Electric Boilers Design Guide

CEMLINE CORPORATION®

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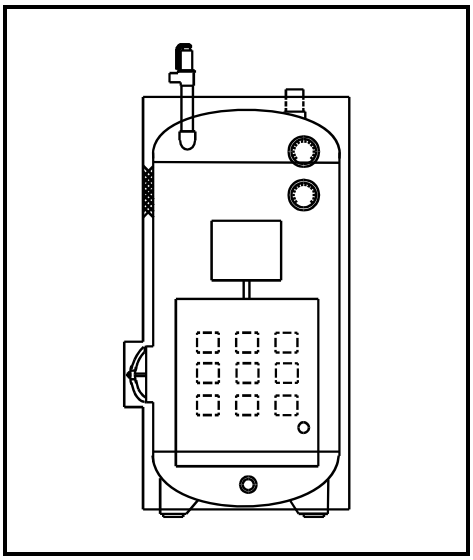

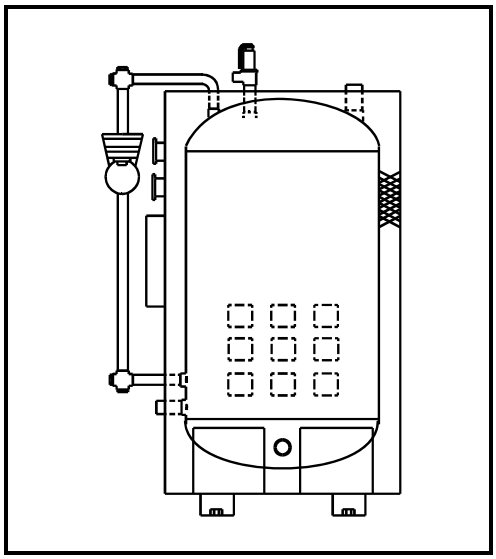

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Disclaimers

This Electric Boiler Design Guide is intended to be as complete and up to date as possible. It covers design information for CEMLINE CORPORATION's Electric Water and Steam Boilers. CEMLINE reserves the right to update this manual and other product information concerning design, at any time and without obligation to notify product owners of such changes.

CEMLINE is not responsible for inaccuracies in specifications, procedures, and / or the content of other product literature, supplied by the manufacturers of components used in CEMLINE Electric Boilers (i.e.: valves, controls, gauges, components, etc.). CEMLINE strives to use only the highest quality components in building Electric Boilers. However, CEMLINE has no direct control over their manufacture, or their consistent quality.

CEMLINE is not responsible for injury to personnel or product damage due to the improper installation, operation, and / or maintenance of CEMLINE Boilers. All installation, operation, and maintenance procedures should only be performed by trained / certified personnel. All personnel performing these procedures should completely and carefully read and understand all supplied materials before attempting the procedures. All personnel should pay strict attention to all Notes, Cautions, and Warnings that appear within the procedures detailed in the Cemline Electric Boiler Installation, Operation, and Maintenance Manual.

CEMLINE welcomes user input as to suggestions for product or manual improvement.

General Information

CEMLINE Electric Boilers are one of the most economical methods of furnishing boiler water or steam because of the superior design of the tanks and heating elements. All CEMLINE Electric Boilers are "Packaged" and ready for installation. All components are sized, wired, mounted, piped, and tested prior to shipment. Each unit is built to exact customer design specifications and requires only connection to water and a power source to be ready for operation.

Each Electric Boiler is listed and approved by Underwriters Laboratories (UL) Standard 834 (Power Boilers).

Each Electric Boiler employs a Carbon (Black) tank, providing years of trouble-free service. All components used in the unit are of highest quality and meet or exceed all customer design specifications and A.S.M.E. Code regulations.

Each Electric Boiler is accompanied by this Installation, Operation, and Maintenance Manual, a Submittal Sheet, C.A.D. Drawing, and detailed Wiring Diagram(s), as well as all documentation supplied by the manufacturer of each major component. If any of these documents are missing, contact either CEMLINE CORPORATION or your authorized sales representative before attempting installation, operation, or maintenance procedures.

This manual is intended to facilitate the selection and design of Cemline Electric Boilers, however this guide is not a replacement for the electric boiler installation, operation, and maintenance manual for installation and maintenance instructions.

Electrical Sizing Calculations

$$KW = \frac{GPH \times \Delta T}{410}$$

$$GPH = \frac{Gallons}{Min} \times \frac{60\ Min}{1\ Hr}$$

ΔT = (Temperature Outlet ºF – Temperature Inlet ºF)

1 British Thermal Unit (BTU) is the quantity of heat required to raise the temperature of 1 Lb of Water 1 ºF between 32 ºF and 212 ºF.

1 KW = 3412.14 BTU/Hr

1 KW Will Raise 410 Gallons of Water 1 ºF

1 Gallon of Water Weighs 8.33 Lbs

$$\#/Hr = \frac{\text{BTU per hour}}{\text{steam pressure latent heat (hfg) in Btu/Hr}}$$

Single and Multiple Installations

Boiler sizing is the responsibility of the designer. ASHRAE practices are recommended to establish loads and sizes. Jurisdictional codes, safety codes, performance codes and standards, along with local building codes need to be observed during the selection process.

Cemline Electric Boilers can be installed either as a single stand-alone unit or in multiple series of boilers with a maximum of 24 boilers. The advantages to using multiple boilers includes allowing for modulation of individual boilers during partial loads, the ability to keep service running in the event a boiler needs to be maintained or repaired, as well as reducing the floor space required by using multiple smaller boilers instead of fewer large boilers. When using multiple boilers, the system should be piped in parallel. When using multiple boilers in the system isolation valves should be installed on each boiler. All proper piping practices should be employed when piping Electric Boilers into the system.

Accessories for the Hydronic System

Air Removal

Air removal (eliminating trapped air in the hydronic system) should be addressed when designing a system with a CEMLINE Electric Boiler. The properly sized system air separator (vessel) with an air vent should be installed in the piping on the system side of the pump at the highest point in the system.

Expansion Tanks

A properly sized expansion tank shall be installed in the CEMLINE Electric Boiler system. Either a compression (plain steel) or air charged diaphragm tanks can be used. In either case the expansion tank should be installed on the suction side of the pump.

Make-Up Water Systems

Proper make-up water piping and components including a pressure reducing valve, a relief valve, and a shut off valves are to be incorporated into the make-up water piping. In addition, proper chemical balancing equipment need to be employed in the make-up water system to ensure suitable water chemistry of the boiler system.

Pumps

CEMLINE Electric Boilers are typically installed in variable / primary pumping arrangement, however primary / secondary pumps can be alternatively utilized but this

arrangement is not required. Flow from the system pump through boiler needs to be established before the boiler can turn on.

Minimum Return Temperature & Minimum Flow Rate

Electric Boilers design makes thermal shock not concerning for damaging the elements and vessel, therefore, the return temperature to the boiler can be designed at a 10 to 50 ºF Delta T. However, some thought should be given to a required minimum flow rate across the elements when they are turned on. Our recommendation is a minimum flow rate of approximately 0.33 – 0.35 GPM per KW of the smallest step or 2.8 – 3 KW per Step / GPM. Therefore, if a boiler has elements with steps at 15 KW the minimum flow rate would be 5 gpm. If the boiler has elements with each step at 40 KW the minimum flow rate would be 14 gpm. See the table below.

KW per Step	Minimum Flow (GPM)	GPM / KW per Step	KW per Step / GPM
12	4	0.33	3
15	5	0.33	3
20	7	0.35	2.9
30	10	0.33	3
40	14	0.35	2.9
60	21	0.35	2.9
80	28	0.35	2.9
90	32	0.35	2.8
108	38	0.35	2.8

System Operating Pressure

CEMLINE Electric Boilers are designed at 125 or 150 psi working pressure depending upon the model. A pressure relief valve is supplied on the boiler. The pressure relief valve supplied will normally be set equivalent to the working pressure of the vessel at 125 or 150 psi. Relief valves can be supplied at 30, 50, 60, 75, 100 psig as specified. Electric Boilers must operate with proper over pressure to prevent water from flashing to steam within the boiler or the system. Ensure that proper over pressurization of the system is set to prevent this occurrence.

Power Requirements

Power Requirements

For Heating Water and Steam

CEMLINE Electric Boilers, depending on the specific unit, can be configured to require 208, 240, 415, 480, or 600 volts for heating water and making steam. The following table lists the voltage and phase configurations available.

Type of Unit	Available Voltages	Phase Requirements	Cemline Code
Boilers	208	3 Phase	BY3
	240	1 Phase	B1
	240	3 Phase	B3
	380	3 Phase	BZ3
	415	3 Phase	CY3
	480	3 Phase	C3
	600	3 Phase	D3

Note: Consult the design specifications for the unit, as well as the supplied Submittal Sheet and Wiring Diagrams, for the specific power requirements for the unit.

CEMLINE Electric Boilers, depending on the specific unit, the ampacity can be found in the catalog / submittal information for the specific boiler. Number of power feeds are determined by the amperage rating of the boiler. See table below for number of power feeds required based upon amperage of the boiler.

Number of Power Feeds	Maximum Amperage
1	760
2	1520
3	2280
4	3040

Service Feed wire based on 75 ºC or greater. Note terminal ratings.

Power Distribution Blocks

Amp rating	Material	#of poles	Line Side	
			Wire range	Openings/pole
115	Aluminum	3	#2-#14	1
175	Aluminum	3	2/0-#14	1
310	Aluminum	3	350kcmil-#6	1
380	Aluminum	3	500kcmil-#6	1
760	Aluminum	3	500kcmil-#4	2
950	Aluminum	3	750kcmil-1/0	2

Grounding Lugs

MOCP	Wire Range	Material	Temp Rating	KV Rating	Openings/pole
200	#6-#14	Copper	90 C	35 KV	1
300	#4-#14	Copper	90 C	36 KV	1
2000	250 kcmil-#6	Aluminum	90 C	37 KV	1

For Controls

All CEMLINE Boilers use 120 volts for control operation. Whether 208, 240, 380, 415, 480, or 600 volts are utilized to heat water, the application line voltage is connected to an isolation transformer that provides constant 120-volt control power.

Electronic Boiler Construction

All CEMLINE Boilers are constructed from superior materials and incorporate only the highest quality components. Each meets or exceeds all applicable American Society of Mechanical Engineers (A.S.M.E.) Code regulations.

Tanks

CEMLINE Electric Boilers are equipped with Carbon (Black) tanks. Each tank is designed and constructed in strict accordance with the latest A.S.M.E. Code regulations, stamped in accordance with the applicable section of the A.S.M.E. Code, and accompanied by the applicable Certificates. Each tank is manufactured using pressure

vessel quality plate and welded by certified welders. All tanks are registered with the National Board of Boiler and Pressure Vessel Inspectors.

Relief Valves

Each boiler is equipped with an A.S.M.E. approved pressure relief valve, providing a means to vent excess pressure; and a drain for removal of accumulated sediment. Each unit is also equipped with a drain to remove accumulated sediment.

Electric Boiler Jackets

The jackets used for all CEMLINE Electric Boilers are equipped with steel jackets that are professionally coated with a superior quality enamel paint. This procedure increases corrosion resistance and provides an attractive, easy to maintain surface.

A nameplate, mounted to the jacket, bears the model and serial numbers of the unit. ***These identification numbers should be included in all correspondence regarding the unit***.

Insulation

All CEMLINE Electric Boilers contain a three-inch (3") layer of fiberglass insulation between the tank and jacket that reduces energy loss. For some models, thicker insulation (up to four inches [4"]) is available as an option.

Heating Elements

Electric Boilers

The heating elements used in CEMLINE Electric Boilers consist of one or more incoloy sheathed removable immersion rods. For 3-phase applications, these rods are grouped together as three (3) phase deltas to achieve the required total kilowatt.

Each rod contains resistance wire surrounded by an ample thickness of compressed magnesium oxide. Individual rods are removable and replaceable with ordinary hand tools for in the field replacement that insures worry free maintenance of the unit.

Other Components

All other components, included in CEMLINE Electric Boilers, have been specifically selected to meet the individual design specifications of the unit. Each component is judged to be of the highest quality to provide long life and superior performance.

Installation

Notes

- All installation, operation, and maintenance procedures should be performed only by experienced, trained, and qualified personnel. Personnel should be trained in and familiar with correct piping and electrical procedures and methods, and should be experienced in working with hot / boiler water systems.

- CEMLINE Electric Boilers are designed for indoor use only. Each unit requires at least two feet (2') of clearance around and above the unit. It should be located on a level non-combustible surface (no more than one-half degree [½º] of slope), capable of supporting the total weight of the unit when filled to capacity.

- The unit should be mounted to the non-combustable floor following applicable architectural and local code requirements for the specific installation site.

- In areas prone to seismic activity, it is recommended that the unit be mounted to the floor according to recommended procedures and codes for the site / location, to make the unit less susceptible to seismic damage.

Water Quality

Properly treating water to the electric boilers is fundamental to the routine maintenance of the unit allowing for a long life of the unit and the system components connected to the electric boiler. Proper water chemistry can prevent water side corrosion from free oxygen, acids, and other minerals by preventing scale deposits on the heating elements. Any water treatment program should be managed under the supervision of a competent water treatment specialist.

Below is a list of water properties and the recommended ranges for use in Cemline electric boilers to control corrosion and scale.

Property of Water	Range
pH	7.5 – 10
Total Hardness (Ca and Mg)	Less than 3 ppm
Alkalinity (CO_3, HCO_3)	Less than 150 ppm
Total Dissolved Solids	Less than 50 ppm
Conductivity	Less than 75 ppm (150 uS/cm)
Chlorides	Less than 30 ppm
Oxygen	Less than .1 mg/liter
Iron	Less than 20 ppm or 0.1 ppm

Safety Information

Cemline electric boilers are designed to comply with safety regulations of ASME Section IV as well as UL. These boilers are provided with an automatic reset high limit cut-off, a manual reset high limit cut-off, a low-water cut-off and pressure relief valve(s) as required by ASME. Other required safety devices based upon jurisdictional and local codes should be provided and installed locally or as an option by the factory. Designers should check with jurisdictional codes, safety codes, and local building codes to verify compliance with all applicable codes.

Steam Boilers

Sizing Steam Boilers

Cemline electric steam boilers sizing charts found in the Electric Boilers Brochure lists a boiler KW with a steam pounds per hour column. The steam pounds per hour column is based upon feedwater at 212ºF with a steam pressure of 0 psig. The designer must add for heating the water from the starting to ending temperatures if the pressure is greater than 0 psig and the feedwater is below 212 ºF. The process for adding heating water starting and ending temperatures is as follows.

1. Look up or calculate the Initial Btu/Hr of the steam boiler.
    a. The Initial BTU/Hr can be selected from the Cemline Electric Boilers Brochure sizing chart*.

    b. To Calculate the Initial BTU/hr.
        1 KW = 3412.142 Btu/Hr

2. Look up or calculate the Required #/Hr of steam.
    a. The Required #/Hr of steam can be selected from the Cemline Electric Boilers Brochure chart*.

    b. To Calculate #/Hr of steam.

$$\#/\text{Hr of steam} = \frac{\text{BTU per hour}}{\text{steam pressure latent heat (hfg) in Btu/Hr}}.$$

3. Calculate the Delta Temperature. Subtract the entering feedwater temperature from the ending steam temperature.

4. Calculate the Additional Btu/Hr required by multiplying the Delta Temperature by the Required #/Hr of Steam.

5. Calculate the Required Btu/Hr by adding the Additional Btu/Hr to the Initial Btu/Hr required at 0 psig steam.

Example: To produce 210#/Hr of steam at 15 psig with feedwater at 80 ºF. heating water from 80 ºF to 250 ºF (15 psig steam temperature). By looking up the #/Hr from the Cemline Electric Boilers Brochure 210 #/Hr is a 60 KW Boiler (204,900 Btu/Hr).

Delta Temperature = Steam Temperature – Feed Water Temperature

250 º - 80 º = 170 º

Additional BTU/Hr = Delta Temperature x Required #/Hr of Steam

170 º x 210 #/Hr = 35,700 Btu/Hr

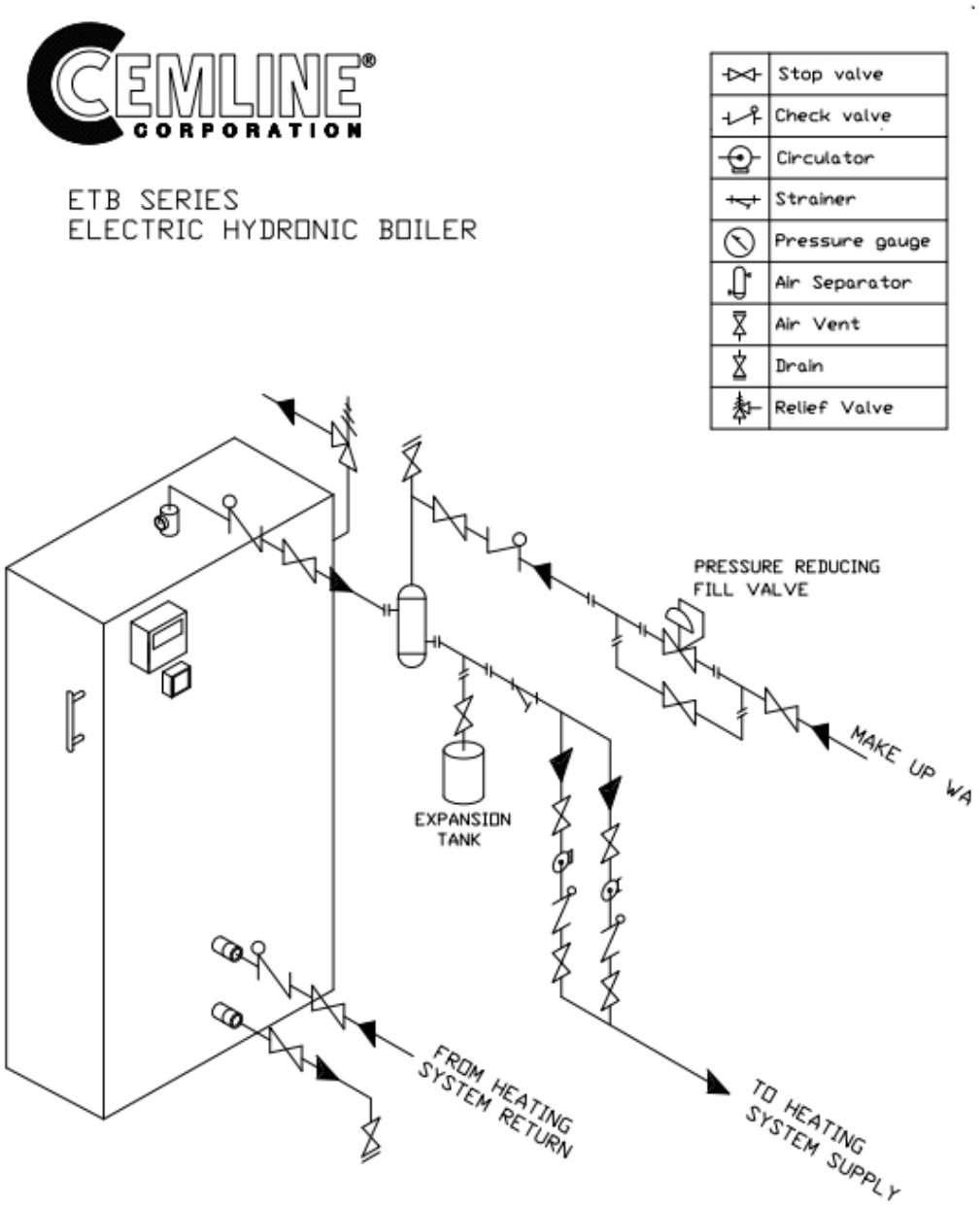
Required BTU/Hr = Initial Btu/Hr + Additional BTU/Hr

204, 900 + 35,700 = 240,600 Btu/Hr

Select a 72 KW Boiler from the Cemline Electric Boilers Brochure which produces 245,880 Btu/Hr.

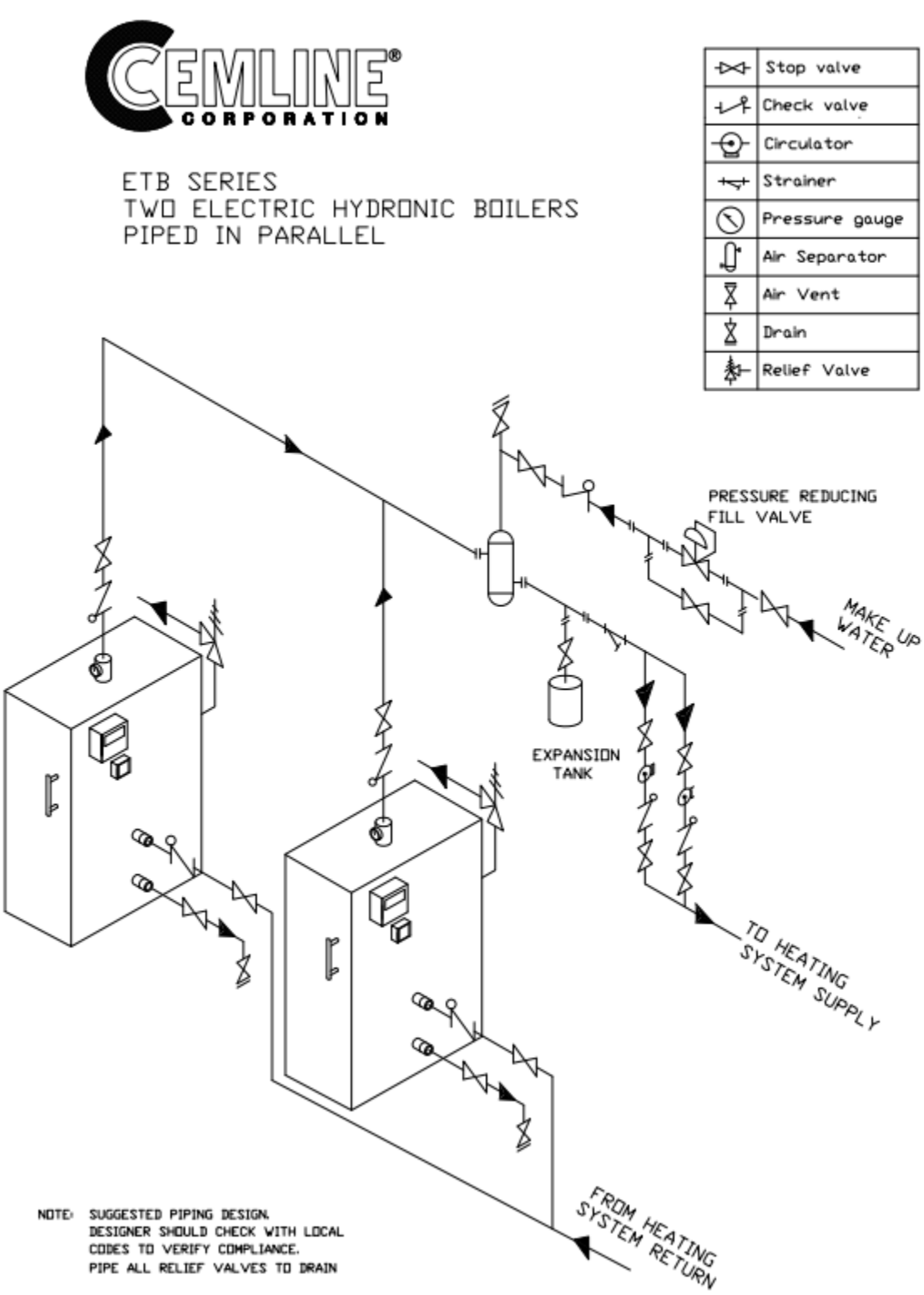
*Steam boiler's BTU/Hr and #/Hr can be found in the Cemline Electric Boilers Brochure.

Piping Diagrams



NOTE: SUGGESTED PIPING DESIGN.
DESIGNER SHOULD CHECK WITH LOCAL
CODES TO VERIFY COMPLIANCE.
PIPE ALL RELIEF VALVES TO DRAIN

Piping Diagrams



Notes

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