Mk8 Micro Modulation Controller

Specification – Hot Water Applications

1.0 Combustion Control and Burner Management

1.1 Provide a fully integrated 'Micro Modulation Controller' that will be fully capable of fuel/air ratio control throughout the entire firing range of the burner, such that no mechanical linkages are required to operate the combustion air inlet damper, fuel flow control and auxiliary dampers. The control for the specified burner and specified fuels will include all necessary interface wiring, software and hardware for a complete fuel/air metering and flame safeguard system. The system will be easily programmable using a full **12.1" colour multi-touch screen Human Machine Interface (HMI)** with the flexibility of optimising combustion quality throughout the load range while ensuring the boiler outlet temperature to within 1°C or 1°F of setpoint.

1.2 The 'Micro Modulation Controller' will be preprogramed to **allow firing on up to four independent fuel curves**.. Each fuel/air ratio curve will be commissioned to enable firing on different fuels, rated capacity or reduced capacity firing as required for the application.

1.3 The system shall be capable of powering and controlling up to **10 direct drive servomotors**. The system will be able to control the servomotors and the **fuel/air ratios to a 0.1° of accuracy with 100% repeatability throughout the firing range**. The position of each motor will be monitored by a voltage dividing system enabling digitised positioning information to be encoded into the control's memory. The relative positions of all the servomotors will be constantly and automatically checked by the system at a rate of 50 times per second.

1.4 The system shall be capable of controlling a minimum of two separate Variable Speed Drives (VSDs) or additional servomotors, via Channels 5 and 6. Each channel will have an analogue input and output which can be user adjustable to a 4 – 20mA signal or a 0 - 10V signal. The input signals will be continually monitored and checked against the commissioned values of the signal and if the signal is outside of

the commissioned value the controller will stop the burner and an error will be logged on the 'Micro Modulation Controller'.

1.5 **The system will use a non-linkage type fuel flow control** valve which shall be furnished for the precise control and metering of fuel input to the burner. Fuel valves will be designed for dual fuel assembly and common servo motor drive when applicable.

1.6 The controller shall use the Autoflame full three-term infinitely adjustable Proportional, Integral and Derivative **(PID) load control** to provide setpoint control to within 1°C or 1°F via a signal from a temperature sensor.

1.7 **Multiple setpoint setup/selection:** The required setpoint will be adjustable and lockable via the touch screen control and/or through a BMS/PC. The controller will allow a reduced setpoint for periods of reduced load, changeable via a voltage input or internal time clock. Additional setpoints will be optional for second setpoint control and night setback. The setpoint can be controlled via an external 4-20mA signal if applicable.

1.8 The system will be capable of setting commissioned options and parameters to suit the specific application including but not limited to the following:

1.8.1 Designation of boiler operating range
1.8.2 Adjustable burner modulating ramp up speed
1.8.3 Intelligent boiler sequencing (Lead Lag)
1.8.4 External modulation control
1.8.5 Automatic Cold Start Routine to prevent thermal shock or excessive condensation
1.8.6 Alarm output signal
1.8.7 Adjustable purge time
1.8.8 Adjustable pilot and main flame proving time
1.8.9 Adjustable flame strength threshold
1.8.10 Selection of flame scanner operation of UV, IR or flame switch. A combination of scanner is also available to option, UV and IR, IR or UV.
1.8.11 Fuel valve and vent valve proving with adjustable high and low gas pressure limits
1.8.12 Fuel valve and pilot configuration.
1.8.13 Adjustable wind box pressure limits.
1.8.14 Outside Temperature Compensation (Outdoor Reset)
1.8.15 Password settings to prevent unauthorised access to commissioning routines
1.8.16 Independent adjustable Proportional Band, Integral Time and Derivative (PID)
1.8.17 Flue Gas Recirculation (FGR) management
1.8.18 Golden Start position and timer

1.8.19 Combustion Air trim

1.8.20 Commission data and configuration settings downloadable to a local PC and Android smartphone via infrared or Bluetooth

1.9 Sequence Timings (limited by standards and codes) – recycle, pre-purge, ignition, first safety time, pilot prove time (pilot trial for ignition PTFI), second safety time (main trial for ignition (MTFI)), main flame proving and post purge.

1.10 A self-adaptive UV - the flame scanner will monitor the minimum required flame signal strength as set in the system options. The sampling frequency of the UV scanner will be adjusted automatically to monitor the mean signal slightly in excess of the minimum to extend the safe operating life of the UV bulb.

1.11 Self-check UV - The UV scanner will self-check itself every 60 seconds to ensure safe and reliable operation. The self-check operation will work by using an electronically controlled paddle to briefly interrupt the flame signal to the UV sensor.

1.12 **Running and Safety Interlock** – the controller will allow additional safety interlocks that are required on the burner and boiler to be wired into designated terminals. One of these terminals will offer a recycling interlock and, as such, any loss of input will result in the system recycling. As soon as this input is re-energised then the system will restart without the requirement for a manual reset. The second terminal will offer a non-recycling interlock and if any loss of input is seen on this terminal, the system will lockout, and the unit will require a manual reset.

1.13 Proof of Closure (POC/CPI) – CPI interlocks installed on the two main safety shut-off valves (SSOV) are wired into the controller in order to ensure that the SSOVs are closed at all times of checking. If the valves are not fully closed, then the interlock to the controller will be lost and this will result in a lockout.

1.14 **Gas Valve Proving** – a gas pressure sensor is installed between the two main safety shut-off valves (SSOV) and vent valve (if installed). The safety shut-off valves (SSOV) and vent valve will be tested for any leakage before each burner start-up, shut-down or both. In the event of any gas leakage detection the system will immediately lockout and prevent the burner firing sequence to start.

1.15 **Gas Pressure limits** – in conjunction with the gas pressure sensor during commissioning the gas pressure will be recorded at each commissioned point (firing rate) and limits are set within the controller such that if there is any deviation from the commissioned value (increase or decrease), the system will lockout and the burner will not operate. Further to this, during normal start-up (after commissioning) the gas pressure will be measured and any deviation from the initial set-up gas pressure will result in a lockout and the burner will not operate. Optional warning thresholds are also configurable, so smaller pressure fluctuations can be

logged as warnings to ensure the operator is aware, this is also to be stored in the system log.

1.16 **Oil Pressure Supervision** – an oil sensor is installed inline to measure the online oil pressure. During commissioning the oil pressure will be recorded at each commissioned point (firing rate) and limits are set within the controller such that if there is any deviation from the commissioned value (increase or decrease), the system will lockout and the burner will not operate.

1.17 **Combustion Air Pressure Switch** – a combustion air flow switch is mounted onto the air inlet to measure the combustion air pressure. The switch will be set for a pressure typically just below the low fire pressure. If the pressure drops below this switch's setting, then the interlock to the controller will be lost, a lockout will occur, and the burner will not operate.

1.18 **Combustion Air Sensor** – an air pressure sensor is mounted onto the air inlet to measure the combustion air pressure. A minimum air pressures can be set when the air pressure goes below the minimum value the system will immediately lockout and stop the burner from firing. Further to this, the air pressure will be recorded at each commissioned point (firing rate) and limits can be set within the controller such that if there is any deviation from the commissioned value (increase or decrease), the system will lockout and the burner will not operate. Optional warning thresholds are also configurable, so smaller pressure fluctuations can be logged as warnings to ensure the operator is aware, this is also to be stored in the system log.

1.19 **Intelligent Boiler Sequencing (IBS)** – All Micro Modulation Controllers shall be capable of implementing IBS for multi boiler (up to 10) installations. The IBS feature shall ensure maximum efficiency from the boiler plant by ensuring that the minimum number of boilers are online for any given load demand. By using the rating of the boilers and the current firing rates of the boilers the IBS will work out the required number of boilers needed to be online. If boilers are not needed to contribute to the load, they will enter a standby warming state so that when needed the boilers will be able to quickly contribute to the load demand.

1.20 **Fuel flow meter input** - 4-20mA signal from a fuel meter can be wired into the controller to provide accurate fuel metering with totalised volume and weight.

1.21 **Multi Burner Control** - A maximum of 10 burners (minimum of 2) can be linked together for simultaneous or individual firing. The start-up sequence is synchronised to ensure all burners fire and modulate at the correct time. If an error occurs, all burners will shut down, if a lockout occurs, ether all burners shut down or the other burners will continue to fire.

1.22 **Pilot relight facility** - When the load is satisfied and has reached the off differential set on the controller, the burner will modulate down to low fire, relight the pilot and

de-energise the main fuel valves, allowing only the pilot to be alight. A time period and temperature offset are set for when the pilot stays energised. Once the time has elapsed or the temperature reached, the system will shut down. If the load demand increases while the pilot is firing, the main valves will energise and the controller will modulate accordingly.

1.23 **Dual Fuel Output Mode (DFOM)** - this allows 2 fuels to be configured and commissioned using 2 separate sets of fuel outputs on the MM (2 main valves and one vent valve) and inputs (Proof of closure/ CPI). No changeover relays are required to change between fuels in DFOM.

1.24 **Internal High Limit Setpoint** – facility to shutdown the burner during commissioning when a pre-set temperature threshold has been met.

2.0 User Interface

2.1 The front of the panel-mounted control will consist of a large 12.1" colour LCD touch screen Human Machine Interface (HMI) providing an easy to read numeric and graphical information. The screen will be adjustable to suit the specific application and ancillary components installed. Separate displays will be individually selectable for the specific application to provide continuously updated information with 24-hour trend logging capability as follows:

2.1.1 Status Display – Fuel Fired, Percentage firing rate, required temperature, actual temperature, hours run and installed software issue.

2.1.2 Micro Modulation – Degrees angular position of servomotors for all servo channels. Analogue input and output signals for VSD Channels.

2.1.3 **Sequencing Status** – Boiler Designation, lead boiler designation, reduced setpoint, lag boiler standby warming status and current status.

2.1.4 **Fuel Metering** – Online fuel consumption for fuels being fired and totalised fuel consumption for each fuel curve commissioned.

2.1.5 **Flame Safeguard** – Graphical display of the flame safeguard sequence logic with indication of current status showing:

2.1.5.1 Flame intensity signal strength for flame
2.1.5.2 Post Purge time and actual position in the cycle
2.1.5.3 Pre-Purge time and actual position in the cycle
2.1.5.4 Combustion air damper/VSD speed position
2.1.5.5 Current firing rate status
2.1.5.6 Main fuel valve status

2.1.5.7 Pilot valve status
2.1.5.8 Spark ignition status
2.1.5.9 Combustion air fan
2.1.5.10 Lockout or run status message
2.1.5.11 Lockout reset capability
2.1.5.12 First Out Annunciation Status

2.1.6 Air, Gas and Oil pressure Sensor – **Graphical display** will indicate commissioned and online pressures and limits.

2.1.7 Exhaust Gas Analyser – online values of O_2, CO, CO_2, NO, NO_2, SO_2, exhaust temperature, ambient temperature, differential temperature, and combustion efficiency.

2.1.8 **Combustion Map** – Real time graphical indication of where the burner is firing in the fuel curve, how much trim is currently in effect and the instantaneous combustion values.

2.2 **Lockouts** – A record of the last 128 lockouts to occur will be kept including a description of the lockout, the time and date of when the lockout occurred and the time and date of when the lockout was reset.

2.3 **System Log** - A record of the last 1000 system events which include system start up and shut down times and additional lockout information

2.4 The controller will allow the **ability to view all settings within the controller** and the user will be capable of making changes to various non-safety related settings online, whilst the burner is firing or in the standby state.

2.5 The controller will allow multiple languages for display purposes and set-up.

2.6 **Online help and diagnostic information will be available** complete with technical manual. Additional Diagnostic screen detailing maximum/ minimum temperature, voltage and current of inputs and outputs.

2.7 **Run Times** - A schedule can be setup to provide a seven-day firing and setpoint configuration. Burner on, off and reduced setpoint can be configured for specific days and times.

3.0 Expansion features

3.1 **First Out Annunciation** – up to 15 inputs can be wired into the Expansion board active high or low. The First Out Annunciations will be fully customisable with labels

to describe the First Out and five different actions if the First Out fails; monitor, recycle, non-recycle, stop EGA trim, Stop EGA sampling.

3.2 **UL compliant First Out shutdowns** – all 15 inputs can be set so that any failure will result in a direct signal to the burner control that will result in a lockout and the burner will not operate. All inputs can only be used as active low (burner will shut down if input is lost) and can only be set as either recycle or non-recycle.

3.3 **Heat flow metering** - The system shall have a built-in heat flow metering function without the requirement of a heat flow meter. The heat flow metering function calculates the flow by the use of actual running temperature, fuel flow into the burner from the firing rate, calculated stack and standing losses (losses via EGA if fitted). This can be done with a set default water return temperature or by the addition of a temperature sensor on the water return pipe. This can also be adapted for use with an economiser or by installing additional temperature sensors.

3.4 **Draft control** – an additional direct drive servomotor can be used on channel 7 and commissioned in the same manner as the combustion control servomotors. This servo can be used to drive a stack damper to control the draft throughout the commissioned firing range. When used with an Autoflame air sensor, the air pressure will be recorded at each commissioned point (firing rate). During running the stack damper will trim automatically to compensate for changes in conditions which cause the stack pressure to differ from the commissioned stack pressure. Further to this, limits can be set within the controller such that if there is any deviation from the commissioned value (increase or decrease), the system will generate an alarm.

3.5 **Fuel Changeover On the Fly (COF)** – this feature allows switching of 2 fuels without shutting down the burner. When COF is enabled and fuel select is triggered while the burner is firing, the burner simply modulates to low fire. The air damper angle is increased to allow extra air for both fuels to fire at the same time, and the second fuel is introduced so both fuels fire simultaneously for a short period of time. The first fuel is then turned off and the burner modulates up to the required firing rate without turning off the burner. The MM still runs through all the standard safety checks.

3.6 **Setpoint Schedule** – Setpoint Schedule allows the user to configure the setpoint to vary during the day or the week or both. Some applications require variable heat output level during different hours of the day or different days of the week or both, for example different production levels or building heating requirements, the user might want the setpoint to vary during the day or during the days of the week or both.

3.7 **Spare temperature inputs** – a facility to tie in additional temperature sensors for monitoring of stack temperature or coil temperature. An optional non-recycling

burner shutdown threshold can be configured to prevent excessive stack and coil temperatures.

3.8 **Water Hardness Monitoring** – a conductivity probe can be used to monitor the hardness of the feedwater to the boiler. Live ppm readings are available on the front display, and warnings and alarms can be configured.

3.9 **Fully Metered Cross-Limited Combustion Control –** the fully metered system will add a layer on top of the standard commission map, with the aim of maintaining the fuel-air ratio for each firing rate. The system can either directly measure mass flow or use corrected volume flows to maintain this ratio. The air damper will be adjusted to achieve commissioned excess air throughout the firing range.

3.10 **"Direct Modbus"** – allows direct communication between up to 10 "MM" controllers and a Modbus system. "Direct Modbus" allows data to be read in order to view boiler room information. Also accepts Read and Read/Write commands. The Read/Write commands are those which allow you to control certain aspect of the devices remotely.