0.01</td>
</tr>
<tr>
<td>Flash point (°C)</td>
<td>66</td>
<td>35</td>
</tr>
<tr>
<td>Sulphur content (% by mass), Max.</td>
<td>3.5</td>
<td>0.2</td>
</tr>
<tr>
<td>Gross Calorific Value (kcal/kg)</td>
<td>10250</td>
<td>10500</td>
</tr>
<tr>
<td>Net Calorific Value (kcal/kg)</td>
<td>9650</td>
<td>10200</td>
</tr>
<tr>
<td>Carbon residue (on 10% residue, percent by mass), Max.</td>
<td>10 (CCR)</td>
<td>0.3 (Ramsbottom)</td>
</tr>
</tbody>
</table>

NOTE:

Oil specifications change from time to time. It is the responsibility of the operator and the supplier to ensure that the oil is as per latest specifications.

For furnace oil, the burner is compatible with oil conforming to IS 1593:1982 - Grade MV II (PG NO.)

For diesel, the burner is compatible with fuel conforming to IS 1460:2005 - BS IV Emission Grade.
3.6 Oil Preheating

Furnace oil fired burners are provided with a heating system which reduces the viscosity of the oil and so allows the pumping and atomization of the oil.

The heating system consists of a heater, a sensing and controlling element.

The burner mounted heating system consists of:

- Heater body
- Electric heater coils
- Temperature transmitter

The temperature sensing element is connected to a temperature controller on the burner control panel. This controller provides adjustment of the heater set-point.

**Oil preheating skid**

Optionally, a separate oil preheating skid can be provided. In this case, the burner mounted heater is absent.

The oil preheating skid usually consists of:

- an electric heater
- a steam heater
- oil pumping system
- an IPRV

**two pumps (one in operation one standby)**

During cold start only the electric heater heats the oil and as steam comes online, the media heater takes over.

**Day Oil Tank Outflow Heater**

Residual fuel oil systems require an outflow heater for the day oil tank. This should come equipped with its own temperature sensing element and controller.

---

### Oil pumps and Throughput:

Table of Oil quality for pump -

<table>
<thead>
<tr>
<th>Oil Viscosity</th>
<th>2.5 to 450 cSt AT NTP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil temperature</td>
<td>0 to 200°C</td>
</tr>
<tr>
<td>Min. Suction Pressure</td>
<td>-0.45 bar to avoid air separation</td>
</tr>
<tr>
<td>Max. Suction Pressure</td>
<td>4 bar</td>
</tr>
<tr>
<td>Rotation Speed</td>
<td>1440 rpm</td>
</tr>
</tbody>
</table>

---

### Table of Oil throughput for various capacities and respective pump capacities-

<table>
<thead>
<tr>
<th>Burner Capacity</th>
<th>Atomizer kg/hr.</th>
<th>Pump on burner</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>140</td>
<td>450</td>
</tr>
<tr>
<td>2.8</td>
<td>200</td>
<td>1000</td>
</tr>
<tr>
<td>3</td>
<td>225</td>
<td>1000</td>
</tr>
<tr>
<td>3.5</td>
<td>230</td>
<td>1000</td>
</tr>
<tr>
<td>4</td>
<td>275</td>
<td>1000</td>
</tr>
<tr>
<td>4.5</td>
<td>300</td>
<td>1000</td>
</tr>
<tr>
<td>5</td>
<td>330</td>
<td>1000</td>
</tr>
<tr>
<td>6.3</td>
<td>400</td>
<td>1500</td>
</tr>
</tbody>
</table>

### ATTENTION!

The temperatures that must be maintained vary according to the quality of the furnace oil supplied. Setting temperatures either higher or lower than necessary can render the whole system non-functional.
Oil Throughput for each capacity is calculated considering Standard calorific values (As per chart on pg. 21).

Boiler Capacity calculation (F&A 100°C) :-

Capacity (TPH)

\[
0.89 \times \text{Oil Flow Rate (\text{kg/hr})} \times \text{Calorific Value (\text{kJ/kg})} = \frac{540}{540}
\]

In above formula 0.89 is Boiler efficiency on NCV basis and 540 is latent heat of vaporization at 100°C.
3.7 Fuel system for Gas

Valve trains
In accordance with EN 676 all burners must be fitted with two class A solenoid valves. Forbes Marshall gas and dual fuel burners are fitted with combined regulator and safety solenoid MBC-VEF as standard.
This includes a module for infinitely varying gas-flow rate according to air flow changes inside the burner.

1. Ball valve
2. Gas filter
3. Gas pressure governor
4. Safety Blow off Valve
5. Pressure gauge
6. Gas pressure switch
7. Double solenoid valve with Ratio Controller(MBC-VEF)
8. Burner
9. Valve proving system (VPS 504)
10. Ball Valve
11. Pilot gas pressure regulator
12. Pilot solenoid valve
13. Burner
14. Slam shut valve
Valve proving
In accordance with EN 676 the use of a valve proving system is required for thermal inputs of 1200 kW or more. During each start-up sequence, the controller carries out a valve proving test.

The internal motor pump increases the gas pressure in the test section by approx. 20 m bar compared to the input-side pressure applied to valve V1.

During the test period, the installed differential pressure switch monitors the test section for leakage.

When the test pressure is attained, the motor pump is switched off. The release time (10-26 s) depends on the test volume and input pressure.
Result of test
If the test section is tight, the contact is released to the automatic burner control.
After maximum 26s - the yellow signal lamp lights up.
If the test section is leaky or if the pressure increase by + 20 mbar is not attained during the test period, the VPS 504 switches to fault condition and red lamp lights up.

VPS Sequence
3.8 Air System

The burner is provided with an integrated centrifugal blower which supplies the air quantity required for combustion.

The blower is powered by side-mounted electrical motor.

Damper System

To regulate the quantity of air that is supplied, dampers are placed at the suction inlet of the burner.

According to the amount of air required for safe and efficient combustion, the controller adjusts the damper opening.

In ECR (Electronic Compound Regulation) burners, the damper opening is controlled by a separate servomotor. The controller sends signals to the servomotor to control its rotation, CW for opening and CCW for closing the damper thus controlling the damper opening.

Blower rotation direction

The direction depends on the 3-Phase connections to the blower motor.

The direction of the blower rotation is critical to the proper functioning of the whole system. The direction should be Clockwise from motor end.

Hinge switch

The hinge switch is arranged in such a manner that the circuit is closed in the burner closed position. In the burner open position, the circuit is interrupted by the release of the tripping pin of the hinge switch.
4 Installation

4.1 Safety notes for installation

Electrically isolate plant

Prior to installation, switch off the mains switch and the safety switch. Failure to comply could cause death or serious injury by electric shock.

Risk of explosion

Fuel leaks can lead to the build-up of explosive gas/air mixtures. With the presence of an ignition source, these then result in an explosion.

4.2 Delivery, transportation and storage

Check delivery

Check the delivery of burner assembly to see that it is complete and that there has been no damage in transit. If the delivery of items is incomplete or items are damaged, contact Forbes Marshall Pvt. Ltd.

Transportation

For the weight and packing dimensions see. Appendix A

Storage

Maintain ambient conditions for storage. see Appendix A

Ensure all the electronic, pneumatic components, mechanical parts are covered and are not directly exposed to rain and direct sunlight.

4.3 Preparation for installation

Tool list

A comprehensive tool list is included in Appendix D of this manual.

Before starting the installation procedure, ensure that all tools listed on the tool list are available.
## 4.4 Physical Mounting

### Mounting Dimensions

<table>
<thead>
<tr>
<th>Capacity (TPH)</th>
<th>a (mm)</th>
<th>b (mm)</th>
<th>c (mm)</th>
<th>d (no. of bolts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>305</td>
<td>247</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>2.8 to 3.5</td>
<td>410</td>
<td>287</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>4 to 5</td>
<td>400</td>
<td>332</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>6.3</td>
<td>425</td>
<td>362</td>
<td>19</td>
<td>8</td>
</tr>
</tbody>
</table>
Mounting the burner

- Screw stay bolts to boiler plate.
- Fit flange gasket to mounting plate.
- **Using suitable lifting equipment** lift the burner and mount onto boiler plate, secure using nuts (ensure correct fit of flange gasket)
- Connect the flexible oil lines ensuring correct connection of supply and return.

Electrode Settings

For consistent and reliable ignition, it is essential that the ignition electrodes are positioned correctly with respect to:

- Oil nozzle
  - Ensure that both electrodes are placed as shown.
  - Both electrode tips are placed 3-5 mm apart from each other
  - The electrode tips are placed 5 mm from the nozzle tip in the longitudinal direction
  - The center of the line joining the electrodes should coincide with the center of the atomizing nozzle

- Pilot gas tube
  - Ensure that both electrodes are placed as shown
  - Both electrode tips are placed 3-5 mm apart from each other
– The electrode tips are placed 5 mm from the pilot tube in the longitudinal direction
– The centre of the line joining the electrode tips should coincide with the center of the open area of the pilot tube.

**WARNING!**

Prior to start of commissioning, it is essential to check that electrode settings from factory are as described above. Deviation from these settings can cause:

- Ignition failure
- Flame failure
- Misfire
4.5 Valve train installation

Risk of explosion!

Gas leaks can lead to the build-up of explosive gas/air mixtures. With the presence of an ignition source, these then result in explosions.

To avoid accidents, follow the following safety instructions on valve train installation.

- Before beginning work, close all the relevant shut off devices and ensure they cannot be accidentally reopened.

- Ensure the valve train components are correctly aligned and that all the joints are clean.

- Flange seals must be fitted correctly on the machined faces.

- Tighten diagonally opposite screws evenly.

- Valve trains must be mounted tension free. Do not compensate for misalignment by over tightening.

- The valve trains must be fixed and supported securely. They must not be allowed to vibrate.

- Observe the maximum permissible total pressure in the valve trains, Ask your gas supplier for the correct gas supply pressure. The supply pressure must not exceed the total permissible pressure.

- Purging of all lines must be conducted prior to startup to remove air, non-combustible gas, water, dust or any other impurities. Failure to conform can lead to damage to the solenoid valves.

- The purging of the gas line has to be strictly done without the Gas Ratio Controller In-Line. All the filters must be cleaned before start-up

- Safety Relief Valve with Ball Valve should be in operation while taking gas in gas line of Burner. This will help to avoid excess qmount of gas to flow in furnace.

Additional installation notes:

To improve start conditions, the distance between burner and solenoid valves (ignition and mains gas) should be as short as possible.

Observe sequence and flow direction of valve train components. Do a water-soap bubble test to ensure all the joints are leak proof.
1. Solenoid valve for pilot gas
2. Combined regulator and safety valve MBC-VEF
3. Gas pressure switch, low.
4. High pressure regulator.
5. Filter
6. Pressure gauge (push button or with bleed valve)
7. Ball valve
8. Slam shut valve
9. Gas pressure switch, High.
10. Valve proving system VPS
11. Safety Blow Off Valve

**NOTE:**
These installation instructions are supplemented by the detailed instructions in the manual for the MBC-VEF.
Installation of MBC-VEF

The MBC-VEF is a combined regulator and safety valve. Additionally, the VPS and gas pressure switches are installed on it and the pilot gas lines are also taken from tappings from this Multi-Bloc.

NOTE:

These installation instructions are valid for the threaded flange version of the MBC-VEF.

1. Mount flange onto the tube lines. Use appropriate sealing material.
2. Insert MBC-VEF. Ensure that flow direction is correct. Ensure that the O-rings are installed in the correct grooves.
3. Tighten screws A-H.
4. After installation, perform leakage test and functional test.
5. Disassembly in reverse order
   3→2→1.

NOTE:

These installation instructions are supplemented by the detailed instructions in the manual for the MBC-VEF. If any conflict arises between the two, instructions given by Karl Dungs GmBh supercede these instructions.

To ensure the gas line is completely flushed before the ratio controller before installation on the line.
Impulse line connections

The MBC-VEF is a combined regulator and safety valve. The MBC-VEF performs the regulating function by varying gas flow according to air flow inside the burner.

It senses air pressure at the discharge of the blower through an impulse line connected between the two.

1. Remove the plastic plug from the pL connection (15).
2. Connect the 1/8" ferrule connector to (15)
3. Ensure that the correct adaptor is connected to impulse connection on the burner side.
4. Insert the tube into both connectors and tighten.
5. Remove the plastic plug from the pF connection (16)
6. Leave it open to the atmosphere.
NOTE:
It is essential to remove the plastic plug from (16). Failure to do so will cause excessive gas flow and lead to dangerously high energy input at start-up.

NOTE:
It is essential to route the impulse line so that no condensate flows back to the MBC-VEF.

Gas pressure switch installation
Two gas pressure switches (GPS) are provided in the gas train. One is a HIGH pressure switch and another is LOW pressure switch.

Both are mounted on opposite flanges.
1. Remove the metal plug on the both flanges (1 & 5) of the MBC-VEF.
2. Place the O-ring included in GPS kit into groove on (1 & 5). Ensure surfaces are clean.
3. Mount the GPS's onto the flange using the screws provided in the kit.

MBC-VEF Connections for GPS
Valve Proving System Installation

The Dungs VPS 504 system is installed on the front facing side of the MBC-VEF.

1. Remove the metal plugs prior to installation.
2. Place the VPS along the two vertically aligned holes (1), (2).
3. Insert the screws provided and tighten in diagonally opposite sequence.
4. Ensure tight sealing.
5. Properly tighten the cover screw. Avoid over tightening!
6. When work on the VPS 504 is complete carry out valve proving and function test.

Pilot gas train installation

A pilot (ignition) gas flame is provided with all Forbes Marshall Pvt. Ltd. gas fired burners.

Before main burner start-up, the pilot gas flame is established and detected by the flame detector. This provides smoother and safer main gas ignition.

The pilot gas train is similar to the main gas train. It consists of the PRV and a solenoid valve. As per capacity there are two main variants:

**Pilot gas line with single solenoid:**

In case of low-capacity burners (below 6.3), a single solenoid is used in the pilot gas line. As shown in figure (1).
Pilot gas line with double solenoid and VPS

In case of higher capacity burners (6.3 TPH and above), a double solenoid and VPS system is provided. As shown in figure (2).

3 Pressure gauge
6 Low gas pressure switch
7 Double solenoid (MBC-VEF)
8 High gas pressure switch
9 Valve proving system
10 Ball valve
11 Pilot gas pressure regulator
12 Pilot gas solenoid valve
13 Burner

Pressure regulator installation

(See figures aside)

Forbes Marshall Pvt. Ltd burners are provided with various pressure regulators. This manual gives instructions for installation and adjustment of the pressure regulator.

For other pressure regulators, the principles remain the same but consult the individual manuals for detailed information.

Outlet pressure adjustment

- Remove the cap A
- To increase the outlet pressure, turn screw B clockwise
  Or
  To reduce the outlet pressure, turn screw B anti-clockwise.
• Check the correctness of the adjustment using the pressure gauge by observing pressure for some time.

• Refit cap A

### Changing the spring

- Remove the cap A. Turn screw B completely anti-clockwise.
- Remove spring retainer C and remove the spring D.
- Fit new spring D.
- Re-fit spring retainer C and by turning screw B set the required outlet pressure.
- Check the correctness of the adjustment using the pressure gauge.
- Refit cap A.

### NOTE:

Refer relevant catalogue for respective model of PRV, slam shut valve and safety blow off valve.

<table>
<thead>
<tr>
<th>Type of spring (Color)</th>
<th>Outlet pressure range (mbar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orange</td>
<td>5 - 20</td>
</tr>
<tr>
<td>Blue</td>
<td>10 - 30</td>
</tr>
<tr>
<td>Red</td>
<td>25 - 55</td>
</tr>
<tr>
<td>Yellow</td>
<td>30 - 70</td>
</tr>
<tr>
<td>Black</td>
<td>60 - 110</td>
</tr>
<tr>
<td>Pink</td>
<td>100 - 150</td>
</tr>
</tbody>
</table>
4.6 Oil BPRV and Air Damper Actuator:

4.6.1 Installation Instructions

- Remove corrosion protection (if applied for storage purposes) and replace by grease before installation.
- Check imperviousness of cable entries and blind plugs prior to setting into operation.
- Tighten evenly all screws of the cover.
- Do not start operation before properly setting the limit stop switches.
- Protect actuators from atmospheric exposure (e.g. canopy)
- Protect actuators from shocks and impacts (e.g. by dropping it)
- Do not fasten ropes, hooks or similar directly to the actuator.
- Permanent overloading and blocking of the actuator may damage it.
- Spark quenching condensers may affect the sense of rotation stability of the actuator and cause damage.

**NOTE:**

While installing couplings DO NOT turn output shaft by force.

Output shaft and fitting spindle must be running coaxially.
4.6.2 Electrical Connections:

- Check for conformity of type of current, line voltage, and frequency with motor characteristics (see type plate on cover and inside the actuator).
- Use screwed cable glands appropriate for the connecting line.
- Do not under-run the minimum bend radius of the wires.
- Make sure to follow the wiring diagram affixed inside the cover.
- For extra-low voltages (e.g. potentiometer) separate wires must be used, if necessary shielded ones.
- All components like switches, potentiometer, relays, etc. are already wired in factory.
- Follow the steps explained under "Determining the sense of rotation" when connecting the actuator (see page 45).
- Before setting the actuator into operation adjust the position limit switches (see page 45)
- The grounding must be done properly on the grounding terminal inside the actuator.

Type of protection IP65 (standard) up to IP67 (optional) are guaranteed only when using appropriate screwed. The grounding wire has to be attached to the appropriate screwed. The grounding wire has to be attached to the appropriate screw with a ring cable lug.
4.7 Electrical connection
Electrically isolate the plant

Prior to installation switch off the mains switch and safety switch. Failure to comply could cause death or serious injury by electric shock.

Ensure proper earthing

Prior to switching on the supply, ensure that the system is correctly earthed. Failure to comply could cause death or serious injury by electric shock.

Prior to start of installation ensure that all relevant instructions given local regulatory codes for installations of this nature are followed.

Note the specific safety instructions given with respect to this panel in the general and safety instructions provided at the start of this manual.

Cable Length
The cable length required varies due to several factors such as:

- floor mounted or equipment mounted panels
- design of equipment house
- capacity of equipment and burner

Panel Location and Installation
Following instructions should be followed for installation of floor mounted panels:

- Ensure that the area is well ventilated
- Ensure that the panel is not placed in direct sunlight
- Ensure that ambient operating conditions as given in Appendix A are maintained
- Ensure that sufficient space is provided for opening and closing of the panel door
- Provide a supply of 230V, 6A that can be isolated without affecting other equipment
- Provide an isolated instrument earthing in case separate analyzer unit is present

Wiring Connections to Control Panel
Ensure that the burner connections to the control panel are wired as per the wiring diagram provided

Ignition line
Ensure that the ignition cables are installed in such a way that there is isolation from other cables

Gas Valve Train
Ensure that gas valve train connections are wired as per the wiring diagram provided in this manual

Earthing
Ensure that a proper earth pit is provided in accordance with relevant local or national regulations. Ensure that there is a separate earth provided to the VFD connections in the ECR package.
5 Commissioning

A pre-commissioning checklist is provided in the appendix. Before the start of the commissioning procedure ensure that all the requirements are satisfied.

In case of dual-fuel burners, the oil system is commissioned and tuned first.

5.1 ECR Burner Initial Settings

Ensure that all connections to the junction box and control panel are as per supplied electrical schematics wiring diagrams.

- Switch on the supply to the control panel
- The acknowledgement screen will be displayed and hooter will sound
- Acknowledge the lockout

- After acknowledgment, the normal operation screen appears
- This screen shows all the important inputs and outputs and also allows for the acknowledgment of lockouts

- Enter the control screen of the panel

NOTE:

It is recommended to give a UPS backup supply to the Control Panel if there are power fluctuations.
- Enter the settings menu of the steam pressure
- Enter the required cut-in pressure in Start at Pr. Below
- Enter the cut-out pressure in Stop at Pr. Above
- Enter the required set-point at Pressure Setpoint

- Check that air servomotor connections at the motor, junction box and control panel are as given in the supplied electrical schematics.
- Ensure that A/M is selected to Manual
- Close the servomotor using Close ON
- Check that the actual input decreases as servomotor closes the damper
- Check that the air damper is fully closed and the actual input is at minimum value
- Save this position using 'Zero Save'

- Open the servomotor using Open ON (ensure first that Close OFF)
- Check that actual input increases as servomotor opens the air damper
- Check that air damper is fully open and actual input is at maximum value
- Save this position using 'Span Save'
- In the same manner, set the zero and span position for the fuel servomotor
Password Prompt Screen:

Enter the user name is “user “and password is “1000” and Press sign-in.

Range Settings in Hidden Screen:

The hidden screen can be accessed by pressing the top left side of the Mimic Screen

Single Fuel Mode Selection:

Dual Fuel Selection:
Oil Temperature Settings Screen:

Firing %age vs Air Damper and VFD %Age:

Oxygen Trim Control Settings:
5.2.1 Detecting the Direction of Sense of Rotation

Position Switch-off

Based on the internal wiring the following assignments apply to sense of rotation (looking through the actuator towards the output shaft) and limit stop switches:

1. Applying line voltage to terminals 1 and 2 produces CCW rotation of the output shaft. The SL switch limits this sense of rotation. If this switch is actuated line voltage is applied to terminal 4 and the supply to the motor is disconnected.

2. Applying line voltage to terminals 1 and 3 produces CW rotation of the output shaft. The SR switch limits this sense of rotation. If this switch is actuated line voltage is applied to terminal 5 and the supply to the motor is disconnected.

3. If the actuator runs in opposite direction to the control commands, switch external connections between terminals 2 and 3. The internal wiring must never be changed.

4. After the limit switches are set, make one complete CW and one complete CCW rotation to ensure the connections are correct.

5.2.2 Setting Switch for CW and CCW Limits

1. Close the Air Damper completely/ Adjust Oil BPRV to 0 deg by using CW or CCW

2. Turn control cam L in the sense of rotation of the control camshaft E until the position limit switch SL clicks.

3. Set control cam R for opposite sense of rotation as described in steps 1 & 2 Until SR Clicks

4. For control purposes activate once again electrically both limit stop positions and readjust, if necessary.
5.3 Oil System Commissioning

For light oil burners, all instructions pertaining to the heating elements are not applicable.

Settings check

- Ensure that the supply oil pressure switch is set at a pressure 2 bar above the supply pressure value.
- Ensure that the return oil pressure switch is set at a pressure 2 bar above the return pressure value.

Oil Heater Settings

Heater Set Point

In case of MCR burners, set the heater set point on the TIC at the control panel

In case of ECR burners, set the heater at the heater submenu of the control menu as shown

Heater Set Point .......... 10-15°C above oil temperature

Thermostat Setting

Adjust the thermostat set point as described in Ch. 6.3.

NOTE:

Ensure that oil lines upto to the burner are completely flushed before proceeding.

Oil line flushing

- Ensure that all oil connections are as per circuit diagram given in Ch. 3.3.
- Ensure that oil supply system is as per specifications given in the technical instruction sheets.
- Ensure that a large tank is available to collect the oil.
- Ensure that the outlet heater on the oil tank is on and functioning.
- Disconnect the return flexible oil hose from its connection to ring-main/tank return line and place it in the oil collection tank.
- Plug the open connection.
- Switch on the heater and the pump.
- Let the oil collect in the collection tank for 2-3 minutes.
- Remove the plug and reconnect the flexible hose.
- Open the strainer and clean the filter with diesel.
Supply pressure setting

The IPRV comes pre-set from the factory to give a supply pressure of 21 bar. However in case of ring main systems the booster pumps cause changes in the supply pressure.

With the pump running and oil temperature at or above the set temperature on the thermostat, check the supply pressure on the supply pressure gauge.
Inlet Pressure Regulating Valve (IPR Valve)

**Function:** This valve is used for adjusting the inlet pressure to the burner.

**Description:** Inside the control valve a piston (1) moving in a cylinder, is forced against the valve needle (3) by a spring (2). If the pressure on the valve needle is greater than the pressure exerted by the spring, the piston will rise and the oil will flow over to the unpressurised side.

The following applies in general, while installing this valve:

The spring side (spring is visible through the port) is always the return side, i.e. the low pressure side. The direction of the overflow is from the pressure side to the spring side. The required pressure is adjusted by means of the wheel provided. Clockwise rotation increases the set pressure and anti-clockwise rotation decreases the inlet pressure.
Air damper Positions

- Ensure that connections to servomotor are as per wiring diagram.
- Check that the air damper position at the start of rotation is completely closed.

Return oil pressure setting

- Take the Hydraulic Lance out of the combustion head (with flexible hoses connected) and keep in the reservoir/bucket to check the spray
- Go to the 'Control' Screen
- Go to oil servo setting and
  - ensure ‘A(Auto)/M(Manual)’ is selected to manual mode
- Bring the oil servo position to ‘Close’
- Go back to 'Control' Screen & Select 'Manual' in the sequencer and go to step 3
- Set oil return pressure 6-8 kg/cm² through BPRV (depending upon the smooth ignition and clear smoke)
- Go to oil servo setting and bring the oil servo position to 'Open'
  Set oil return pressure 15-18 kg/cm² through BPRV (depending upon the desired oil flow rate and clear smoke through stack)

DANGER!

This work is to be carried out on a live main. Ensure that all regulations and procedures for working on live mains are followed.

A second qualified person must be present at the control panel to shut-off supply in case of an emergency.

NOTE:

In case the return pressure is not as specified, the BPRV and oil cam settings must be modified as detailed in Ch.5.4
Blower rotation direction
- Switch the burner on.
- At the start of pre-purge check the blower rotation direction. (CW from motor side).

Initial firing
The damper is pre-set at low-fire position from the factory. Ensure the same.
- Switch on the burner.
- Keep the modulation mode as manual.
- Allow the sequence to progress till ignition and establishment of low fire flame.
- Using a flue-gas analyzer, adjust the air damper setting as detailed in Ch.5.5

Tuning through the modulation range
To tune through the modulation range follow the following sequence:
- Keeping the burner in manual modulation, increase the firing using the modulation dial by increments of 10%.
- At every stage, using the flue gas analyzer for guidance, adjust the air as given in Ch.5.5
- If absolutely necessary, adjust the oil as given in Ch.5.4.2
- Repeat this procedure at least 3 times to ensure repeatable and stable performance.

NOTE:
The BPRV comes pre-set from the factory for both low and high fire settings. Changes to this setting are required only when oil supply system specifications are different from those specified by Forbes Marshall Pvt. Ltd.

NOTE:
Note any abnormal conditions and rectify immediately.
Air pressure switch setting

The air pressure switch comes pre-set at the lowest setting from the factory.

During the burner operation, the APS should be set as follows:

- Remove the plastic cap of the APS as shown in (1).
- When the burner is operating at low firing rate, rotate the dial as shown in (2) till the burner interlock becomes operational.
- Set the APS at a value 20% lower than the value at which it caused the burner to trip.
- Replace the plastic cap and screw tightly.

Example:

Cut-off air pressure ........ 10 mbar
Set point on APS .......... \((1 - 0.2) \times 10 = 8\) mbar
5.4 BPRV and Cam Setting Adjustment

The BPRV setting can be adjusted in two ways.

5.4.1 To change oil throughput throughout the range

Using this method, the oil flow rate throughout the range is either increased or decreased.

- Remove the plug at the bottom of the BPRV as shown in (1).
- Insert an M6 Allen key into the slot at the bottom of the BPRV as shown in (2).
- To increase the oil throughput, rotate the key clockwise as shown.

- To decrease the oil throughput, rotate the key in anti-clockwise direction as shown.

- Replace the plug and tighten.
5.4.2 To change the oil flow rate between high and low

This method is used to change the Δ(oil flow) between low and high fire positions.

- Loosen the side as well as centre Allen bolts as shown in (1).
- Insert an M4 Allen key into the top Allen bolt (2).
- According to requirement do one of the following:

<table>
<thead>
<tr>
<th>REQUIREMENT</th>
<th>ACTION</th>
<th>RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW FIRE FLOW RATE</td>
<td>HIGH FIRE FLOW RATE</td>
<td>DIRECTION OF ROTATION (Of Top Allen Bolt)</td>
</tr>
<tr>
<td>MORE</td>
<td>LESS</td>
<td>ANTI-CLOCKWISE</td>
</tr>
<tr>
<td>LESS</td>
<td>MORE</td>
<td>CLOCKWISE</td>
</tr>
</tbody>
</table>

- Retighten all the bolts.

NOTE:
Whenever, the BPRV is adjusted, a flow-rate test MUST be performed. Do not start the burner directly after this adjustment.

Only if the flow rates at both high and low fire are according to specifications, should the burner be restarted.
Back Pressure Regulating Valve (BPR Valve) with Cam Disc

**Function:** For controlling the quantity of oil being fired through the burner by regulating the return oil pressure.

**Description:** This is similar in construction to IPR Valve. A cam disc is provided with this valve to regulate the back pressure for controlling return oil quantity. The cam is driven by a modulating drive. The return pressure can be adjusted with the help of set screw (1) provided on the top of the valve and by adjusting the eccentricity of the cam disc.

Adjustment of return oil pressure: Low fire pressure can be adjusted by adjusting the top set screw. Now, take the modulating unit to full load and see the return pressure at this point.

If it is too high bring eccentricity of the cam disc can be increased and vice versa. Please note that all settings to be carried out at low fire position only. The cam disc is for changing the eccentricity; loosen the two cam screws provided on the cam. By turning the set screw eccentricity can be changed.
5.5 **Air Adjustment**

In ECR burners, the air servomotor and fuel servomotor are independently controlled. Damper openings for intermediate load points are entered into the ECR controller.

To set damper at all intermediate load points, follow the following procedure:

- Enter the control menu on touchscreen panel
- Enter the stack oxygen settings menu
- The required damper opening should be entered at each intermediate control point in Damper box
- Check combustion parameters at each load point to ensure correct setting
5.6 Gas System Commissioning

Soundness test of valve trains

Soundness test must be performed following any service work on gas fittings.
Results of the soundness test must be recorded on the commissioning report.

Soundness test must be carried out with the main ball valve and MBC-VEF solenoid valves closed.

Test pressure in valve train .............. 100 to 150 mbar
Waiting time for pressure equalization.........5 mins
Max. permissible pressure loss ...................... 1 mbar

1st Test phase
Ball valve upto first valve seat
1. Connect the test assembly to the filter and test point 1 or 2 of the MBC-VEF.
2. Open test point 3 between the valves V1 and V2.

2nd Test phase
Between the valve seats
1. Connect the test assembly to the point 3 between the valves V1 and V2.
2. Open test point 4 after V2.

NOTE:
In systems with VPS, test phase 2 is optional.

3rd Test phase
Between valves and burner inlet
1. This test can only be carried out during operation.
2. The flange joints and fittings are coated with a non-corrosive foam forming solution (e.g. soap solution).
Safety Blow-off Valve Setting

Ensure that the safety blow-off valve is set to the required pressure given in the technical information sheet.

NOTE:

All above settings must be performed on the pilot gas line components as applicable.

Pre-setting on gas pressure switches

Low gas pressure switch: Approx. 50 mbar
High gas pressure switch: Approx. 30 mbar

These settings are only valid during the commissioning.

Before commissioning is complete the gas pressure switches must be set according to instructions provided in Ch. 5.7

For dual fuel burners ensure that the fuel changeover switch is set to GAS

Setting the MBC-VEF

- Open the protective slide.
- Using a M2.5 Allen Key, set the N dial to 0.2-0.25
- Start the burner in manual modulation and at low fire.
- Check the functioning of the pilot gas system, the valve proving and main gas ignition reliability.
- Using a FGA (Flue Gas Analyser), check the combustion parameters at LOW fire.
- In case of excess air, adjust the dampers as described previously or increase the setting on N.
- In case of excess fuel, increase the air supply or reduce the setting on N.
- Check that flow rate on the gas flow meter is as required depending on capacity.
- Proceed slowly to HIGH fire, set the ratio V to get optimum combustion as per the FGA readings.
- Again check that the flow rate on gas flow meter is as required depending on capacity.
- Run through the modulation cycle manually and check readings at every intermediate load point.
- If required adjust $V$ to get optimum combustion parameters.
- Close the slide and secure it with the screw as shown.

**DANGER!**

Under **NO** circumstances should settings on the MBC-VEF be changed without consulting a Forbes Marshall representative.

Changing the settings can:

- cause extensive physical damage to the combustion chamber and the burner.
- pose a life-threatening risk to anyone in the vicinity of the equipment.

In these circumstances, Forbes Marshall Pvt. Ltd will not accept any liability for the product.

**NOTE:**

a) $N$ is minimum gas pressure setting for ignition.

b) "$V$" is ratio of gas pressure to air pressure. (For e.g., for increasing gas during normal operation while keeping air constant, "$V$" is required to be increased.)
5.7 Concluding work following commissioning

Set the low gas pressure switch

- Start the burner.
- Observe the pressure gauge reading at inlet to MBC-VEF at LOW fire.
- Remove the plastic cap of the GPS as shown in (1).
- Increase the set point on the dial as shown in (2) till a lock-out is initiated.
- Set the gas pressure switch at a value 20% less than the value at which lock-out was initiated.
- Close and screw on the cover.

Example:
Cut-off low gas pressure ........ 120 mbar
Set point on LGPS .......... (1- 0.2) x 120 = 96 mbar

Set the high gas pressure switch

- Start the burner.
- Observe the pressure gauge reading at outlet of MBC-VEF at HIGH fire.
- Decrease the set point on the dial till a lock-out is initiated.
- Set the gas pressure switch at a value 20% more than the value at which lock-out was initiated.

Example:
Cut-off high gas pressure ........ 50 mbar
Set point on HGPS .......... (1+0.2) x 50 = 60 mbar
5.8 Shutdown periods
For short breaks in operation (e.g. flue tube cleaning etc.)
- Isolate the burner from the power and fuel supply
- Ensure that both are restored before firing.

For long breaks in operation
- Isolate the burner from the power supply.
- Close all fuel shut-off valves.
- For furnace oil, after start-up allow sufficient time for oil to reach required temperature before starting in automatic mode.
6 Servicing

6.1 Safety notes on servicing

DANGER!
Failure to carry out maintenance and service work in the manner, sequence and timing shown here can have severe consequences such as:

- extensive physical damage to the combustion chamber and the burner.
- loss of life

In these circumstances, Forbes Marshall Pvt. Ltd will not accept any liability for the product.

Qualified personnel
Only qualified and experienced personnel should carry out the service work.

Prior to service work:
1. Electrically isolate the equipment.
2. Close fuel shut-off devices.

Post service work:
1. Restore all connections.
2. Function test on whole system.
3. Check exhaust to ensure that combustion performance is maintained.
4. Complete the maintenance entry in the logbook.

NOTE:
The completion of maintenance section of logbook is essential for troubleshooting in the future.
Endangering operational safety

Beyond the instructions given here, under no circumstances should any other repair work be attempted on the following components:

- Modulating servomotors
- Flame sensor
- Burner controller
- Oil pressure switches
- Solenoid valves
- Air pressure switch
- Gas pressure switches
- MBC-VEF Gas Regulator
- Thermostat
- Oil Pump
- Atomizing nozzle
- VPS (Valve Proving System)
- SBV (Safety Blow Off Valve)

Risk of explosion due to gas leak

Take care when dismantling and reassembling parts of the gas valve train. Ensure that their alignment is true and screws are correctly and adequately tightened.

Gas leaks should be checked with Soap Bubble Test at each connection on Gas line.

DANGER!

Prior to starting service work, the oil preheater and oil carrying lines and components must be allowed to cool down. According to local regulations protective equipment must be used.
### 6.2 Servicing Schedule

The frequency of essential servicing operations is given below. For safe functioning of the system, it is essential to follow this sequence and regularly record it in the logbook.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Frequency of servicing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weekly</td>
</tr>
<tr>
<td><strong>Control Circuit</strong></td>
<td></td>
</tr>
<tr>
<td>Clean flame sensor (UV sensor/ Photocell)</td>
<td></td>
</tr>
<tr>
<td>Check electrode settings and wire insulation</td>
<td></td>
</tr>
<tr>
<td>Remove the thermostat probe and calibrate the thermostat</td>
<td></td>
</tr>
<tr>
<td>Check continuity of thermostat contacts by varying the set point</td>
<td></td>
</tr>
<tr>
<td>Check continuity of oil pressure switches by varying the set point</td>
<td></td>
</tr>
<tr>
<td>Air pressure switch sensor cleaning and set point check</td>
<td></td>
</tr>
<tr>
<td>Control panel fan and filter cleaning</td>
<td></td>
</tr>
<tr>
<td>Retighten all the wires inside the junction box</td>
<td></td>
</tr>
<tr>
<td>Ignition cable replacement</td>
<td></td>
</tr>
<tr>
<td>Remove the heater temperature element and its thermo well and clean</td>
<td></td>
</tr>
<tr>
<td><strong>Air Circuit</strong></td>
<td></td>
</tr>
<tr>
<td>Air fan and flame window cleaning</td>
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<tr>
<td>Air damper grub screw tightening</td>
<td></td>
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<tr>
<td>Air Servomotor Coupling screw tightening</td>
<td></td>
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<tr>
<td>Punker plate cleaning</td>
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<td>Oil lance and gas header centering check</td>
<td></td>
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<tr>
<td>Oiling of roller end bearings and damper shaft</td>
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</tr>
<tr>
<td>Procedure</td>
<td>Frequency of servicing</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td></td>
<td>Weekly</td>
</tr>
<tr>
<td><strong>Oil Circuit</strong></td>
<td></td>
</tr>
<tr>
<td>Oil Strainer cleaning</td>
<td></td>
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<tr>
<td>Drain oil preheater and fill with fresh oil</td>
<td></td>
</tr>
<tr>
<td>Open IPRV and BPRV, clean and check for smooth movement of piston</td>
<td></td>
</tr>
<tr>
<td>Oiling of camshaft and cam</td>
<td></td>
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<tr>
<td>Diffuser Plate Cleaning</td>
<td></td>
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<tr>
<td><strong>Hydraulic Lance</strong></td>
<td></td>
</tr>
<tr>
<td>Remove atomizer and clean in diesel</td>
<td></td>
</tr>
<tr>
<td>Open lance and check O-rings for wear</td>
<td></td>
</tr>
<tr>
<td>Open lance and check spring for buckling</td>
<td></td>
</tr>
<tr>
<td>Pressure gauge calibration</td>
<td></td>
</tr>
<tr>
<td>Replace hydraulic hoses</td>
<td></td>
</tr>
<tr>
<td>Oil pump cleaning</td>
<td></td>
</tr>
</tbody>
</table>
6.3 Servicing Procedures

IPRV cleaning

- Ensure that fuel supply is cut-off
- Place a collection bucket underneath the IPRV
- Remove the bottom hexagonal head
- Remove the top handle
- Carefully pickout the spring from the internal cylinder
- Clean the bottom needle, handle rod and spring in a light oil like diesel.
- Refit in reverse order, ensure tight connection.
- Ensure that any oil spillage is cleaned before restarting
- Ensure that supply pressure is maintained before proceeding.
BPRV cleaning

- Ensure that fuel supply is cut-off
- Place a collection bucket underneath the BPRV
- Loosen the BPRV follower\(^1\) from its locked position on the cam groove
- Open the bottom hexagonal head of the BPRV\(^2\)
- Open the top hexagonal head \(^3\) and remove the follower\(^1\) and internal piston\(^4\) and spring\(^5\)
- Clean all components in a light oil like diesel
- Refit the components in reverse order and ensure tight connection.
- Ensure that any oil spillage is cleaned before restarting.
- Ensure that return pressure is maintained throughout the range before proceeding
Strainer Cleaning

- Ensure that the fuel supply is cut-off
- Place a collection bucket beneath the strainer
- Loosen the hexagonal head① as shown
- Remove the mesh②
- Clean the mesh in light oil like diesel
- Refit in reverse order, ensure tight connection
Lance Servicing

Removing the lance

- Ensure that burner is electrically isolated
- Ensure that fuel supply is cut-off
- For furnace oil burners, allow sufficient time for cooling of the oil lines
- Remove the hinge bolts
- Open the burner hinge
- Loosen the top bolt of the centering mechanism
- Slide the lance and punker plate assembly out of the burner
- Disconnect oil lines to the lance

During this servicing, following work should also be performed:

- Clean the punker plate with diesel
- Clean the electrodes with a dry cloth

After servicing replace in reverse manner and ensure that the hydraulic lines are leak-proof.
SOP for Replacement of Atomizer

- Remove the old atomizer by using spanner of size 24.
- Remove the cap from back side of the lance.
- Loosen the adjustment screw so as to reduce spring tension.
- Fit the new atomizer from the front side of the oil hydraulic lance and tighten it using the force of hand (without spanner).
- Re-tighten the adjustment screw to its original position.
- Tighten the atomizer with spanner of size 24.
- Re-tighten the cap.
O-ring and Spring Inspection

- Using an adjustable wrench, loosen the cylinder
- Pull out the plunger and piston
- Observe the O-rings on the plunger and piston for wear, rips or flatness
- Replace if O-rings are deformed in any manner.
- Clean the internal passages and the plunger and piston in diesel.
- Refit all components
- Check that all connections and nozzle shut-off are leak proof.
SOP for Assembly of Oil Pump & Pump Motor

1) Figure (A) shows the exploded view of the oil pump (1) and motor assembly

2) Pump motor (7) is 1st mounted on the burner plate (6) with 4 bolts such that the protrusion on the mounting flange of the motor (7) rests into the groove given on the burner plate (6). Also on the opposite side of the burner plate, pump bracket (4) is mounted with the help of same mounting bolts. (Pump bracket (4) & pump motor (7) are mounted on the burner plate (6) with the same set of nut & bolts)

3) Motor coupling (5) is mounted on the motor shaft such that grub screw is tightened against the key mounted in the key way of the motor shaft

4) Pump side coupling (2) is fitted on the pump shaft such that the grub screw for fixing the coupling on the pump shaft when tightened goes into the dimple given on the pump shaft

5) The assembly of the pump (1) and pump coupling (2) (step no.4 above) is mounted on the pump bracket (4) such that rubber spider (3) is sandwiched between the pump coupling (2) and motor coupling (5) as shown in fig (B)

6) The gap between the pump coupling (2) and the spider (3) is to be maintained as 1.5 mm. Also the gap between the spider (3) and the motor coupling (5) is to be maintained as 1.5 mm by sliding the motor coupling on the motor shaft accordingly. Same is to be verified by checking the distance between two couplings which should be 3 mm (Refer fig. B)
**Thermostat Setting and Calibration**

1. Ensure that the fuel supply is cut-off
2. Drain the oil circuit
3. Remove the thermostat probe from the thermowell
4. Using an adjustable wrench, loosen the thermowell
5. Clean the thermowell stem using a light oil
6. Check the thermostat calibration using a separate thermometer and a hot water bath
7. Adjust the low temperature set point needle (green) and high temperature set point needle (red) and check for contact change over when current point needle (black) crosses low and high set point needles.
MBC-VEF Gas Filter Changing

- Ensure that the main ball valve is closed
- Ensure that the burner is electrically isolated
- Remove the screws ① & ②
- Remove and inspect the filter
- Replace the filter if the Δp across the test points ① & ② is
  - Higher than 10 mbar
  - Twice the value at last inspection
6.4 Replacement Schedule

Some components of the burner have a limited lifetime. Replace these components according to this replacement schedule

**DANGER!**

It is essential to replace the components according to the schedule given in this manual. Failure to do so can cause:

- extensive physical damage to the combustion chamber and the burner.
- loss of life

In these circumstances, Forbes Marshall Pvt. Ltd will not accept any liability for the product

**NOTE:**

All components should be regularly inspected and replaced if required

<table>
<thead>
<tr>
<th>Component</th>
<th>Lifetime (Yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomizing Nozzle</td>
<td>1</td>
</tr>
<tr>
<td>Flexible Hoses</td>
<td>½ year</td>
</tr>
<tr>
<td>Checkstat</td>
<td>2</td>
</tr>
<tr>
<td>Resistance Potentiometer</td>
<td>1</td>
</tr>
<tr>
<td>Pressure Gauges</td>
<td>2</td>
</tr>
<tr>
<td>Oil Solenoid Valves</td>
<td>3</td>
</tr>
<tr>
<td>Pump</td>
<td>4</td>
</tr>
<tr>
<td>Gaskets</td>
<td>1</td>
</tr>
<tr>
<td>O-rings</td>
<td>1</td>
</tr>
</tbody>
</table>
7 Troubleshooting

If the burner is found either out of operation, in lockout or not functioning in any other manner, use the control panel lights as reference for troubleshooting and make a step by step check for analysis.

When a fault occurs, the very basic things to be checked are as follows

- Check if the control panel has 3-phase supply and the 1-phase supply (used for the major electrical components and controls) MCB is not tripped.
- Check if the connections for the concerned instrument because of which the problem has been caused, are intact and not broken at the terminal block on the burner control box or the control panel and is receiving power too.
- Check if there is gas supply in the main gas line for gas fired burners.
- Check if there is Oil(FO/HSD) in the Day Oil Tank for Oil Fired Burners
- Check if all the level switches from the mobrey on the boiler, fuel and air pressure switches, thermostats function correctly and are well connected.
## 7.1 Oil Troubleshooting

<table>
<thead>
<tr>
<th>Subreason</th>
<th>Reason</th>
<th>Fault Condition</th>
<th>Fault Position</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrong Connection</td>
<td>Pump motor doesn't start</td>
<td>Pump jammed</td>
<td>Pump/Motor</td>
<td>Check connections for correctness and tightness</td>
</tr>
<tr>
<td>No supply</td>
<td>Pump doesn't rotate</td>
<td>Pump doesn't rotate</td>
<td>Pump/Motor</td>
<td>Check continuity</td>
</tr>
<tr>
<td>Dirt particles</td>
<td>High/Low water switch trips</td>
<td>Coupling disengaged</td>
<td>Interlocks</td>
<td>Open and clean pump</td>
</tr>
<tr>
<td>Dry running</td>
<td>Water levels abnormal</td>
<td>Coupling Broken</td>
<td>Interlocks</td>
<td>Check for blockage in line</td>
</tr>
<tr>
<td>Coupling disengaged</td>
<td>Boiler pressure high</td>
<td>Water levels abnormal</td>
<td>Interlocks</td>
<td>Check for fuel in line</td>
</tr>
<tr>
<td>Coupling Broken</td>
<td>Switch contacts non-functional</td>
<td>Boiler pressure high</td>
<td>Interlocks</td>
<td>Check for blockage in line</td>
</tr>
<tr>
<td>Water levels abnormal</td>
<td>Damper not at low position</td>
<td>Boiler pressure high</td>
<td>Interlocks</td>
<td>Check for fuel in line</td>
</tr>
<tr>
<td>Boiler pressure switch</td>
<td>Potentiometer faulty</td>
<td>Damper not at low position</td>
<td>Interlocks</td>
<td>Allow pump to cool</td>
</tr>
<tr>
<td>Servomotor potentiometer</td>
<td>Ambient light on flame sensor</td>
<td>Boiler pressure high</td>
<td>Interlocks</td>
<td>Allow pump to cool</td>
</tr>
<tr>
<td>Flame sensor</td>
<td>Hinge is not closed</td>
<td>Servomotor potentiometer</td>
<td>Interlocks</td>
<td>Allow pump to cool</td>
</tr>
<tr>
<td>Hinge switch faulty</td>
<td>Hinge switch</td>
<td>Servomotor potentiometer</td>
<td>Interlocks</td>
<td>Allow pump to cool</td>
</tr>
</tbody>
</table>

Pump/Motor doesn't start

- Check connections for correctness and tightness
- Check continuity
- Open and clean pump
- Replace pump
- Allow pump to cool
- Check for blockage in line
- Check for fuel in line
- Replace pump
- Align coupling
- Replace coupling
- Allow feed water to normalize
- Replace switch
- Allow pressure to reduce
- Replace switch
- Check servomotor functioning
- Replace if required
- Replace potentiometer
- Locate light source
- Eliminate or re-orient away from light source
- Close the hinge securely with bolts
- Replace hinge switch

Burner Pump doesn't start
<table>
<thead>
<tr>
<th>Fault Condition</th>
<th>Fault Position</th>
<th>Reason</th>
<th>Subreason</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blower motor doesn't start</td>
<td>Motor</td>
<td>Motor connections are incorrect Motor connections are not continuous Motor connections are not continuous Voltage is not available Voltage is not available</td>
<td>Checkstat not closing contact Checkstat not closing contact Checkstat not closing contact Checkstat not closing contact</td>
<td>Check and correct connections Check power supply Check bank controller setting Check set-point for correctness Adjust if necessary Ensure probe is properly inserted and tightened Check and correct connections Check power supply Check bank controller setting Check set-point for correctness Adjust if necessary Ensure probe is properly inserted and tightened</td>
</tr>
<tr>
<td>Valve doesn't open</td>
<td>Valve</td>
<td>Valve doesn't open Valve doesn't open</td>
<td>Valve doesn't open Valve doesn't open</td>
<td>Check and correct connections Check power supply Check bank controller setting Check set-point for correctness Adjust if necessary Ensure probe is properly inserted and tightened Check and correct connections Check power supply Check bank controller setting Check set-point for correctness Adjust if necessary Ensure probe is properly inserted and tightened</td>
</tr>
<tr>
<td>Safety Solenoid doesn't open</td>
<td>Servomotor</td>
<td>Servomotor potentiometer Servomotor potentiometer</td>
<td>Safety Solenoid doesn't open Safety Solenoid doesn't open</td>
<td>Check and correct connections Check power supply Check bank controller setting Check set-point for correctness Adjust if necessary Ensure probe is properly inserted and tightened Check and correct connections Check power supply Check bank controller setting Check set-point for correctness Adjust if necessary Ensure probe is properly inserted and tightened</td>
</tr>
<tr>
<td>Blower starts but no pre-purge</td>
<td>Blower motor</td>
<td>Blower starts but no pre-purge</td>
<td>Blower starts but no pre-purge</td>
<td>Check and correct connections Check power supply Check bank controller setting Check set-point for correctness Adjust if necessary Ensure probe is properly inserted and tightened Check and correct connections Check power supply Check bank controller setting Check set-point for correctness Adjust if necessary Ensure probe is properly inserted and tightened</td>
</tr>
</tbody>
</table>

**Modulating Burner**
<table>
<thead>
<tr>
<th>Fault Condition</th>
<th>Fault Position</th>
<th>Reason</th>
<th>Subreason</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulating Burner</td>
<td>Servomotor</td>
<td>Servomotor not at low position</td>
<td>Potentiometer faulty</td>
<td>Replace servomotor</td>
</tr>
</tbody>
</table>
| | Servomotor | Servomotor potentiometer not giving contact at low position | Potentiometer faulty | Replace servomotor
<p>| | | Electrodes incorrectly positioned | Electrodes faulty | Replace servomotor |
| | | Electrodes dirty or wet | Electrodes dirty or wet | Clean electrodes |
| | | Ceramic cover is cracked | Ceramic cover is cracked | Replace electrodes |
| | | Ignition cable connection loose | Ignition cable connection loose | Replace ignition cable |
| | | Ignition Transformer faulty | Ignition Transformer faulty | Replace Ignition transformer |
| | | Pre-purge completed, ignition failure | Pre-purge completed, ignition failure | Replace Ignition transformer |
| | | | | Check connections at both ends |</p>
<table>
<thead>
<tr>
<th>Fault Condition</th>
<th>Fault Position</th>
<th>Reason</th>
<th>Subreason</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety solenoid does not open fully</td>
<td>Safety solenoid does not actuate properly</td>
<td>Safety solenoid does not open fully</td>
<td>Refer above section on safety solenoid failure</td>
<td>Refer above section on safety solenoid failure</td>
</tr>
<tr>
<td>Oil supply pressure too high</td>
<td>Oil supply pressure too high</td>
<td>SOPS trips</td>
<td>Check O-rings inside the lance as described in Ch6.3</td>
<td>Replace ROPS</td>
</tr>
<tr>
<td>No oil injected</td>
<td>SOPS tripping</td>
<td>SOPS tripping</td>
<td>Tighten BPRV till proper pressure is achieved</td>
<td>Replace ROPS</td>
</tr>
<tr>
<td>Spark generated, flame absent</td>
<td>Oil supply</td>
<td>Oil supply</td>
<td>Check spark for proper operation and setpoint</td>
<td>Replace ROPS</td>
</tr>
<tr>
<td>Reason</td>
<td>Subreason</td>
<td>Fault Condition</td>
<td>Fault Position</td>
<td>Remedy</td>
</tr>
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<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Air pressure switch trips</td>
<td>Air damper is open sufficiently &amp; APS still tripping</td>
<td>Flame present, not detected</td>
<td>Air supply</td>
<td>Check that sensor tube is correctly orientated</td>
</tr>
<tr>
<td></td>
<td>A.F ratio is too high</td>
<td></td>
<td>Flame sensor</td>
<td>Replace APS</td>
</tr>
<tr>
<td></td>
<td>Flame sensor dirty</td>
<td></td>
<td>Oil supply</td>
<td>Check that sensor tube is clean</td>
</tr>
<tr>
<td></td>
<td>Flame sensor connections incorrect</td>
<td></td>
<td>Air supply too Low</td>
<td>Adjust the air damper as described in Ch5.5</td>
</tr>
<tr>
<td></td>
<td>Flame sensor oriented incorrectly</td>
<td></td>
<td></td>
<td>Clean the flame sensor</td>
</tr>
<tr>
<td></td>
<td>Flame sensor faulty</td>
<td></td>
<td></td>
<td>Check connections</td>
</tr>
<tr>
<td></td>
<td>Oil throughput too high at initial fire</td>
<td></td>
<td></td>
<td>Adjust orientation so that window is facing flame direction</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Replace flame sensor</td>
</tr>
<tr>
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<td></td>
<td>Loosen the BPRV till proper return pressure achieved</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Adjust Damper to increase Air Supply</td>
</tr>
<tr>
<td>Reason</td>
<td>Subreason</td>
<td>Fault Position</td>
<td>Fault Condition</td>
<td>Remedy</td>
</tr>
<tr>
<td>--------</td>
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<td>--------</td>
</tr>
<tr>
<td>Air bubbles in oil supply</td>
<td>Moisture content in oil</td>
<td>Oil supply</td>
<td>Flame is unstable</td>
<td>Evaluate moisture content of oil. If above recommended value, drain day oil tank and replace with fresh, dry oil.</td>
</tr>
<tr>
<td>Oil temperature too high</td>
<td>Pressure fluctuations in supply</td>
<td>Air supply</td>
<td>Air supply too high</td>
<td>Check the set point on heater. Remove the heater temperature control element and check contact changeover. Check temperature controller. Replace heater temperature control element or temperature controller.</td>
</tr>
<tr>
<td>Oil temperature too high</td>
<td>Oil temperature too high</td>
<td>Oil supply</td>
<td>Oil temperature too high</td>
<td>Check the set point on heater. Remove the heater temperature control element and check contact changeover. Check temperature controller. Replace heater temperature control element or temperature controller.</td>
</tr>
<tr>
<td>Adjust Damper</td>
<td>Adjust the air damper as described in Ch5.5</td>
<td>Air supply</td>
<td>Air quantity low</td>
<td>Adjust Damper</td>
</tr>
<tr>
<td>Replace nozzle</td>
<td>Replace nozzle</td>
<td>Flue tubes</td>
<td>Flue tubes are choked</td>
<td>Center the nozzle</td>
</tr>
<tr>
<td>Clean flue tubes with wirebrushes</td>
<td>Clean flue tubes with wirebrushes</td>
<td>Nozzle</td>
<td>Nozzle spray not centered</td>
<td>Dry off the oil line</td>
</tr>
<tr>
<td>Flue tubes are choked</td>
<td>Flue tubes are choked</td>
<td>Nozzle</td>
<td>Nozzle spray not centered</td>
<td>Dry off the oil line</td>
</tr>
<tr>
<td>Smoky flame/ Clinker</td>
<td>Smoky flame/ Clinker</td>
<td>Nozzle</td>
<td>Nozzle</td>
<td>Replace nozzle</td>
</tr>
</tbody>
</table>

Modulating Burner
<table>
<thead>
<tr>
<th>Fault Condition</th>
<th>Fault Position</th>
<th>Reason</th>
<th>Subreason</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sparky flame</td>
<td>Refractory</td>
<td>Air quantity high</td>
<td>BPRV response lagging behind damper</td>
<td>Adjust the air damper as described in Ch5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nozzle choked</td>
<td>Restriction in oil supply</td>
<td>Open and clean nozzle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BPRV</td>
<td>Damper grub screws loose</td>
<td>Replace BPRV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oil supply Lines</td>
<td>Suction hood screws loose</td>
<td>Replace BPRV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Screws</td>
<td>Imbalanced impeller</td>
<td>Trace for restriction in line causing lesser oil flow</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Impeller</td>
<td>Loose Refractory Fitting</td>
<td>Tighten all screws</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refractory</td>
<td>Refractory didn’t cured after fitting</td>
<td>Balance impeller through qualified personnel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vibrations</td>
<td>After fitting new refractory it must be kept 48 hrs. For curing</td>
<td>Tighten refractory fitting bolts.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Standard fitting procedure not followed</td>
<td>Replace Rope</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 7.2 Gas Troubleshooting

<table>
<thead>
<tr>
<th>Reason</th>
<th>Fault Position</th>
<th>Subreason</th>
<th>Fault Condition</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>High/Low water switch tips</td>
<td>Interlocks</td>
<td>Water levels abnormal</td>
<td>Switch contacts non-functional</td>
<td>Allow feed water to normalize</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Boiler pressure high</td>
<td></td>
<td>Replace switch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Switch contacts non-functional</td>
<td></td>
<td>Allow pressure to reduce</td>
</tr>
<tr>
<td>Burner doesn't start</td>
<td>Servomotor</td>
<td>Servomotor potentiometer</td>
<td>Damper not at low position</td>
<td>Replace switch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flame sensor</td>
<td>Ambient light on flame sensor</td>
<td>Replace switch if required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hinge switch</td>
<td>Hinge is not closed</td>
<td>Check servomotor functioning</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Replace potentiometer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Locate light source</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Eliminate or re-orient away from light source</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Close the hinge securely with bolts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Replace hinge switch</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Re-tight all tube fittings</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Try 3 or 4 times and replace</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Set to right fuel, replace switch if required</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Switch is set to wrong fuel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Solenoid Valve is locking</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fuel changeover switch</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Solenoid Valve leak</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Leak through tubing between main SV and Pilot SV</td>
</tr>
</tbody>
</table>

---

**FORBES MARSHALL**

---

**Modulating Burner**
<table>
<thead>
<tr>
<th>Fault Condition</th>
<th>Fault Position</th>
<th>Reason</th>
<th>Subreason</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burner doesn't start</td>
<td>Gas Pressure Switches</td>
<td>Servomotor not at low position</td>
<td>Servomotor potentiometer giving wrong signal</td>
<td>Replace servomotor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Servomotor potentiometer</td>
<td></td>
<td>Replace servomotor potentiometer</td>
</tr>
<tr>
<td></td>
<td>Low Gas Pressure</td>
<td>No gas available</td>
<td></td>
<td>Check for main ball valve open</td>
</tr>
<tr>
<td></td>
<td>Switch trips</td>
<td>Gas pressure is below set point LGPS trips</td>
<td></td>
<td>Check with gas supplier</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gas pressure is correct LGPS trips</td>
<td></td>
<td>Adjust Pressure Relief Valve to get proper gas pressure</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Replace spring of pressure relief valve</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Replace pressure relief valve</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gas pressure is correct LGPS trips</td>
<td>Check LGPS for contact switchover, correct connection, correct setpoint</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Replace LGPS</td>
</tr>
<tr>
<td>Servomotor not at high position</td>
<td></td>
<td>Servomotor not at high position</td>
<td></td>
<td>Replace servomotor</td>
</tr>
<tr>
<td>Servomotor potentiometer</td>
<td>Servomotor not at low position</td>
<td>Servomotor potentiometer giving wrong signal</td>
<td></td>
<td>Replace servomotor potentiometer</td>
</tr>
<tr>
<td>Servomotor potentiometer</td>
<td>Servomotor not at low position</td>
<td>Servomotor non-functional</td>
<td></td>
<td>Replace servomotor</td>
</tr>
<tr>
<td>Servomotor potentiometer</td>
<td>Potentiometer not giving contact at low position</td>
<td>Potentiometer faulty</td>
<td></td>
<td>Replace potentiometer</td>
</tr>
<tr>
<td>Pre-purge completed</td>
<td>Electrodes</td>
<td>Electrodes incorrectly positioned</td>
<td>Gap too high</td>
<td>Correct electrode positioning as per Ch4.4</td>
</tr>
<tr>
<td>Ignition failure</td>
<td>Electrodes dirty or wet</td>
<td></td>
<td></td>
<td>Replace electrodes if positioning correction not possible</td>
</tr>
<tr>
<td></td>
<td>Ceramic cover is cracked</td>
<td></td>
<td></td>
<td>Clean electrodes</td>
</tr>
<tr>
<td></td>
<td>Ignition Cable</td>
<td>Ignition cable is charred</td>
<td></td>
<td>Replace electrodes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>voltage not generated</td>
<td></td>
<td>Replace ignition cable</td>
</tr>
<tr>
<td></td>
<td>Ignition Transformer</td>
<td>voltage not generated</td>
<td></td>
<td>Replace ignition Transformer</td>
</tr>
<tr>
<td>Subreason</td>
<td>Reason</td>
<td>Fault Condition</td>
<td>Fault Position</td>
<td>Remedy</td>
</tr>
<tr>
<td>-----------</td>
<td>-------</td>
<td>----------------</td>
<td>----------------</td>
<td>--------</td>
</tr>
<tr>
<td>Leakage between solenoid valves</td>
<td>Ignition cable connection loose</td>
<td>Valve Proving System</td>
<td>Ignition transformer faulty</td>
<td>Check connections at both ends</td>
</tr>
<tr>
<td>No leakage, VPS trips</td>
<td>VPS trips</td>
<td></td>
<td></td>
<td>Replace ignition transformer</td>
</tr>
<tr>
<td>Gas header line choked</td>
<td></td>
<td></td>
<td></td>
<td>Check VPS connections to junction box</td>
</tr>
<tr>
<td>Gas pressure is above set point</td>
<td></td>
<td></td>
<td></td>
<td>Replace VPS</td>
</tr>
<tr>
<td>HGPS trips</td>
<td></td>
<td></td>
<td></td>
<td>Check VPS internal connections and mounting</td>
</tr>
<tr>
<td>HGPS trips</td>
<td></td>
<td></td>
<td></td>
<td>Replace VPS</td>
</tr>
<tr>
<td>Gas pressure is correct</td>
<td>Pilot Gas Solenoid fails to open</td>
<td></td>
<td></td>
<td>Replace VPS</td>
</tr>
<tr>
<td>HGPS trips</td>
<td></td>
<td></td>
<td></td>
<td>Check VPS connections to junction box</td>
</tr>
<tr>
<td>HGPS trips</td>
<td></td>
<td></td>
<td></td>
<td>Replace VPS</td>
</tr>
<tr>
<td>HGPS trips</td>
<td></td>
<td></td>
<td></td>
<td>Adjust pressure relief valve to get proper gas pressure</td>
</tr>
<tr>
<td>Replace VPS</td>
<td></td>
<td></td>
<td></td>
<td>Replace pressure relief valve</td>
</tr>
<tr>
<td>Replace pressure relief valve</td>
<td></td>
<td></td>
<td></td>
<td>Replace HGPS</td>
</tr>
<tr>
<td>Replace spring of pressure relief valve</td>
<td></td>
<td></td>
<td></td>
<td>Replace HGPS</td>
</tr>
<tr>
<td>Replace HGPS</td>
<td></td>
<td></td>
<td></td>
<td>Check HGPS for contact switchover, correct connection, correct setpoint</td>
</tr>
<tr>
<td>Replace HGPS</td>
<td></td>
<td></td>
<td></td>
<td>Replace connections</td>
</tr>
<tr>
<td>Replace Pilot Solenoid</td>
<td></td>
<td></td>
<td></td>
<td>Replace Pilot Solenoid</td>
</tr>
<tr>
<td>Reason</td>
<td>Subreason</td>
<td>Fault Condition</td>
<td>Fault Position</td>
<td>Remedy</td>
</tr>
<tr>
<td>--------</td>
<td>-----------</td>
<td>-----------------</td>
<td>----------------</td>
<td>--------</td>
</tr>
<tr>
<td>Pilot pressure too low</td>
<td>Flame sensor dirty</td>
<td>Flame sensor connections incorrect</td>
<td>Main Gas Valve</td>
<td>Adjust pressure relief valve to get proper gas pressure</td>
</tr>
<tr>
<td>Flame sensor oriented incorrectly</td>
<td>Flame sensor faulty</td>
<td>Main Gas Solenoid fails to open</td>
<td>Pressure Relief Valve</td>
<td>Replace spring of pressure relief valve</td>
</tr>
<tr>
<td>Main line pressure too low</td>
<td>Air Damper Opening high</td>
<td>Gas throughput too high at initial fire</td>
<td>Gas Supply</td>
<td>Replace pressure relief valve</td>
</tr>
<tr>
<td>Pressure fluctuations in supply</td>
<td>Moisture content in gas</td>
<td>Evaluate moisture content of gas</td>
<td>Gas Supply</td>
<td>Check connections</td>
</tr>
<tr>
<td>Oscillating Exhaust damper</td>
<td>Contact Gas supplier</td>
<td></td>
<td>Gas Supply</td>
<td>Replace Main Solenoid</td>
</tr>
<tr>
<td>Contact Gas supplier</td>
<td></td>
<td></td>
<td>Gas Supply</td>
<td>Adjust N dial on the MBC-VEF as described in Ch 5.6</td>
</tr>
<tr>
<td>Check Flue gas tubes and exhaust damper</td>
<td></td>
<td></td>
<td>Gas Supply</td>
<td>Adjust N dial on the MBC-VEF as described in Ch 5.6</td>
</tr>
<tr>
<td>Flame sensor faulty</td>
<td>Main Gas Valve</td>
<td>Flare generated, Main Flame Absent</td>
<td>Flame is unstable</td>
<td>Complete orientation so that window is facing flame direction</td>
</tr>
<tr>
<td>Main line pressure too low</td>
<td>Main line pressure too low</td>
<td>Flame puffs at start</td>
<td>Gas Supply</td>
<td>Check connections</td>
</tr>
<tr>
<td>Gas throughput too high at initial fire</td>
<td>Gas throughput too high at initial fire</td>
<td></td>
<td>Gas Supply</td>
<td>Replace flame sensor</td>
</tr>
<tr>
<td>Moisture content in gas</td>
<td>Evaluate moisture content of gas</td>
<td></td>
<td>Gas Supply</td>
<td>Replace pressure relief valve</td>
</tr>
<tr>
<td>Pressure fluctuations in supply</td>
<td>Evaluate moisture content of gas</td>
<td></td>
<td>Gas Supply</td>
<td>Check connections</td>
</tr>
<tr>
<td>Contact Gas supplier</td>
<td></td>
<td></td>
<td>Gas Supply</td>
<td>Replace pressure relief valve</td>
</tr>
<tr>
<td>Check Flue gas tubes and exhaust damper</td>
<td></td>
<td></td>
<td>Gas Supply</td>
<td>Check connections</td>
</tr>
<tr>
<td>Flame is unstable</td>
<td></td>
<td></td>
<td>Gas Supply</td>
<td>Replace Main Solenoid</td>
</tr>
<tr>
<td>Contact Gas supplier</td>
<td></td>
<td></td>
<td>Gas Supply</td>
<td>Adjust N dial on the MBC-VEF as described in Ch 5.6</td>
</tr>
<tr>
<td>Check Flue gas tubes and exhaust damper</td>
<td></td>
<td></td>
<td>Gas Supply</td>
<td>Evaluate moisture content of gas</td>
</tr>
<tr>
<td>Fault Condition</td>
<td>Fault Position</td>
<td>Reason</td>
<td>Subreason</td>
<td>Remedy</td>
</tr>
<tr>
<td>-----------------</td>
<td>----------------</td>
<td>--------</td>
<td>-----------</td>
<td>--------</td>
</tr>
<tr>
<td>Flame is unstable</td>
<td>Servo-Motor</td>
<td>Faulty Capacitor</td>
<td></td>
<td>Replace the split phase capacitor start electronic card on the servo-motor</td>
</tr>
<tr>
<td>High CO readings</td>
<td>Gas Supply</td>
<td>Air quantity low</td>
<td></td>
<td>Adjust the air damper as described in Ch5.5</td>
</tr>
<tr>
<td>High O2 readings</td>
<td>Air Supply</td>
<td>Flue tubes are choked</td>
<td></td>
<td>Clean flue tubes with wire brushes</td>
</tr>
<tr>
<td></td>
<td>Header</td>
<td>Gas Supply High, Setting of 'V' is incorrect</td>
<td></td>
<td>Reset V value as described in Ch5.6 and evaluate throughout the range</td>
</tr>
<tr>
<td></td>
<td>Gas Supply</td>
<td>Air quantity high</td>
<td></td>
<td>Adjust the air damper as described in Ch5.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Header choked</td>
<td>Open and clean header</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Replace header</td>
</tr>
<tr>
<td></td>
<td>Gas Supply</td>
<td>Setting of variation value 'V' is incorrect</td>
<td></td>
<td>Reset V value as described in Ch5.6 and evaluate throughout the range</td>
</tr>
<tr>
<td>Vibrations</td>
<td>Impeller</td>
<td>Damper grub screws loose</td>
<td></td>
<td>Tighten all screws</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suction hood screws loose</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Imbalanced impeller</td>
<td></td>
<td>Balance impeller through qualified personnel</td>
</tr>
</tbody>
</table>
Appendix A
Permissible ambient conditions

Temperature

During operation:
-10° C ……+ 45° C (Oil)
-15° C ……+ 45° C (Gas)

Transport/storage:
-20° C ……+70° C

Humidity

max. 80% relative humidity
above dew point

max. 95% relative humidity
above dew point

Electrical data

Burner control
Supply
Supply at control panel input 230 VAC, 4A
Earth
Max. permissible potential 2V
drop across neutral and earth

Weights

Burner
approx. 400 – 600 kgs
Gas train
approx. 35 – 200 kgs
# Appendix B

## Burner Dimensions

### Overall Burner Dimensions as per above views (mm)

<table>
<thead>
<tr>
<th>Burner Capacity (TPH)</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>247</td>
<td>194</td>
<td>1368</td>
<td>600</td>
<td>940</td>
<td>844</td>
</tr>
<tr>
<td>2.8</td>
<td>287</td>
<td>195</td>
<td>1450</td>
<td>740</td>
<td>1025</td>
<td>1020</td>
</tr>
<tr>
<td>3</td>
<td>332</td>
<td>350</td>
<td>1766</td>
<td>780</td>
<td>1075</td>
<td>1085</td>
</tr>
<tr>
<td>3.5</td>
<td>362</td>
<td>311</td>
<td>1690</td>
<td>795</td>
<td>1165</td>
<td>1122</td>
</tr>
<tr>
<td>4</td>
<td>362</td>
<td>311</td>
<td>1690</td>
<td>795</td>
<td>1165</td>
<td>1122</td>
</tr>
<tr>
<td>4.5</td>
<td>362</td>
<td>311</td>
<td>1690</td>
<td>795</td>
<td>1165</td>
<td>1122</td>
</tr>
<tr>
<td>5</td>
<td>362</td>
<td>311</td>
<td>1690</td>
<td>795</td>
<td>1165</td>
<td>1122</td>
</tr>
<tr>
<td>6.3</td>
<td>362</td>
<td>311</td>
<td>1690</td>
<td>795</td>
<td>1165</td>
<td>1122</td>
</tr>
</tbody>
</table>
Appendix C

The structure of the ECR burner controller menu is described below:

Normal Operation Screen
Appendix D

Tools List

Ensure that the following tools are available during any commissioning or servicing work

<table>
<thead>
<tr>
<th>Tool</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allen Key Set</td>
<td>(2.5 to 20)</td>
</tr>
<tr>
<td>Spanner Set</td>
<td>(6 to 32)</td>
</tr>
<tr>
<td>Crimping Tool</td>
<td></td>
</tr>
<tr>
<td>Bending Tool</td>
<td>(for SS tube 1/4&quot;)</td>
</tr>
<tr>
<td>Tube Cutter</td>
<td></td>
</tr>
<tr>
<td>Adjustable Spanner</td>
<td>(Medium and Large)</td>
</tr>
<tr>
<td>Lifting Crane</td>
<td></td>
</tr>
<tr>
<td>Lifting Lug</td>
<td></td>
</tr>
<tr>
<td>Box Spanner (Size 24)</td>
<td></td>
</tr>
<tr>
<td>1/4&quot; Flathead screwdriver</td>
<td></td>
</tr>
<tr>
<td>1/8&quot; Flathead screwdriver</td>
<td></td>
</tr>
<tr>
<td>Box Spanner (Size 1/2&quot;)</td>
<td></td>
</tr>
<tr>
<td>Multimeter</td>
<td></td>
</tr>
<tr>
<td>Manometer</td>
<td></td>
</tr>
</tbody>
</table>
## Appendix E

Precommissioning Checklist

<table>
<thead>
<tr>
<th><strong>PRECOMMISSIONING CHECKLIST</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Appliance properly installed, supported by proper foundation, level and centered</td>
</tr>
<tr>
<td>☐ Ducting from appliance to flue gas outlet</td>
</tr>
<tr>
<td>☐ Oil tank provided with outflow heaters, drains and vent, insulation and placed at suitable height</td>
</tr>
<tr>
<td>☐ Fuel line size is of proper size upto the header, insulated properly</td>
</tr>
<tr>
<td>☐ Filters are installed in fuel line</td>
</tr>
<tr>
<td>☐ Fuel supply is available and ready</td>
</tr>
<tr>
<td>☐ Water piping completed, treated water available</td>
</tr>
<tr>
<td>☐ Steam piping completed till consumption point</td>
</tr>
<tr>
<td>☐ All other piping, drains completed</td>
</tr>
<tr>
<td>☐ Mobrey's installed, wired</td>
</tr>
<tr>
<td>☐ Pressure switches installed, wired and tubing completed</td>
</tr>
<tr>
<td>☐ Pressure transmitting element installed, wired</td>
</tr>
<tr>
<td>☐ Differential Pressure Transmitters installed, wired</td>
</tr>
<tr>
<td>☐ Control panel installed (on a foundation if reqd), wired</td>
</tr>
<tr>
<td>☐ Earthing connected to panel</td>
</tr>
<tr>
<td>☐ Electrical supply connected and available</td>
</tr>
<tr>
<td>☐ Gas train piping completed and flushed with high pressure just before the ratio controller, with the ratio controller NOT INLINE.</td>
</tr>
<tr>
<td>☐ All required compliance certificates completed</td>
</tr>
<tr>
<td>☐ Certified boiler attendant available</td>
</tr>
<tr>
<td>☐ Burner package has all components listed on packing list</td>
</tr>
<tr>
<td>☐ Burner and control panel wired</td>
</tr>
<tr>
<td>☐ Continuity tested</td>
</tr>
<tr>
<td>☐ Contact changeover test of all control switches</td>
</tr>
<tr>
<td>☐ All wires tightened</td>
</tr>
<tr>
<td>☐ All bolts tightened</td>
</tr>
<tr>
<td>☐ Servo Motor for air and oil rotated two cycles (clockwise and counterclockwise) completely in manual mode and end positions calibrated. To confirm if the position Feedback is OK.</td>
</tr>
<tr>
<td>☐ Blower motor rotating in correct direction</td>
</tr>
<tr>
<td>☐ Fuel supplier certificate showing compliance with requirements given in manual</td>
</tr>
<tr>
<td>☐ External contractor certificate for gas valve train</td>
</tr>
<tr>
<td>☐ Lifting Equipment</td>
</tr>
<tr>
<td>☐ Burner Tool Kit</td>
</tr>
</tbody>
</table>
## Appendix F
### Post-Commissioning Checklist

<table>
<thead>
<tr>
<th>POST COMMISSIONING CHECKLIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>OIL</td>
</tr>
<tr>
<td>☐ Oil Purging Report</td>
</tr>
<tr>
<td>☐ NA</td>
</tr>
</tbody>
</table>

Report Including

| ☐ Oil Supply Pressure        | Gas Pressure Before PRV         |
| ☐ Oil Return Pressure        | Gas Pressure After PRV          |
| ☐ Oil Temperature Set        | Gas Pressure After MBC-VEF at Low |
| ☐ Max. Oil Flow Rate         | Gas Pressure After MBC-VEF at High |
| ☐ Min. Oil Flow Rate         | Max. Gas Flow Rate              |
| ☐ Chart of O2 and CO readings at all intermediate points | Min Gas Flow Rate |
| ☐ Chart of O2 and CO readings at all intermediate points Commissioning Report | Chart of O2 and CO readings at all intermediate points |
| ☐ Completed Logbook for first day | Completed logbook for first day |
### Appendix G

**Spares List**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Description</th>
<th>Burner Capacity (TPH)</th>
<th>Quantity per burner (Each)</th>
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<tbody>
<tr>
<td>1</td>
<td>Flame Viewing Window</td>
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<td>2a</td>
<td>Hub Disc</td>
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<td>Impeller</td>
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<td>Photo Cell (Oil fired)</td>
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<td>Air Damper Shaft Bearing</td>
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<td>Oil Servometer</td>
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<td>Oil Servomotor Potentiometer</td>
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<td>AR-63 cam</td>
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<td>BPRV, 3/4&quot;</td>
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Modulating Burner
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<th>Burner Capacity (TPH)</th>
<th>Quantity per burner (Each)</th>
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<td>10</td>
<td>Oil Pump (FO)</td>
<td>Refer table for pump capacities on page no. 22</td>
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<td>Pump Motor Coupling</td>
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<td>Heater &amp; Header Gasket, For Furnace Oil application at 130°, 40 bar, non-asbestos</td>
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<td>18</td>
<td>15 NB CS FIG.14 strainer SCR D. BSP, with 120 mesh SS 304 screen, N-IBR</td>
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<td>19</td>
<td>IPRV 3/8&quot;</td>
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<td>IPRV 3/4&quot;</td>
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<td>Oil Pressure Switch, Danfoss</td>
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<td>Sr No.</td>
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<td>Burner Capacity (TPH)</td>
<td>Quantity per burner (Each)</td>
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<td>-------</td>
<td>------------------------------------------------------------------------------</td>
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<tr>
<td>21</td>
<td>Pressure Gauge, Flange-mounted, 0-40kg, 63 mm dia</td>
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<td>22</td>
<td>Safety Solenoid Valve NC (230 VAC)</td>
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<td>1 No. (with burner without OPH)</td>
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<tr>
<td></td>
<td>Coil for Safety Solenoid valve, 20W, (230V)</td>
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<td>Safety Solenoid Valve NC (115VAC)</td>
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<td>1 No. (Only with OPH)</td>
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<td>Coil for Safety Solenoid valve, 20 W,(115V)</td>
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<td>1 No. (Only with OPH)</td>
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<td>23</td>
<td>Actuation Oil Solenoid Valve NO (115 VAC)</td>
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<td>Coil for Actuation Oil Solenoid valve, 14W,115V</td>
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<td>Coil for Actuation Oil Solenoid valve, 14 W,(115V)</td>
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<td>Combined Dial Thermometer cum thermostat</td>
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<td>26</td>
<td>Flame Nozzle</td>
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<td>27</td>
<td>Burner Mounting Gasket</td>
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<td>28</td>
<td>Burner Hinge Gasket</td>
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<td>29</td>
<td>Silicon cap for igniter</td>
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<td>2 Nos. for mono fuel &amp; 4 Nos for dual fuel</td>
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<td>30</td>
<td>Ignition Electrode Φ12 mm (Oil fired)</td>
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<tr>
<td>30A</td>
<td>Ignition Electrode (Gas fired)</td>
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Modulating Burner
<table>
<thead>
<tr>
<th>Sr No.</th>
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<th>Burner Capacity (TPH)</th>
<th>Quantity per burner (Each)</th>
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<td>31</td>
<td>Lug for igniter</td>
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<td>2 Nos. for mono fuel &amp; 4 Nos. for dual fuel</td>
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<td>Silicon Cable D7</td>
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<td>8 meters for mono fuel &amp; 14 meters for duel fuel</td>
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<td>Electrode Cap Black</td>
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<td>Lug for Electrode</td>
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<td>Punker Plate (Gas/Dual fired)</td>
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<td>4/4.5/5</td>
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<td>6.3</td>
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<td>Punker Plate (Oil fired)</td>
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<td>Hydraulic Lance</td>
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<td>O Ring AS 568-A, -14,VITON</td>
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<td>38</td>
<td>Air Damper Servomotor</td>
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<td>39</td>
<td>Resistance Pot - Air servomotor</td>
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<td>40</td>
<td>Flexible Hose Pipe, suitable for 140 deg C, 40 Kg/cm2(G) pressure, nominal bore 3/8&quot;, end connections 3/8&quot; BSP (F), one end straight &amp; other 10 end 90 deg bend</td>
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<td>3</td>
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<tr>
<td></td>
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<td>2.8/3/3.5/4/4.5/5/6.3</td>
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<tr>
<td>Sr No.</td>
<td>Description</td>
<td>Burner Capacity (TPH)</td>
<td>Quantity per burner (Each)</td>
</tr>
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<td>--------</td>
<td>------------------------------------------------------------------------------</td>
<td>----------------------------</td>
<td>-----------------------------</td>
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<tr>
<td>41</td>
<td>Flexible Hose Pipe, suitable for 140 deg C, 40 Kg/CM2(G) pressure, nominal bore 1&quot;, end connections 1&quot; BSP (F), 2 Mtr long.</td>
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<td>42</td>
<td>FLEXIBLE HOSE PIPE, SUITABLE FOR 140 DEG C, 40 KG/CM2(G) PRESSURE, NOMINAL BORE 3/4&quot;, END CONNECTION 3/4&quot; BSP (F) BOTH END STRAIGHT, 1 MTR LONG, Medium: Natural gas/LPG</td>
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<td>1 No. (for gas and dual fuel burners only)</td>
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<td>43</td>
<td>Gas Pressure Switch-GW150A5, 5-150mBar with connecting plug</td>
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<td>44</td>
<td>Valve Proving System 504</td>
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<td>45</td>
<td>Pressure gauge : range : 0 - 100 m Bar, mounting vertical, 4&quot; dial size, ½&quot; connection for Gas/Dual fired)</td>
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<td>46</td>
<td>Ball Valve for Pilot gas line</td>
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<td>47</td>
<td>Pilot Gas Solenoid Valve</td>
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<td>Pilot Gas PRV</td>
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<td>6.3</td>
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<td>Push button cock ½&quot;</td>
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<td>Gas Multibloc, MBC-VEF</td>
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<td>Mounting flange for Pilot Gas size ½&quot;</td>
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<td>Ignition Transformer</td>
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<td>R to I converter</td>
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<td>Flame Relay</td>
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<td>Control System (PLC)</td>
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<td>57</td>
<td>Prizm (HMI)</td>
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</table>
Appendix H

Questionnaire

The following questionnaire should be used to check the knowledge level of any person operating the equipment.

- If APS trips, that means …
  a) Air quantity is insufficient
  b) Damper is fully open

- At LOW fire, return pressure is 6 bar and at HIGH it is 19 bar. What adjustment must be performed to get 7 bar at low and 17 bar at HIGH?
  a) Cam adjustment
  b) BPRV Bottom Screw adjustment

- If APS is cutting off at 7 mbar during setting, what should be set point of APS?

- If required oil temperature is 110°C, what is the required setting on
  a) Heater Control
  b) Checkstat

- If burner while firing on gas shows O2 below 2%, V setting on MBC-VEF should be
  a) Increased
  b) Decreased

- If flue gas is smoky at HIGH and normal at LOW, but oil at HIGH is at normal setting, what should be done?
  a) Increase oil
  b) Increase air

- For ECR burners, air setting can be changed from which screen?
  a) Air Servo screen
  b) Stack Oxygen screen

- What function does the following perform?
  a) BPRV
  b) UV Detector
  c) DUNGS MBC-VEF

- How many servomotors are used in an ECR burner package?

- Return pressure on the gauge is 17 bar. Which of the following is true:
  a) Oil throughput is high
  b) Oil throughput is low

- Which is the correct nozzle to be used for Forbes Marshall modulating burners?
  a) Charles Berganzo, B-5, 60°
  b) Fluidics Instruments, W1, 50°
- For HSD models which of the following will be missing?
  a) IPRV
  b) Heater and Thermostat

- What does the RED light on the VPS display signify?
  a) Gas train has high pressure
  b) Gas valves are leaking

- In MCR burners, how is air quantity adjusted?
  a) Using modulating drum of servomotor
  b) Using linkages of air damper

- In MCR burner how is the Oil flow going through the atomizer adjusted?
  a) BPRV (Back Pressure Regulating Valve)
  b) IPRV (Initial Pressure Regulating Valve)
Appendix I

Standards
All Forbes Marshall burners are manufactured in accordance with the relevant standards.

- BS EN 267:2009 - Automatic Forced Draught Burners for Liquid Fuels
- BS EN 230:2005 - Automatic Burner Control Systems for Oil Burners
- BS EN 676:2003 + A2 2008 - Automatic Forced Draught Burners for Gaseous Fuels
- BS EN 298:2003 - Automatic Gas Burner Control Systems for Gas Burners and Gas Burning Appliances With or Without Fans
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