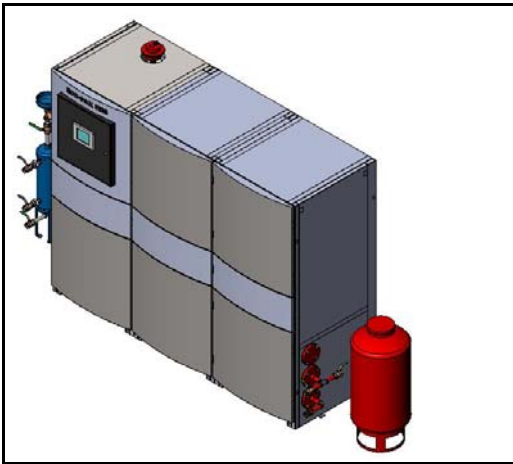


## ECO\*PAK MBS™ 1140 – Ultra-Efficient Boiler Plant Technical Submittal Package

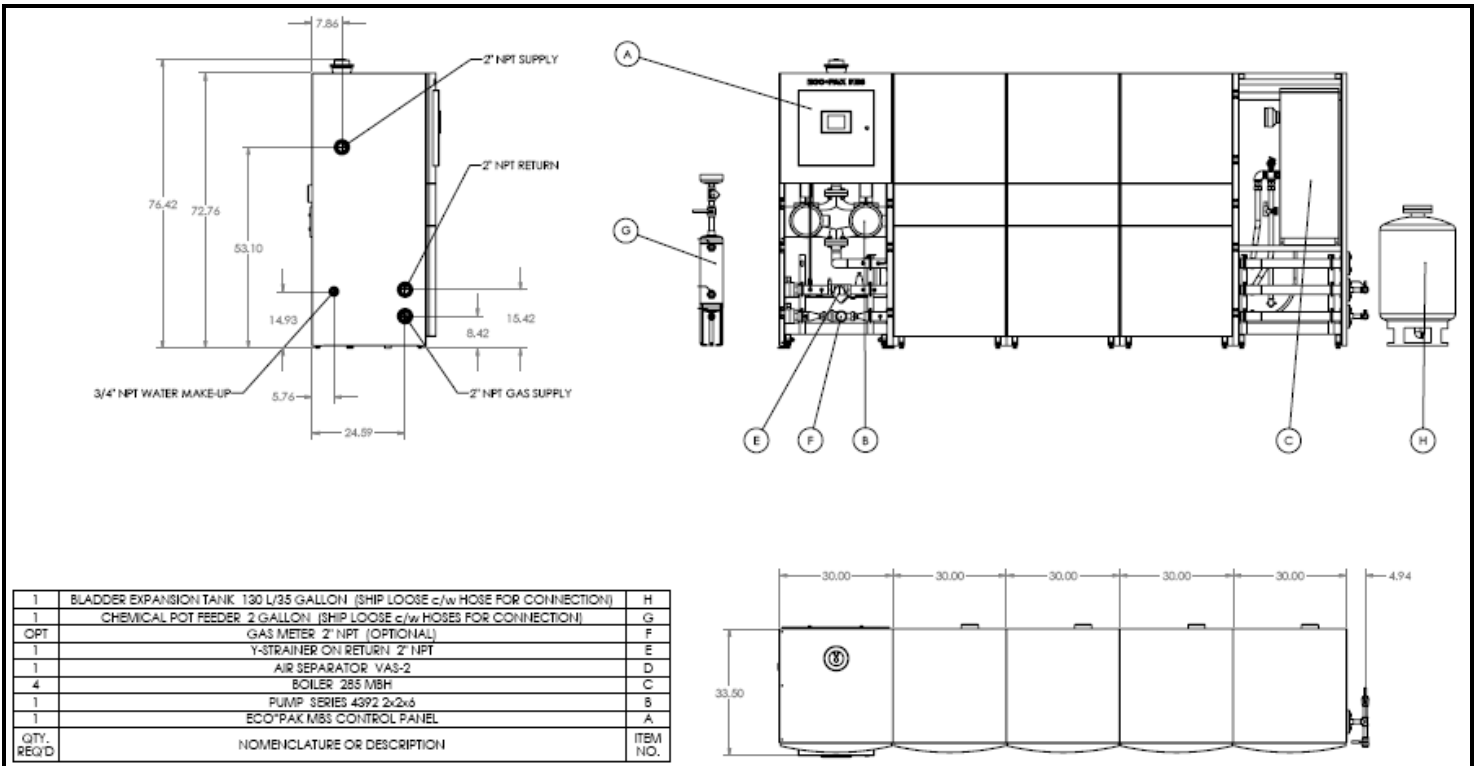
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The Armstrong ECO\*PAK MBS™ ultra-efficient boiler package is suited for new construction. This system is also well suitable for replacements and retrofits of the existing boiler plants.

The unit size, the heating capacity ranges from 38,000 Btu/hr up to 1,036,000 Btu/hr. The minimum 5% low turndown heating output is available to satisfy low heating demands while maintaining high efficiency levels.

The construction is a modular design intended for easy access through mechanical room doorways, and quick assembly on site.



## Mechanical Specification

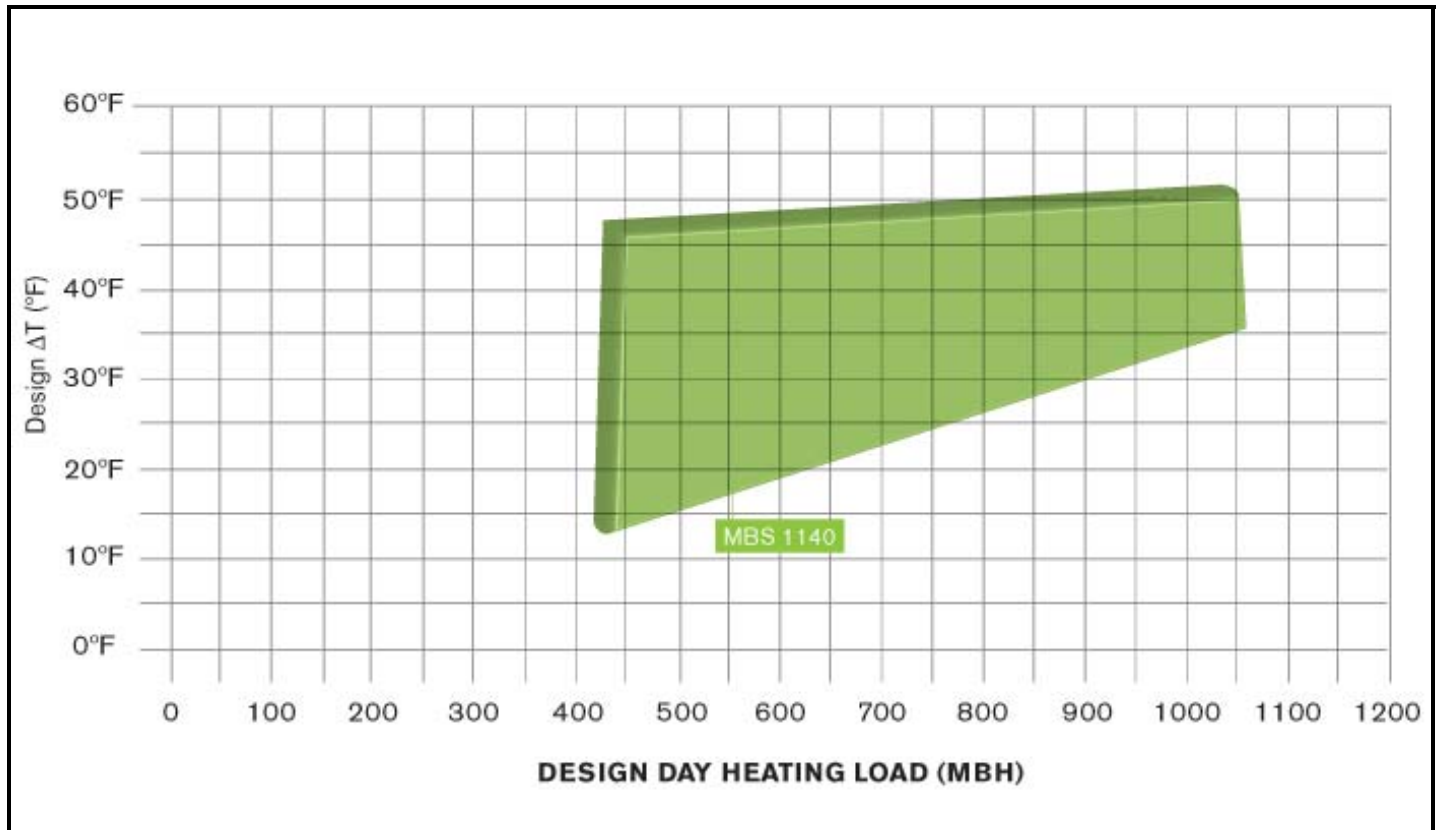
The ECO\*PAK MBS is a factory integrated assembly that provides building heating water in place of a site assembled boiler plant. The ECO\*PAK MBS includes all the necessary mechanical, electrical, and control equipment that comprise a complete boiler plant system, including but not limited to: hot water pump, condensing boilers, integrated controller with temperature sensors & serial communication to BAS, expansion tank, air separator, isolating valves, strainer, chemical pot feeder, make-up water system, and interconnecting piping with air vents, drain cocks and test points. As an option, the ECO\*PAK MBS is supplied with gas meter and hot water flow sensor.

The complete ECO\*PAK MBS package carries a twelve (12) month limited warranty from the ship date or eighteen (18) month limited warranty from the start up/commissioning, whichever comes sooner.

## Package Description

### Design Envelope

The Design Envelope is a pre-set of series of the most efficient ECO\*PAK MBS selections for given set of design day load and system delta T ranges. The integrated controller uses proprietary control logic to optimize pump speed and boiler flame to best match changing building load requirements. Design Envelope approach ensures the desired system efficiency, trouble free operation and equipment life cycle for a broad range of building scenarios.





## Standard construction features

The ECO\*PAK MBS has the following constructions features:

- components are fully enclosed to prevent tampering, or damage
- the design is of modular construction for installation in difficult to access areas and to allow for future additions of capacity through additional modules
- the primary structure is constructed with a rigid welded frame, made of corrosion resistant galvanized steel
- internal process piping is flanged black steel schedule 40 pipe
- the rigid base is fitted with adjustable level mounts
- the rigid base includes anchor brackets on the bottom frame members for anchoring to the concrete pad during installation
- the enclosure has removable wall panels with high grade enamel paint (the panels have grooved slots and locking hangers to prevent vibration during operation)
- all internal electrical wiring is quick connect electrical socket-and-plug assembly for speedy interconnection wiring between modules on site
- all water piping and fittings are black steel with ½" foam insulation
- the assembly is UL listed
- the control system is an "all-variable speed" algorithm that optimizes flow and boiler flame to maximize occupant comfort, minimize gas consumption and optimize plant energy efficiency

## Boilers

The ECO\*PAK MBS 1140 ultra-efficient boilers include four ECO\*PAK Model 285 fully modulating low NO<sub>x</sub> gas fired condensing boilers featuring stainless steel heat exchanger. The boilers bear ASME "H" stamp and are National Board listed. The boilers are certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard for the US and Canada. The boilers are also certified for use on Natural Gas and LPG and comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard and the minimum efficiency requirements of the latest edition of the ASHRAE 103 Standard. The boilers meet minimum U.S. Environmental Protection Agency and Department of Energy guidelines for "Energy Star" efficiency. The boilers operate at a minimum of 93% Annual Fuel Utilization Efficiency. The boilers have also an independent laboratory rating for Oxides of Nitrogen (NO<sub>x</sub>) of 55 ppm or less corrected to 3% O<sub>2</sub>.

The boilers are certified for indoor installation and are capable of full modulation firing down to 20% of rated input with a turn down ratio of 5 to 1.

The boilers are constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber is sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port is provided for flame verification. The burners are a premix design and are constructed of high temperature stainless steel with a woven metal fiber outer covering to provide modulating firing rates. The boilers are supplied with a gas valve designed with negative pressure regulation and are equipped with a variable speed blower system, to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The boilers operate in a safe condition at a derated output with gas supply pressures as low as 4 inches of water column.

The boilers are installed and vented with either Direct Vent system with sidewall termination or Direct Vent system with vertical roof top termination of both, the vent and combustion air.

Standard boilers are designed for operation up to 4,500 feet with no field adjustments. Output ratings are reduced by 4% for each 1,000 feet above sea level up to 4,500 feet only. High altitude boilers have a high altitude label affixed to the unit and are designed for operation from 4,501 feet up to 12,000 feet with no field adjustments. For high altitude models, output ratings are reduced by 2% for each 1,000 feet above sea level.



## Variable Speed Pump System

The Armstrong 4392 Integrated Variable Speed (IVS) twin-head pump is designed for duty/standby operation. The pump housing is constructed with cast iron and impellers are made of gunmetal bronze. The pump utilizes economical inside-type, single-spring mechanical seal, serviced by removing the rotating assembly while the pump casing remains in the line.

The motors are NEMA premium efficiency (MG1 part 31 insulation) TEFC type, Class F insulation with Class B temperature rise, suitable for inverter duty application. The motors are also UL listed. The integrated variable speed pump assembly incorporates a factory optimized pump assembly, electrical motor, and controls. The impellers are dynamically balanced to provide smooth, vibration-free operation. Radially split volute with equal suction and discharge flange sizes have tapped openings for gauge, flush and drain connections.

## Integrated controller

The integrated controller is housed with a NEMA Type 12 enclosure. The controller system is PLC based, and includes its own dedicated power circuit breaker, terminal strip and main disconnect switch. The controller includes a door mounted 5.7" touch-screen Human Machine Interface (HMI) for all necessary user interface functions. The integrated controller is pre-programmed with project specific data for easy start-up and commissioning. On start-up a read only screen displays Outdoor Air (OA) temperature, Heating Water Supply (HWS) temperature, Heating Water Return (HWR) temperature, system hot water  $\Delta T$ , system heat output in MBH (optional), and pump kW usage. The initial screen displays boiler(s) status, pump status, and system status. System run time and individual pump run hours are also displayed. Alarms, data trending of system parameters are also displayed on the HMI and logged in the memory of the HMI available for upload when required. A second screen (password protected) provides access to field adjustable parameters such as input time, night setback, holiday setting and virtual hand/off/auto (HOA) and time extension buttons. All subsequent screens are also password protected and give access to mode/system set-up, PID set-up, frost protection, clock set-up, reset, and restore default screen.

The integrated controller provides a standard BAS communication via Modbus. Optional communication capabilities include BACnet IP, BACnet Ethernet, BACnet MS/TP and LonWorks. All BAS terminals are clearly marked.

The integrated controller provides the following functions:

1. Ensures minimum hot water flow rates are maintained to operate in the high efficient condensing mode at all times within a variable primary flow configuration
2. Optimizes boiler firing rate to match exact heating loads
3. Optimizes boiler sequencing to achieve the highest efficiency possible from the system

The integrated controller is factory tested with all control sequences and alarms simulated.

## General Specification

ECO*PAK MBS™ Technical Data		ECO*PAK MBS™ 1140
<b>Boiler Modules</b>		
Number of boilers		4 x MB285
Total nominal heat input range (net)	MBH (kW)	204 to 1024 (60 to 300)
Total nominal heat input range (gross)	MBH (kW)	248 to 1140 (73 to 334)
Total heat capacity output 150/115°F (66/46°C )	MBH (kW)	1040 (305)
Total gas consumption (NG)	CFH (m <sup>3</sup> /h)	1060 (30)
Total gas consumption (LPG)	CFH (m <sup>3</sup> /h)	456 (13)
Flue gas temperature 150/115°F (66/46°C )	°F (°C)	120 (49)
Nominal gas inlet pressure (NG)	in W.C. (mbar)	4 to 13 (10 to 32)
Nominal gas inlet pressure (LPG)	in W.C. (mbar)	8 to 13 (20 to 32)
CO <sub>2</sub> (NG)	%	8.0 to 10.0
CO <sub>2</sub> (LPG)	%	9.0 to 11.0
Maximum pressure at flue outlets	in W.C. (mbar)	5 (12)
Combustion air/flue connection size	in (mm)	4/4 (101/101)
Boiler module weight (each)	lbs (kg)	396 (180)
<b>Pump/Control Module</b>		
Design flow rate (35°F Δt)	GPM (l/s)	60 (3.79)
Residual head	ft (kPa)	34.7 (104)
Minimum operating pressure (at boiler inlet)	psi (bar)	12 (0.8)
Cold fill pressure (setting at water make up and expansion tank)	psi (bar)	15 (1.0)
Maximum system rated pressure	psi (bar)	80 (5.5)
Factory set safety valve relief pressure	psi (bar)	30 (2.1)
Maximum operating temperature	°F (°C)	210 (99)
Electric supply 208/230/460V / 3 / 60Hz or 575V / 3 / 60Hz		
Full load current at 208/460V/575V	A	18.21/12.8/11.4
LTHW supply and return connections	in (mm)	2 (50)
Gas connection	in (mm)	2 (50)
Condensate drain connection	in (mm)	1/2 (13)
Boosted cold water/mains water connection	in (mm)	3/4 (19)
Minimum cold water supply pressure	psi (bar)	15 (1)
Pump module weight	lbs (kg)	462 (210)
<b>General Information</b>		
Overall assembly length	in (mm)	155.25 (3943)
Overall assembly depth	in (mm)	27 (686)
Overall assembly height	in (mm)	72 (1829)
Total weight (dry)	lbs (kg)	2046 (928)
Total weight (wet)	lbs (kg)	2121 (962)

## **MBS Integrated Controller - Sequence of Operation**

### **General Information**

The MBS NA Integrated Controller is designed as a modular system controlling 2 to 4 condensing boilers and 2 variable speed pumps in duty/standby configuration. All system functions are monitored and controlled by a PLC, (Programmable Logic Controller). System data may be read from or input to the PLC by a 5.7" touch screen display panel (HMI).

Output signals are to the variable frequency drives (VFD), condensing boilers, and to the building automation system (BAS). The following summarizes the range of input/output variables possible for the Integrated Controller:

### **Possible (maximum) Input/Output (I/O) Variables:**

1. 1 digital input (DI) for remote start/stop signal from BAS
2. 4 digital outputs (DO) for alarms:
  - a. pump/motor/VFD alarm
  - b. temperature sensor alarm
  - c. boiler alarm
  - d. system general alarm for possibility to send to BAS
3. 3 analog input (AI) for system hot water supply and return temperatures (NTC type) and for outdoor air temperature (transmitter 4-20 mA configurable range)
4. 3 AI's for pump inlet, outlet pressure sensors and for strainer pressure sensor
5. 4 DO's for up to 4 boiler start/stop run signal
6. 4 DI's for up to 4 boiler run feedback signal
7. 4 DI's for up to 4 boiler alarm status fault signal
8. 4 analog outputs (AO) for boiler capacity modulation signal, 0-10Vdc
9. 1 DI for gas emergency shut off for possibility of connection to external emergency switch
10. 1 serial port for communication with the BAS (standard protocol Modbus)
11. 1 serial port for communication with the VFD's using Modbus protocol (communicate pump speed, alarm, feedback and kW)

### **Optional Integrated Controller I/O:**

1. 1 AI for system HW supply flow measurement
2. 1 AO for 2-way modulating bypass valve
3. Pulse input for optional gas meter
4. 1 DI for gas meter open feedback signal
5. Serial communication to BAS using BACnet/IP, BACnet/Ethernet, BACnet/MSTP, and LonWorks

### **Processor Generic Logical Features:**

1. Standard MBS NA Integrated Controller supplied with 5.7" Human Machine Interface (HMI) with color touch-screen
2. A schematic of the system displayed on the HMI showing all variable speed primary pumps variables on the screen
3. System hot water supply & return temperatures are displayed. These temperature sensors are located on inlet and outlet headers of the MBS NA package
4. Outdoor air temperature is displayed
5. Control boilers output temperature (SHWST) by sending modulating signal to maintain system hot water supply temperature set-point, control algorithm in Sequence of Operation section below



6. Monitor boiler(s) minimum and maximum flows (when flow sensor ordered separately) and perform necessary control outside operating flow range. Minimum and maximum pump speeds are pre-defined and entered for each MBS Model
7. Re-set system hot water supply temperature based on outdoor air temperature
8. Sequence boiler(s) based on their best efficiency performance curve as required by system demand
9. Monitor System HWRT
10. Compare System hot water return temperature to its set-point
11. SHWRT set-point reset based on outdoor air temperature
12. PID control algorithms for pump speed control based on SHWRT and modulating boiler capacity control in PLC.
13. Ability to select one of three default hot water system sizes (small, medium, & large) for pump control loop
14. Manual and automatic alternation of primary pumps based on hours of operation, 1 week alternation, adjustable
15. Alarms include temperature sensor failure, pump/motor/drive failure, boiler failure, and general system alarm
16. 3 levels of password protection on operator interface
  - a. level 1 is operator level: H-O-A function, display of all parameters
  - b. level 2 is installer level: all parameter setup except for PID variables
  - c. level 3 is factory level: all parameter settings including defaults
17. As options, display system hot water flow and gas consumption on the HMI

## **Pump Speed Control Algorithm:**

Upon start-up the Integrated Controller calculates the initial SHWRT set-point based on outdoor air temperature sensor. The Controller compares actual SHWRT with its set-point and displays an "error" value which controls pump speed.

Controller varies pump speed in order to maintain SHWRT set-point

## **Sequence of Operation:**

1. When MBS NA Integrated Controller (Controller) is set to "Local" the HW duty pump is automatically started at preset minimum speed and **ALL** boilers enabled
2. When Controller is set to "REMOTE", BAS senses heat demand called by system
3. BAS sends signal to controller to start hot water duty pump at preset minimum speed and enable **ALL** boilers. Once enable signal by BAS is received AND the building schedule is satisfied AND OAT drops below 60°F (adjustable) then enable MBS system
4. Once started the Controller calculates the system hot water supply temperature (SHWST) set-point by measuring outside air temperature

Default values are as follows:

- Min OAT = 0°F
- Max OAT = 60°F
- Min SHWST = 100°F
- Max SHWST = 150°F

5. ALL boilers start once flow has been verified by their own control system (boiler flow switch)
6. If hot water flow has not been verified by Controller within specified time delay then send start signal to HW standby pump at same preset minimum speed and issue HW duty pump alarm on HMI
7. If lag pump does not start shut down, issue pump and general alarms
8. Controller sends an analog signal to modulate boilers capacity to maintain the SHWST set-point
9. Controller modulates HW duty pump speed to satisfy hot water system demand
10. Controller calculates boiler heat output capacity in MBH if optional water flow sensor is selected and installed
11. Controller displays actual boiler heat output capacity in MBH on HMI

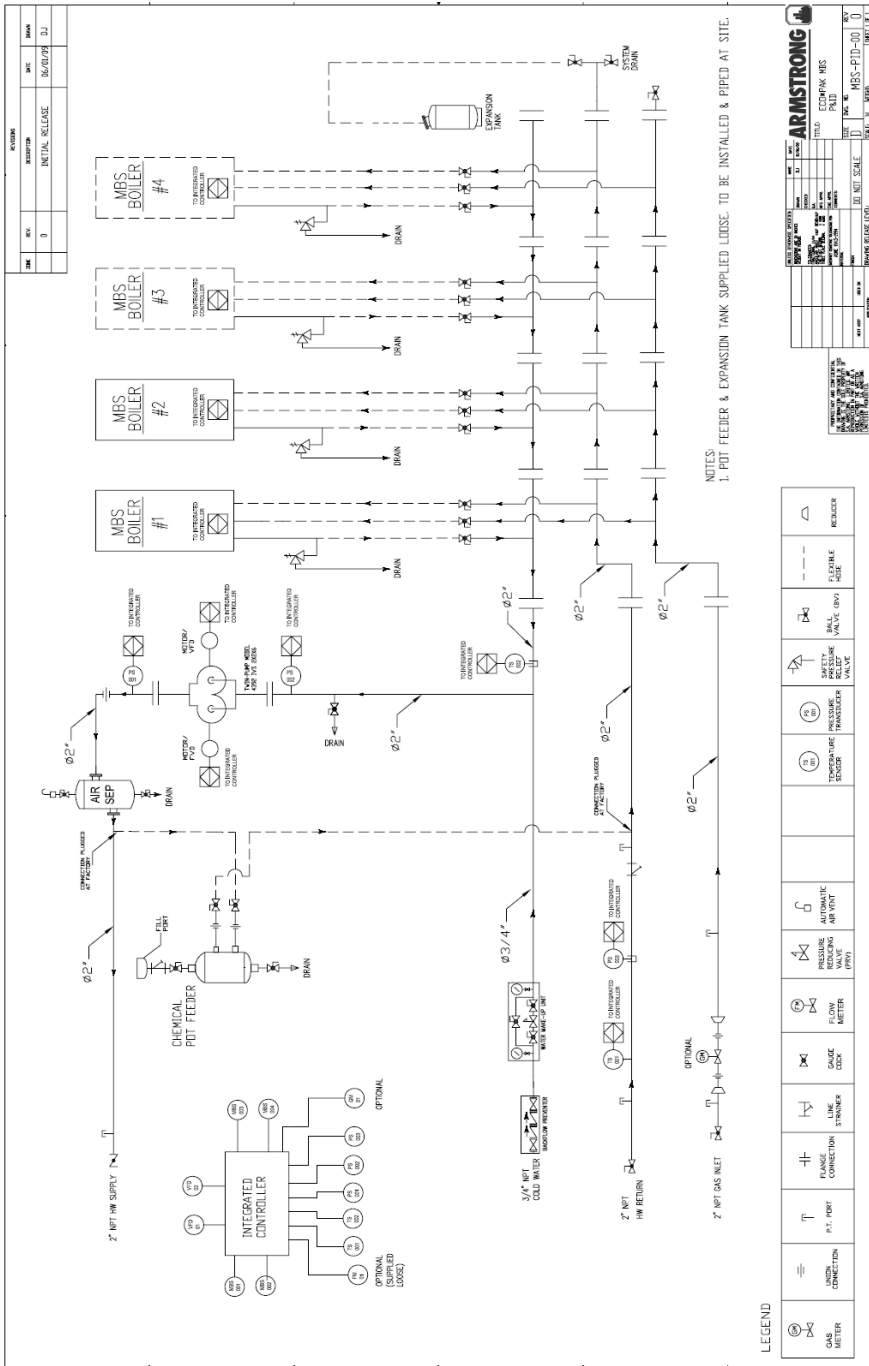
## **BOILER SEQUENCING ALGORITHM**



12. Controller runs the boilers at best efficiency by sequencing boilers on and off at predetermined optimum efficiency staging points
13. When lead boiler is running at less than its minimum capacity for more than 2 minutes (adjustable), shut down boiler
14. Duty pump is still running at pre-determined minimum speed
15. If no heat demand is required while lead boiler is OFF for more than 20 minutes (adjustable), shut OFF HW duty pump
16. Should more heat capacity to building load be required start LEAD boiler provided a time delay has elapsed since LEAD boiler has been OFF
17. HW duty pump will start once LEAD boiler is enabled
18. All boiler alarms are displayed on HMI (touch-screen)
19. Controller performs manual and automatic alternation of HW pumps based on hours of operation (1 week alternation adjustable)
20. If gas emergency shut off signal is connected to Controller, when activated, Controller will shut off operation of MBS system, and issue an alarm (general system alarm).
21. First shut down boiler and after 1 minute delay (adjustable) shut down pump.
22. 1<sup>st</sup> and 2<sup>nd</sup> stage frost protection is provided as standard. This feature is only active when MBS system is disabled by BAS
23. Controller monitors SHWST and maintains temperature above 41°F (adjustable)
24. When SHWST drops below 41°F but above 37°F (adjustable) then start duty pump and run at preset minimum speed
25. If SHWST drops below 37°F then LEAD boiler is signaled to run at minimum capacity with pump running at minimum speed
26. The frost protection is enabled even though the MBS is in REMOTE and BAS is commanding OFF



## Process and Instrumentation Diagram



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