## Application Design Guide

# Benchmark® E Boilers with Edge Controller

## Models 216 through 684




**Other documents for this product include:**

- OMM-0169 BMK E with Edge Installation, Startup, Operation and Maintenance Manual
- TAG-0109 Benchmark E Electrical Power Guide

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Heating and Hot Water Solutions

AERCO International, Inc. • 100 Oritani Drive • Blauvelt, NY 10913
USA: T: (845) 580-8000 • Toll Free: (800) 526-0288 • AERCO.com
Technical Support • (800) 526-0288 • Mon-Fri, 8 am - 5 pm EST
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# 1. Introduction

AERCO Benchmark E (BMK E) electric boilers optimize hydronic systems for peak performance and efficiency. They operate with high turndown to match the changing requirements of the energy input, minimize cycling and maximize seasonal efficiency. Their compact footprint allows flexibility and reduce total project installation costs. This guide helps designers apply the BMK E boilers to the most common types of systems. If a special application is needed, please call your local AERCO Representative or the AERCO factory for specific application information.

**IMPORTANT!**

This Design Guide is not intended to replace the instructions found in the product's manual. Please read the manual carefully before proceeding with installation.

# 2. Single and Multiple Applications

Benchmark E boilers can be applied either as stand-alone single units or in multiple batteries of boilers with unlimited input. Actual boiler sizing and selection are the responsibility of the designer. ASHRAE standards recommend sizing equipment with a minimum of oversizing for maximum system efficiency.

# 3. Piping

## 3.1 Pressure and Temperature Ratings

The maximum allowable working pressure (MAWP) for the Benchmark boilers are as follows:

| BMK Model | MAWP |
|---|---|
| BMK E 216 - 684 | 150 psig (1103 kPa) |

Individual ASME pressure relief valves are supplied on each boiler in setpoints of 30, 50, 60, 75, 100, 125, or 150 psig (207, 414, 517, 689, 862, or 1034kPa), as specified.

BMK E units are applicable to systems with temperatures of 50 °F to 220 °F (10 °C to 104.4 °C). While most heating applications are designed with a 20 °F (11 °C) temperature drop, BMK E boilers are capable of 100 °F (55 °C) temperature drop through the heat exchanger without thermal stress.

## 3.2 Flow Rate Specifications

BMK E boilers require the following minimum flow rate for proper boiler temperature control. To prevent erosion of construction materials, maximum flow per boiler is limited as shown below.

| BMK Model | Minimum Flow Rate | Maximum Flow Rate |
|---|---|---|
| BMK E 216 - 684 | 25 gpm (95 lpm) | 350 gpm (1325 lpm) |

## 3.3 Pipe Design Provisions

Minimum flow must be observed. Ancillary flow devices including pumps and valves must be selected and operated to provide minimum flow. Controls (internal boiler controls and/or building automation system) must be configured to operate pumps and valves to allow flow through BMK boilers in operation.

For multiple boiler installations, the piping must be designed to ensure balanced flow through all the boilers. This can be accomplished by using reverse-return piping or a balancing valve at the outlet of each boiler. Failure to balance flow evenly through the boilers will prevent full delivery of boiler capability at design conditions and may cause over-cycling and unnecessary stress on the boilers.

The BMK E boiler is approved for zero-side clearance in two-unit pairs in applications where space is at a premium. Piping should be located to allow free access between boilers. For maintenance purposes, each BMK boiler shall have individual valves on supply and return from the system.

When used with a refrigeration (chiller) system, the boilers must be installed to prevent the chilled medium from entering the boiler.

## 4. Typical Applications

BMK E boilers can be used in any closed-loop heating system within their design limitations. The following typical piping and wiring schematic diagrams represent the most common types of installation detail. These diagrams are not intended for any particular system but are rather composites of how AERCO boilers interface with heating and domestic hot water applications in the real world. The designer should incorporate BMK E boilers in each system so as to achieve maximum operating efficiency.

With ultimate control over the energy transfer process under a broad range of temperatures, the designer should first consider how the system best needs the supplied energy. The boilers should then be applied in the manner that best enables them to use their finite control and capability to supplement the system, using minimum applied energy. The following examples illustrate typical piping and wiring diagrams with brief description of the application and its features:

**IMPORTANT!**

For all applications with Boiler Sequencing Technology, the header sensor (S-1) must be located 2-10 ft from the nearest boiler.

- Diagram 4-1: Space Heating
- Diagram 4-2: Space Heating (Primary-Secondary Piping)
- Diagram 4-3: Space Heating with Reserve Unit Control
- Diagram 4-4: Space Heating with Boiler Sequencing Technology
- Diagram 4-5: Space Heating (Primary-Secondary Piping) w/ Boiler Sequencing Technology
- Diagram 4-6: Combination System with 2-Port Buffer Tank & Domestic Summer Pump Mode
- Diagram 4-7: Space Heating with Hybrid Plant Boiler Sequencing Technology
- Diagram 4-8: Peak Load Management (PLM) Time-Schedule Priority Screen
- Diagram 4-9: Peak Load Management (PLM) BAS Priority Screen
- Diagram 4-10: Peak Load Management (PLM) Analog Input Priority Screen

**Concept Drawings:** The following illustrations are only concept drawings, not engineered drawings. They are not intended to describe a complete system, nor any particular system. It is up to the system designer to determine the necessary components for and configuration of the particular system being designed, including ancillary mechanical and control components, and any safety devices which in the judgement of the designer are appropriate, in order to properly size, configure and design that system and to ensure compliance with building and safety code requirements.

## 4.1 Space Heating

**Application Description & Features:** AERCO Benchmark E boilers are best used in variable-primary systems to provide space heating. Supply temperature is maintained via constant setpoint, outdoor air reset or remote setpoint command (from building automation system or remote analog signal). If using outdoor air reset, the application utilizes the optional AERCO-supplied outdoor air sensor. The Edge controller supports integration with BAS via BACnet IP and MSTP.

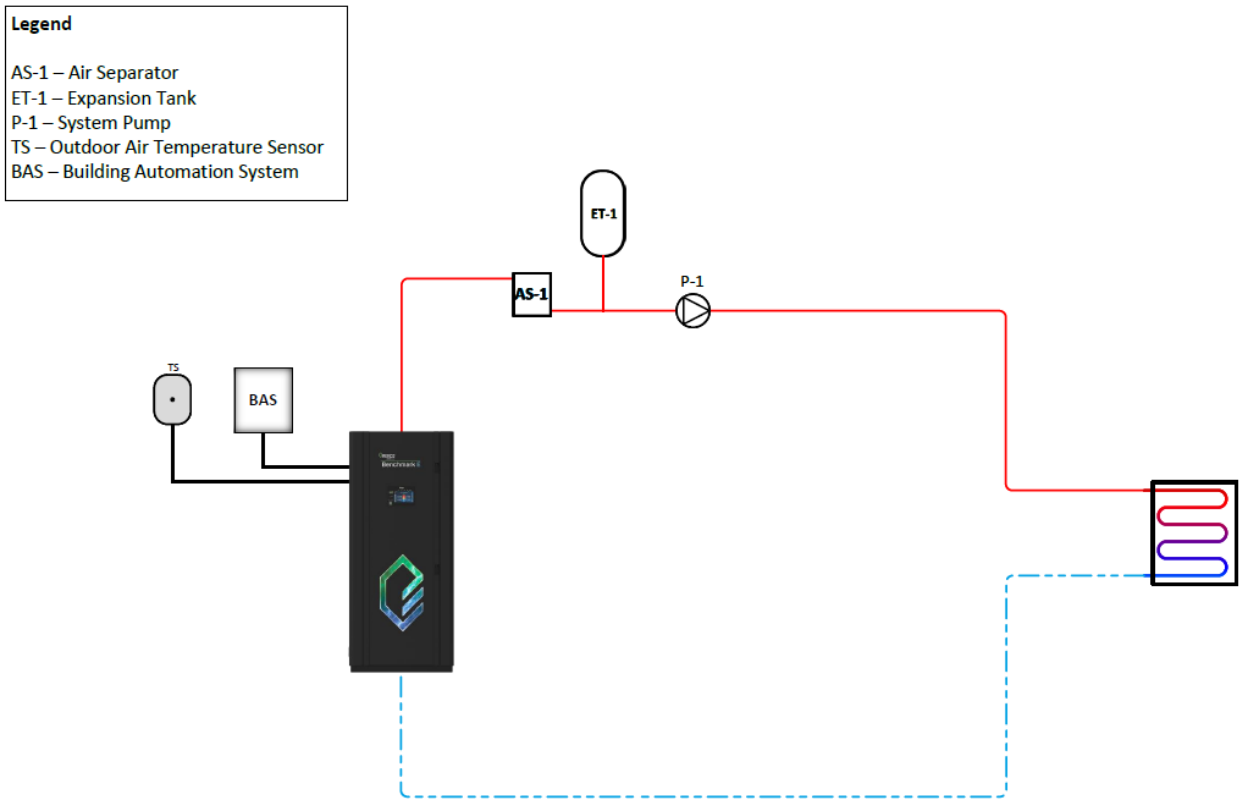



*Figure 4-1: Space Heating (Variable-Primary) Piping*

## 4.2 Space Heating (Primary-Secondary Piping)

**Application Description & Features:** Boiler plant is piped in primary-secondary method with individual boiler pumps. Supply temperature is maintained via constant setpoint, outdoor air reset or remote setpoint command (from building automation system or remote analog signal). The Benchmark E can control an on/off pump. If using outdoor air reset, the application utilizes the optional AERCO-supplied outdoor air sensor. The Edge controller supports integration with BAS via BACnet IP and MSTP.

**Legend**

P-1 – Boiler Pump
HS-1 – Hydraulic Separator
TS – Outdoor Air Temperature Sensor
BAS – Building Automation System




*Figure 4-2: Space Heating (Primary-Secondary) Piping*

## 4.3 Space Heating with Reserve Unit Control

**Application Description & Features:** AERCO Benchmark E boilers can control a reserve unit via dry contact relay. The dry contact relay is tied to the remote interlock of the reserve unit. When the Benchmark E boiler is at high power output, the dry contact relay closes, enabling the reserve unit. Supply temperature is maintained via constant setpoint, outdoor air reset or remote setpoint command (from building automation system or remote analog signal). If using outdoor air reset, the application utilizes the optional AERCO-supplied outdoor air sensor. The Edge controller supports integration with BAS via BACnet IP and MSTP. Motorized isolation valves are recommended for optimal efficiency and prevention of additional standby losses in off/disabled units. If system flow is outside the specified flow requirements of the BMK E, motorized isolation valves must be used.

**NOTE:** The gas-fired Benchmark also has the reserve unit relay control feature. A Benchmark E can enable/disable a gas-fired Benchmark via reserve unit relay and vice versa.

**NOTE:** The Benchmark E reserve unit relay can enable/disable a gas-fired Benchmark cascade manager. This allows a Benchmark E to operate as the lead boiler (first on, last off), while the gas-fired Benchmark manager boiler operates as a reserve gas boiler cascade controlled via BST.

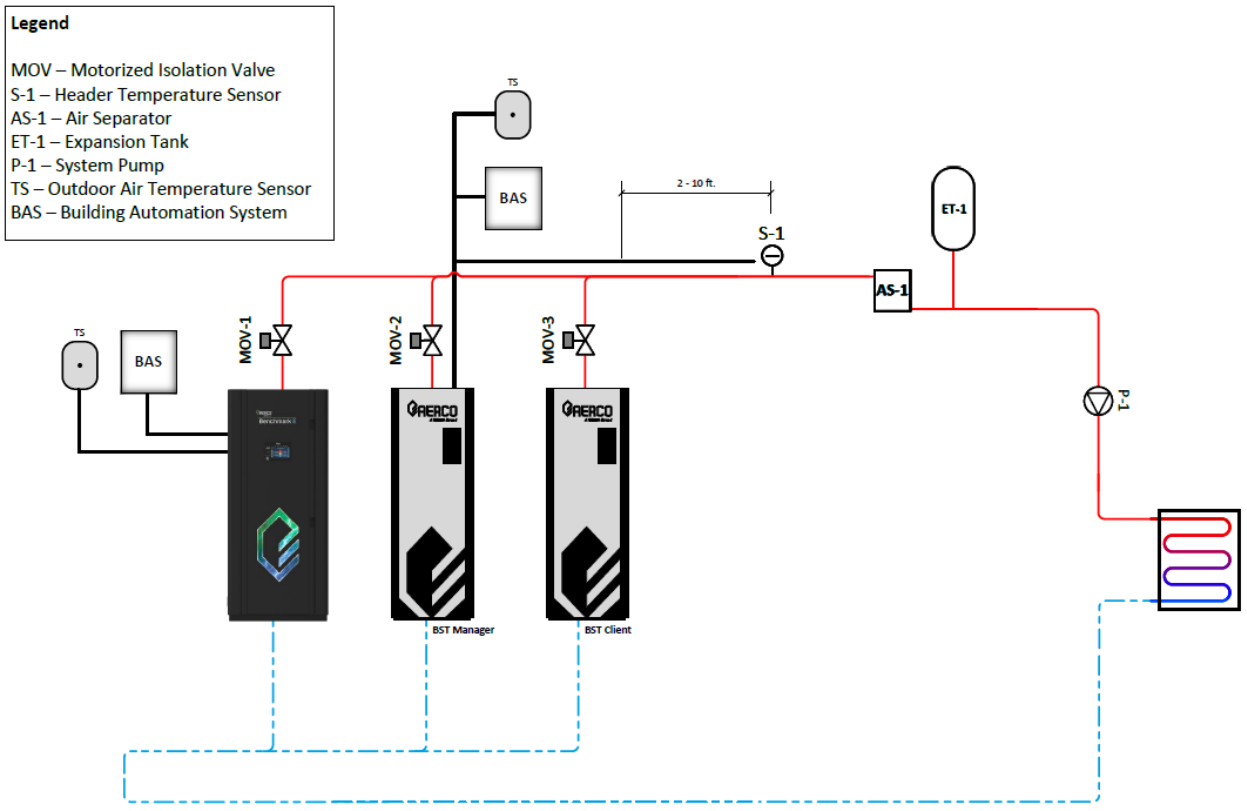



*Figure 4-3: Space Heating (Variable-Primary) Piping with Reserve Unit Control*

## 4.4 Space Heating with Boiler Sequencing Technology (BST)

**Application Description & Features:** AERCO Benchmark E boilers can be operated via Boiler Sequencing Technology (BST) to provide space heating. Supply temperature is maintained via constant setpoint, outdoor air reset or remote setpoint command (from building automation system or remote analog signal). This feature can utilize several components, including:

- Optional AERCO supplied header sensor
- Outlet temperature sensor(s)
- Sequencing valves
- Outdoor air sensor

Motorized isolation valves are recommended for optimal efficiency and prevention of additional standby losses in off/disabled units. If system flow is outside the specified flow requirements of the BMK E plant, motorized isolation valves must be used. There are two separate cascade control methods for the AERCO Benchmark E. BST Supply (sBST) reads the supply temperature header sensor in determining plant behavior. BST Internal Setpoint (iBST) reads the average outlet temperature sensor of each unit in the cascade to determine plant behavior.

- The AERCO Edge controller sequences the boiler plant for maximum system efficiency.
- Sequencing valves isolate standby boilers under normal operation, reducing minimum flow requirements of the plant. In conditions in which the maximum flow of an individual boiler may be exceeded, sequencing valves of some of the standby boilers can be programmed to remain open to prevent an overflow condition of active boilers (reference Minimum Open Valves settings in the Edge controller)
- Edge controller supports integration with BAS via BACnet IP and MSTP.

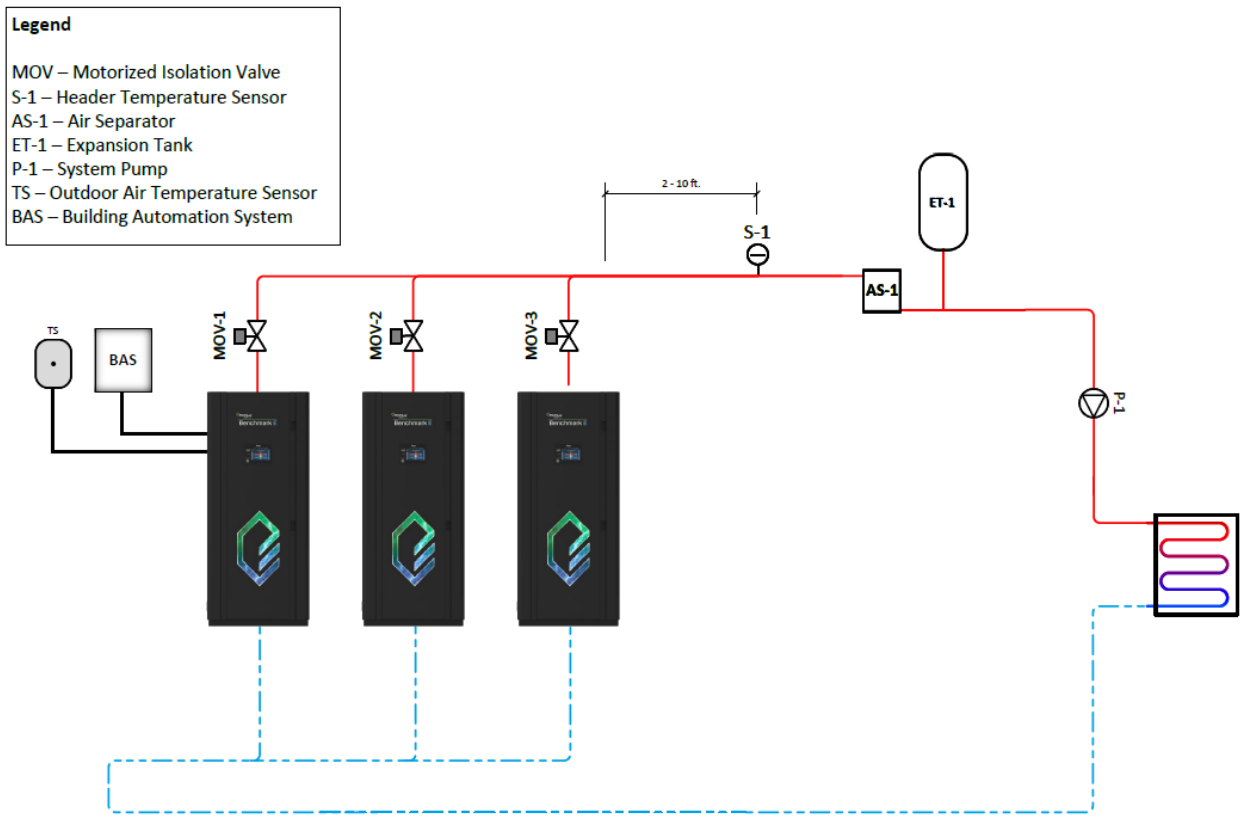



*Figure 4-4: Space Heating (Variable-Primary) Piping with BST*

## 4.5 Space Heating (Primary-Secondary Piping) with Boiler Sequencing Technology

**Application Description & Features:** Boiler plant is piped in primary-secondary method with individual boiler pumps. Benchmark boilers can be operated via Boiler Sequencing Technology (BST) to provide space heating. Supply temperature is maintained via constant setpoint, outdoor air reset or remote setpoint command (from building automation system or remote analog signal). Application utilizes AERCO supplied header sensor and outdoor air sensor.

- The AERCO Edge controller sequences the boiler plant for maximum system efficiency.
- Edge controller supports integration with BAS via BACnet IP and MSTP.

**Legend**

P-1,2,3 – Boiler Pump
HS-1 – Hydraulic Separator
S-1 – Header Temperature Sensor
TS – Outdoor Air Temperature Sensor
BAS – Building Automation System

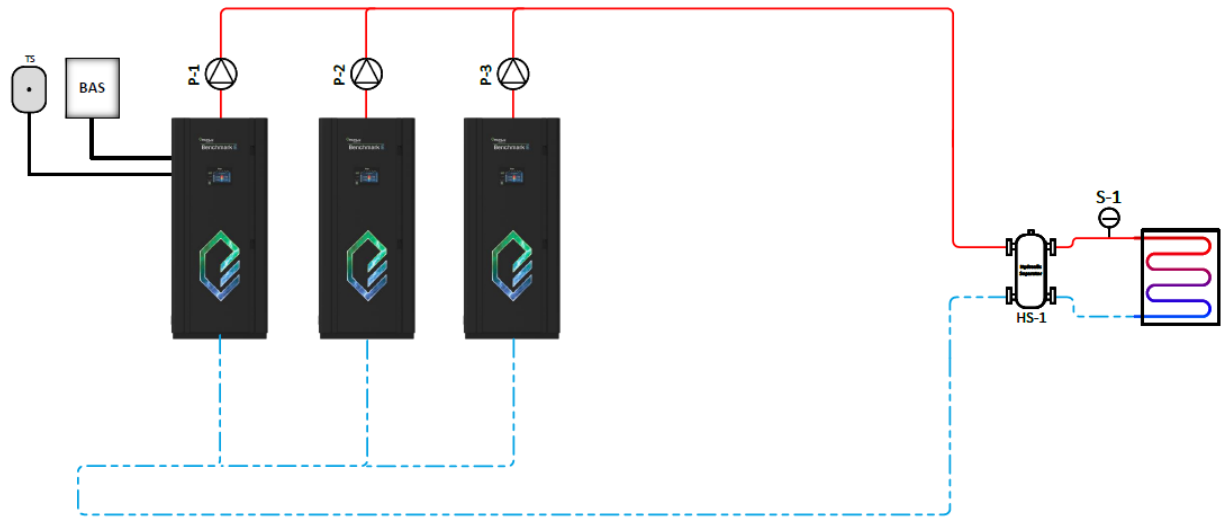



*Figure 4-5: Space Heating (Primary-Secondary) Piping with BST*

## 4.6 Combination System w/ 2-Port Buffer Tank & Domestic Summer Pump

**Application Description & Features:** AERCO Benchmark E boilers can be operated via Boiler Sequencing Technology (BST) to provide space heating and domestic hot water generation through AERCO SmartPlate EV water heaters. Space heating supply temperature is maintained as constant setpoint, via outdoor air reset or from remote setpoint command (from building automation system or via remote analog signal). DHW boiler/summer pump runs continuously to provide boiler water to the water heaters. 2-port buffer tank is utilized to dampen out fast domestic load transitions and minimize boiler cycling. Application utilizes AERCO supplied header sensor, sequencing valves and outdoor air sensor. Motorized isolation valves are recommended for optimal efficiency and prevention of additional standby losses in off/disabled units. If system flow is outside the specified flow requirements of the BMK E, motorized isolation valves must be used.

- The AERCO Edge Controller sequences the boiler plant for maximum system efficiency.
- Sequencing valves isolate standby boilers from the system, reducing the system's minimum flow requirement.
- Edge controller supports integration with BAS via BACnet IP and MSTP.
- If outdoor reset is used, the minimum supply temperature of the reset schedule must be sufficient to meet the heating requirements of the SmartPlate EV water heater.

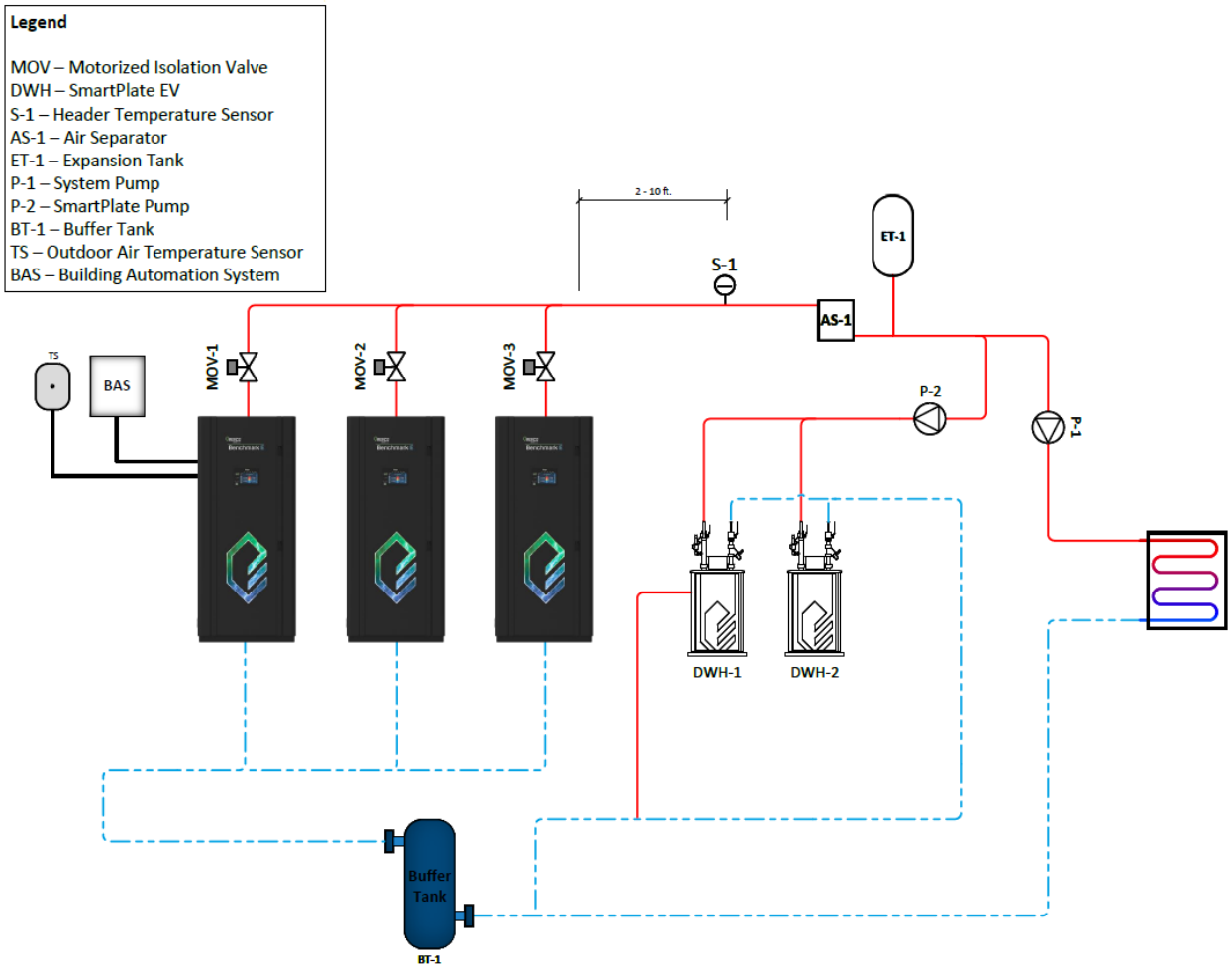



*Figure 4-6: Combination System with 2-Port Buffer Tank and Domestic Summer Pump Piping*

## 4.7 Space Heating with Hybrid Plant Boiler Sequencing Technology

**Application Description & Features:** AERCO Benchmark and Benchmark E boilers can be operated via Boiler Sequencing Technology (BST) to provide space heating. The cascade can be sequenced by fuel type. If electric is the configured priority, all Benchmark E boilers will fire before any Benchmark boilers fire. If gas is the configured priority, all Benchmark Boilers will fire before any Benchmark E boilers fire. Supply temperature is maintained via constant setpoint, outdoor air reset or remote setpoint command (from building automation system or remote analog signal). Application utilizes AERCO supplied header sensor, sequencing valves and outdoor air sensor. Motorized isolation valves are recommended for optimal efficiency and prevention of additional standby losses in off/disabled units. If system flow is outside the specified flow requirements of the BMK & BMK E, motorized isolation valves must be used.

- The AERCO Edge controller sequences the boiler plant for maximum system efficiency.
- Sequencing valves isolate standby boilers, reducing minimum flow requirement.
- Edge controller supports integration with BAS via BACnet IP and MSTP.

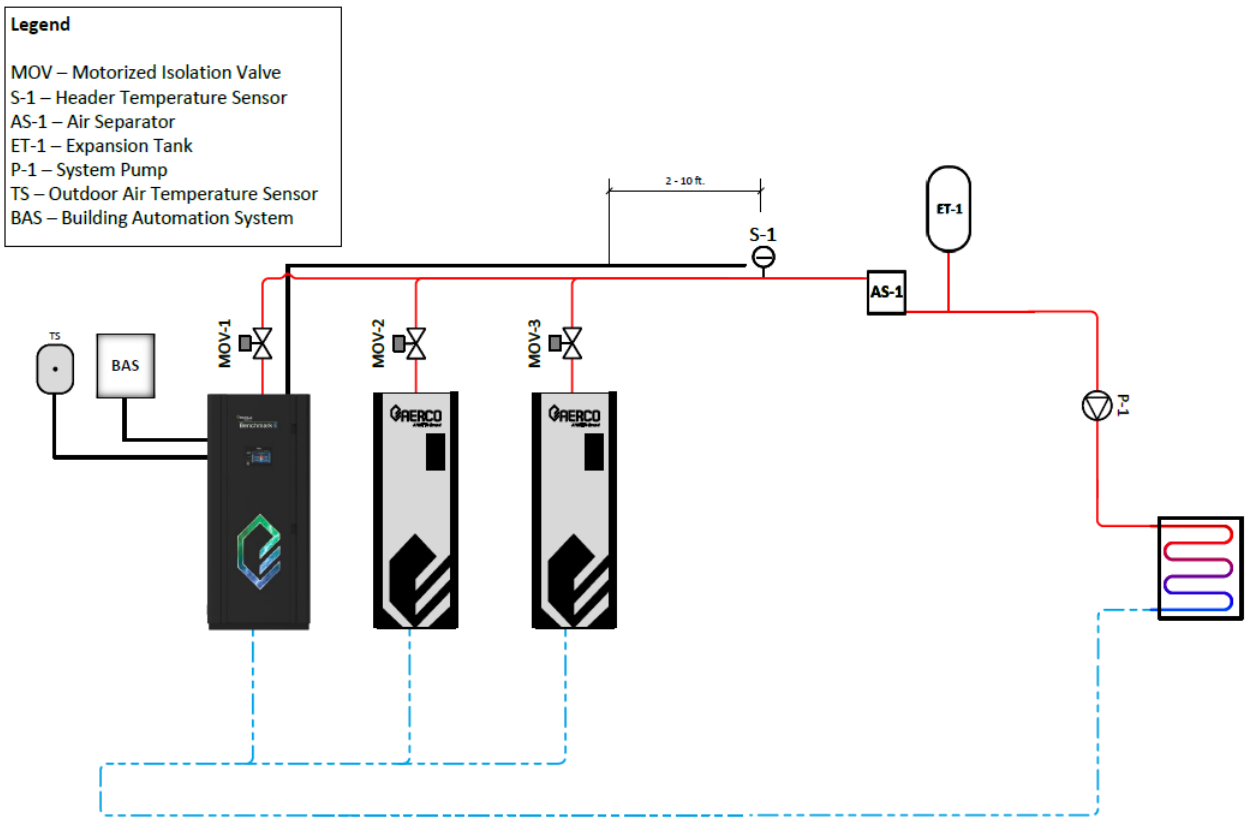



*Figure 4-7: Space Heating with Hybrid BST Plant (Variable-Primary) Piping*

## 4.8 Peak Load Management (PLM)

**Application Description and Features:** AERCO Benchmark E boilers can limit their electrical usage in both Standalone and Cascade modes (including Hybrid) based on three different methods of operation: Time-schedule, Building Automation System (BAS), and Analog Input. In Cascade Mode, PLM settings are configured with the Manager unit and are applied to all client units. When PLM is enabled, the Edge X controller will limit the boiler's maximum output based on the selected PLM operation method. Multiple PLM methods can be enabled, however it requires each method to be assigned to a priority level. If the highest method of priority fails, the unit will switch to the next highest priority enabled (For example, if BAS is priority #1 and Time-Schedule is priority #2 and the Manager unit loses communication with the BAS, the unit will follow the set time schedule). There is also a configurable transition delay timer for the PLM feature. Transition delay allows gas-fired units to warm up (ignition process, auxiliary delays, etc.) and be ready to support demand. When PLM is disabled, the boiler will operate in its standard mode, where output is controlled by heating demand and setpoint conditions.

**Time-Schedule Priority:** The Edge X controller limits boiler output by utilizing user-defined "peak-time" windows within the local 24-hour time duration. Up to 2 peak-time windows can be configured, with "Start" and "Stop" time settings for each window independently. During peak windows, the Edge X controller will limit the maximum allowable power output of the Benchmark E.

- Local Time Zones must be configured for this method
- 2 Peak-Time Windows cannot overlap.

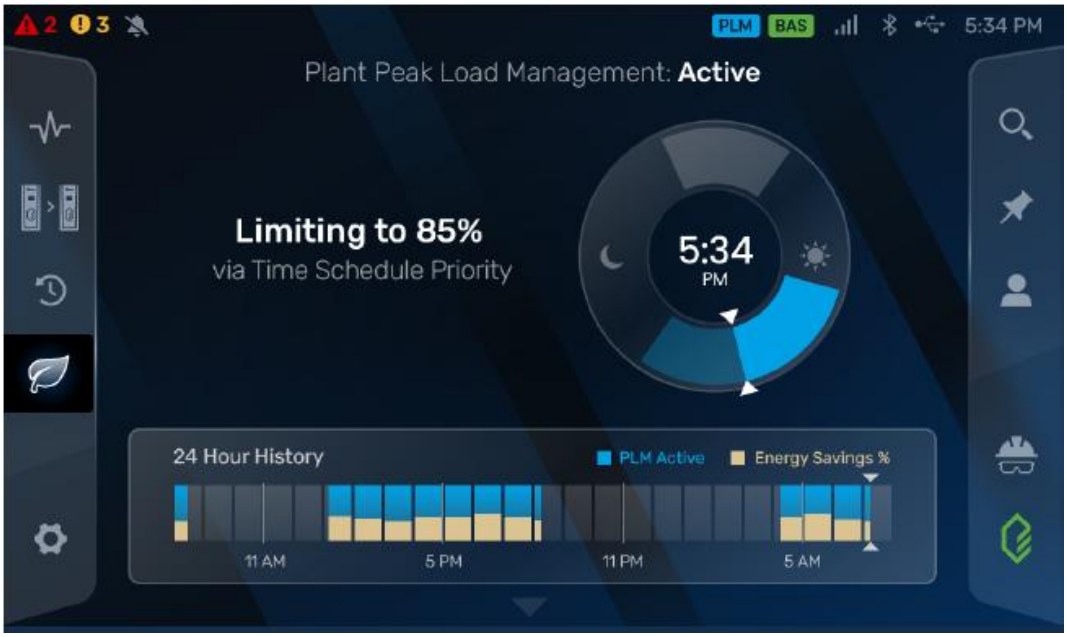



***Figure 4-8: PLM Time-Schedule Priority Screen***

**BAS Priority:** The Edge X controller reads the specified BAS data point for "PLM State," and when conditions are met the controller limits power accordingly. The Benchmark E's behavior is dictated by BAS parameters (allowable output, trigger, etc.). If communication is lost with the BAS, the controller will move to the next highest priority method of operation.

- The Edge X controller currently supports integration with BAS via BACnet IP and MSTP.




*Figure 4-9: PLM BAS Priority Screen*

**Analog Input Priority:** The Edge X controller reads external analog signal (AI5) for PLM Power Limiting. This signal can be either 0-10 V or 4-20mA. This signal will correspond to a percentage (e.g. 2.5V = 25%) and proportionally limit the maximum power output of the boiler. Several parameters are required for Analog PLM: Signal Type, Min Signal, Max Signal, Min Threshold, Max Threshold.




*Figure 4-10: PLM Analog Input Priority Screen*

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