E-Series

Steam Generator
&
Fluid Heater

Installation Manual

CLAYTON INDUSTRIES
City Of Industry, California
USA

R016600X2
10-2016

For your convenience, enter your unit's specific model and serial number in the space below. The model and serial number are located on the right-hand side of the electronic controls cabinet.

MODEL: ________________________ **SERIAL NUMBER:** ______________________

Steam Generator
and
Fluid Heater
Installation Manual

CLAYTON INDUSTRIES
17477 Hurley Street
City of Industry, CA 91744-5106
USA
Phone: +1 (626) 435-1200
FAX: +1 (626) 435-0180
Internet: www.claytonindustries.com
Email: sales@claytonindustries.com

FACTORY DIRECT SALES AND SERVICE
UNITED STATES OFFICES
ATLANTA • CHICAGO • CINCINNATI • CLEVELAND • DALLAS • DETROIT
KANSAS CITY • LOS ANGELES • NEW ENGLAND • NEW JERSEY
NORTHERN CALIFORNIA

LICENSEES, AFFILIATES, SALES and SERVICE DISTRIBUTORS WORLDWIDE

Table of Contents

SECTION I - INTRODUCTION

The ***CLAYTON STEAM GENERATOR*** is manufactured in accordance with the American Society of Mechanical Engineers (ASME) Boiler Pressure Vessel Code (BPVC), Section I. Construction and inspection procedures are regularly monitored by the ASME certification team and by the Authorized Inspector (AI) commissioned by the Jurisdiction and the National Board of Pressure Vessel Inspectors (NBBI).

The NBBI is a nonprofit organization responsible for monitoring the enforcement of the various sections of the ASME Code. Its members are the chief boiler and pressure vessel inspectors responsible for administering the boiler and pressure vessel safety laws of their jurisdiction.

The electrical and combustion safeguards on each ***CLAYTON STEAM GENERATOR*** are selected, installed, and tested in accordance with the standards of the Underwriters' Laboratories and such other agency requirements as specified in the customer's purchase order.

NOTE

It is important that the steam generator/fluid heater, feedwater skid, and all installation accessories and options be installed in accordance with ASME/ANSI Codes, as well as, all applicable Federal, State, and local laws, regulations and codes.

NOTE

Clayton startup engineers or service technicians reserve the right to refuse commissioning of any Clayton equipment if Clayton startup/service personnel determines such equipment installation fails to meet the guidelines and requirements outlined in this installation manual.

NOTE

Clayton sales representatives and service technicians *ARE NOT* authorized to approve plant installation designs, layouts, or materials of construction. If Clayton consultation or participation in plant installation design is desired, please have your local Clayton sales representative contact Clayton corporate headquarters for more information and pricing.

(This page intentionally left blank.)

SECTION II - GENERAL INFORMATION

2.1 Location

Give careful consideration to your Clayton equipment investment and the equipment warranty when selecting an installation location. The equipment should be located within close proximity to necessary utilities, such as fuel, water, electricity, and ventilation. General consumption data for each model is provided in Table 1 of Section VI. General equipment layout and dimensions are provided in Table 2 of Section VI. For actual dimensions and consumption information, please refer to the data submitted with each specific order.

NOTE

Clayton's standard equipment is intended for indoor use only. Clayton's equipment must be protected from weather at all times. The steam generator/fluid heater, and any associated water and chemical treatment equipment must be maintained at a temperature above 45° F (7° C) at all times.

Maintain adequate clearance around your Clayton equipment for servicing needs. Maintain a minimum clearance of 60 inches (1.5 m) in front of the equipment, a minimum clearance of 36 inches (1 m) to the left and right sides, and a minimum clearance of 18 inches (0.5 m) to the rear of the equipment. Ample overhead clearance, including clearance for lifting equipment, should be considered in case the coil requires removing. Equipment layout and dimensions are provided in Table 2 of Section VI. Review the Plan Installation drawing supplied with the order for specific dimensions and clearance information.

CAUTION

ALL combustible materials must be kept a minimum of 48 inches (1.2 m) from the front and 18 inches (0.5 m) from the top, rear, and sides of the equipment. A minimum clearance of 18 inches (0.5 m) must also be maintained around the flue pipe. Flooring shall be non-combustible. This equipment must not be installed in an area susceptible to corrosive or combustible vapors.

IMPORTANT

KEEP CLAYTON EQUIPMENT CLEAR OF ALL OBSTRUCTIONS. DO NOT ROUTE ANY NON-CLAYTON PIPING, ELECTRICAL CONDUIT, WIRING, OR APPARATUS INTO, THROUGH, OR UNDER CLAYTON EQUIPMENT. ANY OBSTRUCTIONS CREATED BY SUCH NON-CLAYTON APPARATUS WILL VERY LIKELY INTERFERE WITH THE PROPER OPERATION AND SERVICING OF THE EQUIPMENT. ALL SUCH INTERFERENCE IS THE SOLE RESPOSIBILITY OF THE CUSTOMER. CLAYTON'S PLAN INSTALLATION DRAWINGS, INCLUDING JOB-SPECIFIC DRAWINGS, ARE FOR VISUAL REFERENCE ONLY.

2.2 Positioning and Anchoring Equipment

2.2.1 General Installation Requirements

Lifting instructions are provided in Appendix A. Proper rigging practices and equipment must be applied when lifting this equipment. Forklifts with roll bars can be used for installations with overhead space limitations.

WARNING

DO NOT attach rigging gear to the top coil lifting hook or any part of this equipment other than the main frame.

When used, mounting legs with fasteners are provided. **All legs and fasteners must be attached. DO NOT alter the lengths of the mounting legs without first consulting Clayton.** The mounting legs are designed to provide adequate space and accessibility for servicing the equipment. Proper floor drains must be provided under the generator(s). **MAKE SURE ALL EQUIPMENT IS LEVELED AND ALL ANCHORING POINTS ARE USED.**

Level the equipment using full-size, stainless steel, slotted shims that match the equipment pads designed and provided on the equipment. Clayton recommends full-size slotted shims. If slotted machine shims are used, Clayton requires C-size or larger for pump skids and E-size for generator and water skids. Use full-sized anchors to anchor the equipment. Make sure anchors are strong enough to withstand operating, wind, and seismic loads that exists in the installation location.

To enhance serviceability and accommodate service personnel, Clayton recommends placing its generators, main positive displacement (PD) feedwater pumps, feedwater skids, and water treatment skids on 4–6 inch (10–15 cm) high equipment maintenance pads. These equipment maintenance pads on which the equipment will be installed must be 3–6 inches (8–15 cm) wider and longer than the equipment base plates. Make sure the equipment maintenance pads are properly reinforced and leveled.

Fully grout into place all generators, pumps, and skids, after leveling and anchoring, to provide adequate support and **minimize equipment vibration. Grouting is important, but it does not replace the use of metal shims under each anchor bolt location. Every anchor hole location on the equipment skid(s) requires an anchor bolt.**

It is recommended the mass of the concrete foundation be sufficient to absorb the dynamic and static forces from the operation, wind, or seismic conditions that exist at the specific equipment installation location. **Accepted concrete construction guidelines, for equipment installation, recommends that the concrete foundation be at least 5 1/2” to 7 1/2” (14 cm to 19 cm) thick, depending on soil, underground water, environmental, and seismic conditions.**

If Clayton’s generator, pump, or skid are mounted on a surface other than a concrete foundation, such as a steel structure, then the equipment base frame must be supported on rigid steel beams that are aligned along the length of the equipment base frame. It is strongly recommended that Clayton’s equipment be supported with horizontal and vertical main structural members at all its equipment anchor pads.

Perform stress calculations for the steel structure to confirm it has adequate rigidity to minimize baseplate distortion and vibration during operation. Clayton recommends incorporating vibration isolation on this type of installation.

2.2.2 Equipment Anchoring

To properly secure the equipment base frames to the equipment maintenance pads and foundation, proper anchor bolts are required. The anchor bolt diameter must be fully sized to the anchor bolt holes in Clayton’s equipment base frame. For required bolt sizes, see the plan installation drawings for the specific Clayton equipment. The anchor bolt length extending above the foundation should equal the total height of all shimming and leveling devices, 3/4–1 1/2 inch (2–4 cm) grout filler for leveling, the equipment base frame thickness, washer set, anchor bolt nut, and an additional 1/2 inch (1.5 cm) above anchor bolt nut (See Figure 2-1.).

The proper anchor bolt length and its embedded depth must meet all static and dynamic loading from the operation of the equipment, wind loading, and seismic loading.

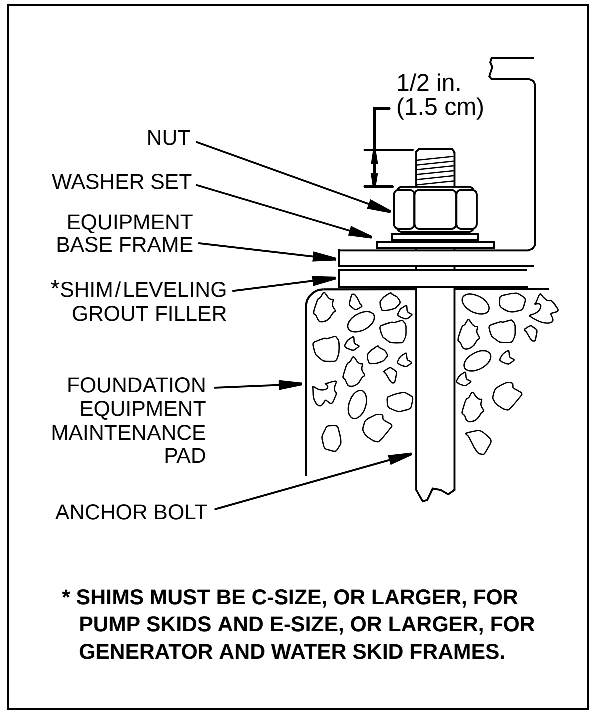


Figure 2-1 Anchor bolt installation

CAUTION
Failure to adequately support Clayton’s equipment can lead to excessive vibration, which is detrimental to Clayton’s product and component life cycle, especially electrical components.

2.2.3 Grouting

Make sure to grout the entire equipment base frame before making any additional connections to your Clayton equipment. Grouting the equipment base frame to the foundation provides a good and sturdy union between them. Grout is a concrete-type material that is used to fill the gap between the equipment base frame and the foundation. The grout increases the mass of the base to help reduce equipment vibration, which is fundamental to product life. In addition, the grout will fill any voids or imperfections in the foundation surface to increase proper equipment support. When the grout hardens, the equipment base frame and the foundation becomes one solid unit to support the equipment.

2.2.4 Clayton PD Feedwater Pump Placement

Clayton's PD pump placement and its relative position to Clayton's generator is critical for managing pump-induced equipment vibration; therefore, this helps to extend equipment and component life. Substantial hydraulic vibration can develop when pipe runs between the PD feedwater pump(s) and the heating coil inlet are lengthened and/or elevated without additional piping design and component changes.

IMPORTANT

To prevent voiding Clayton's equipment warranty, it is required that any intended relocation of Clayton's PD feedwater pump from the generator be pre-approved by Clayton's engineering group prior the equipment installation design.

DO NOT MOVE OR RELOCATE THE POSITION OF CLAYTON'S MAIN PD FEEDWATER PUMP, RELATIVE TO THE GENERATOR, AS SHOWN ON CLAYTON'S PLAN INSTALLATION DRAWING, WITHOUT FIRST CONSULTING WITH CLAYTON'S ENGINEERING GROUP.

Clayton's service team is restricted from commissioning or starting any Clayton equipment where the main PD feedwater pump(s) has been relocated without prior approval.

2.3 Combustion Air

A sufficient volume of air must be continuously supplied to the boiler room to maintain proper combustion. **Boiler room fresh air vents must be sized to maintain air velocity less than 500 sf/m with less than 1/4 inch water pressure drop. Ventilation openings must be sized at 3 ft^2/100 bhp or larger.** As a guideline, there should be 12 cfm of air per boiler horsepower.[1] This will provide sufficient air for combustion and outer shell cooling. Refer to Table 6.1A and 6.1B of Section VI for the required area of free air intake.

An inlet air duct should be used when there is insufficient boiler room air, when the boiler room air supply is contaminated with airborn material or corrosive vapors, and when noise consideration is required. A suitable inlet weather shroud is required and an air filter should be installed when there is a potential for airborn contaminates. Air inlet filters capable of filtering airborn contaminates down to 3 microns are required for FMB equipped units. If an inlet air duct is used in cold weather climates, it must contain a motor operated damper with a position interlock switch to prevent freezing of the heating coil. The maximum allowable pressure drop in the inlet air duct system is 0.5 inch water column.

[1] This guideline is based on an installation at about sea level; high altitude installations require more air.

2.4 Customer Connections - Steam Generator

The number, type, and size of required customer connections will vary with equipment size and type of skid package provided. Table 2-1 below identifies the required steam generator customer connections for the various skid packages. The equipment connections and sizes are provided in Tables 6-2 through 6-6 in Section VI.

Additional customer connection tables located in Section III provide detailed descriptions of connections for Clayton water treatment packages.

Steam generator installation guidelines are provided in the following sections. Water treatment component installation guidelines are provided in Section III.

Table 2-1: Customer Connections

Required Customer Connections Include:	EQUIPMENT PACKAGES			
		STEAM GENERATORS WITH		
	Steam Generator only	Feedwater Receiver	Water Skid	Generator Skid
Exhaust Stack	X	X	X	X
Separator Steam Outlet	X	X	X	X
Safety Relief Valves Discharge	X	X	X	X
Feedwater Inlet	X	X	X	
Coil Drain(s)	X	X	X	
Separator Drain	X	X	X	
Steam Trap(s) Outlet	X	X	X	
Fuel Inlet	X	X	X	X
Fuel Return (Oil Only)	X	X	X	X
Atomizing Air Inlet (Oil Only)	X	X	X	X
Electrical Connection-Primary	X	X	X	X
Electrical-Generator Skid Interconnect		X	X	
Coil Gravity Drain	X	X	X	X
Fuel Pump Relief Valve (Oil Only)	X	X	X	X

2.5 Exhaust Stack Installation

(See Figures 2-2, 2-3, 2-4, 2-5, and 2-6.)

2.5.1 Installing Exhaust Stacks

Clayton strongly recommends a barometric damper on all installations. Proper installation of the exhaust stack is essential to the proper operation of the Clayton steam generator. Clayton specified allowable back-pressure of 0.0 to -0.25 w.c.i. must be considered when designing and installing the exhaust stack. The stack installer is responsible for conforming to the stack draft back-pressure requirements. Ninety-degree elbows should be avoided. Forty-five degree elbows should be used when the stack cannot be extended straight up. ***Stacks in excess of 20 feet (6 meter) may require a barometric damper. Stacks for all low NOx generators require a barometric damper.***

The material and thickness of the exhaust stack must comply with local code requirements, and be determined based on environmental and operating conditions (exposure to the elements, humidity, constituents of fuel, etc.). The area of free air space between the exhaust stack and building, roof, or flashings must also comply with local codes. The material used for roof flashings must be rated at a minimum of 600° F (315° C). A “weather cap” must be installed on top of the exhaust stack.

IMPORTANT

The specified exhaust stack connection size (shown in Tables 6-2 through 6-5, in Section VI, and in Clayton’s Plan Installation Drawings) is the minimum required for Clayton’s equipment. It is NOT indicative of the required stack size to meet installation requirements or by local codes. All exhaust stack installations must be sized to meet prevailing codes, company and agency standards, and local conditions, as well as, the recommended requirements specified above.

NOTE

Clayton recommends all generators purchased with our integral economizers be installed with stainless steel, insulated, double-walled exhaust stacks. All units operating on light or heavy oil should use stacks constructed with stainless steel. Clayton recommends all heavy oil units use a free-standing, vertical stack, with clean-out access, as shown in Figure 2-4

NOTE

All oil-fired units must have an exhaust gas temperature indicator installed in the stack.

A removable spool piece must be installed at the generator flue outlet to facilitate removal and inspection of the heating coil. To permit sufficient vertical lift, the spool piece should be at least 4 feet (1.2 m) tall. The spool installation should be coordinated with the customer supplied rigging. If operating on any type of fuel oil, an access door must be provided immediately at the generator flue outlet (first vertical section) to provide a means for periodic water washing of the heating coil. The section of the stack located inside the building should be insulated to reduce heat radiation and noise.

Exhaust stacks are to be self-supporting (maximum stack connection load is 50 lbs. {22 kg}) and must extend well above the roof or building, (refer to local building codes). If nearby structures are higher than the building housing the steam generator(s), the stack height should be increased to clear these structures.

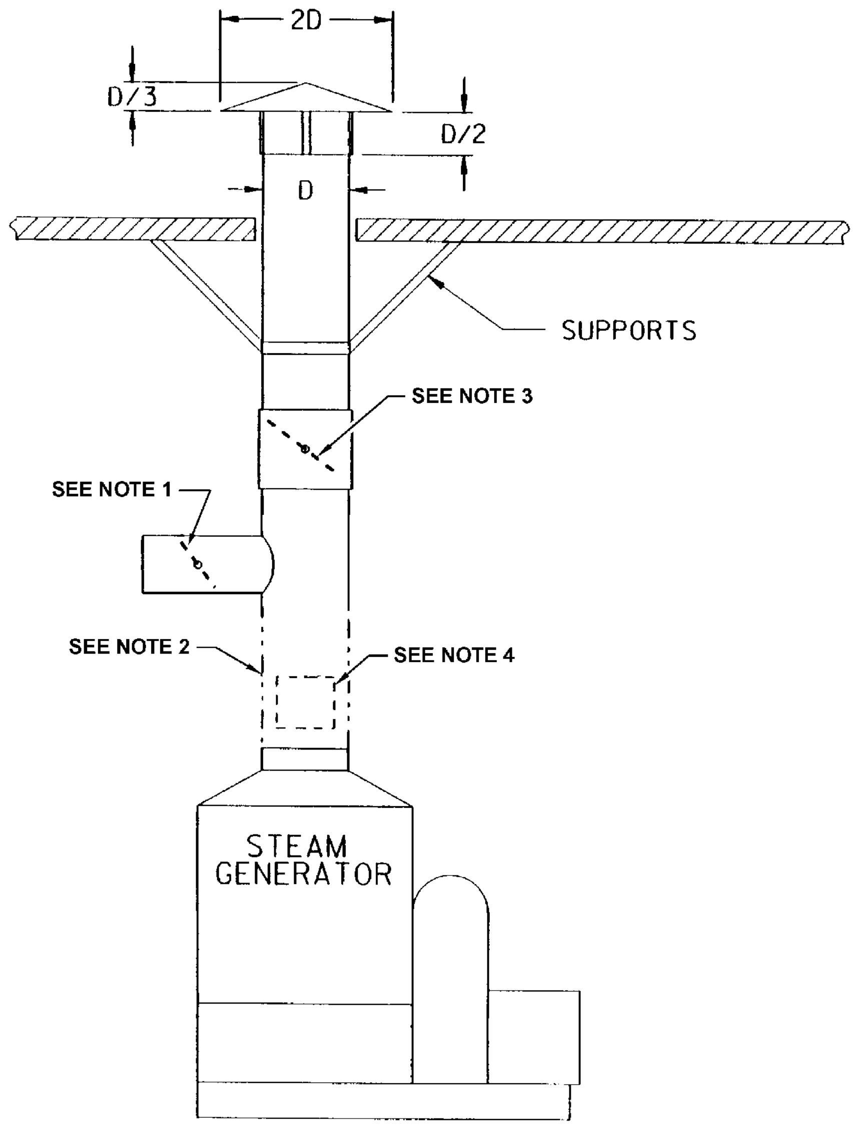
NOTE

It is strongly recommended that a back draft damper (full size and motor operated with position interlock switch) be installed to prevent freeze damage to the heating coil. Machine installations, in cold weather zones, that plan to lay the machine up wet and may encounter freezing conditions must install an air-tight back draft damper in the exhaust stack to prevent down-draft freezing.

Clayton recommends insulating all exhaust stacks to maintain gas temperatures above dew point.

Special consideration should be given to installations in and around residential areas. Depending on the design, some noise and harmonic vibration may emanate from the exhaust stack. The noise/harmonics may bounce off surrounding structures and be offensive to employees and neighbors. If this condition occurs, a stack muffler is recommended. In-line stack mufflers are typically used, installed vertically and above roof level. They may be installed horizontally or closer to the equipment.

See Figures 2-2, 2-3, and 2-4 for stack configurations.



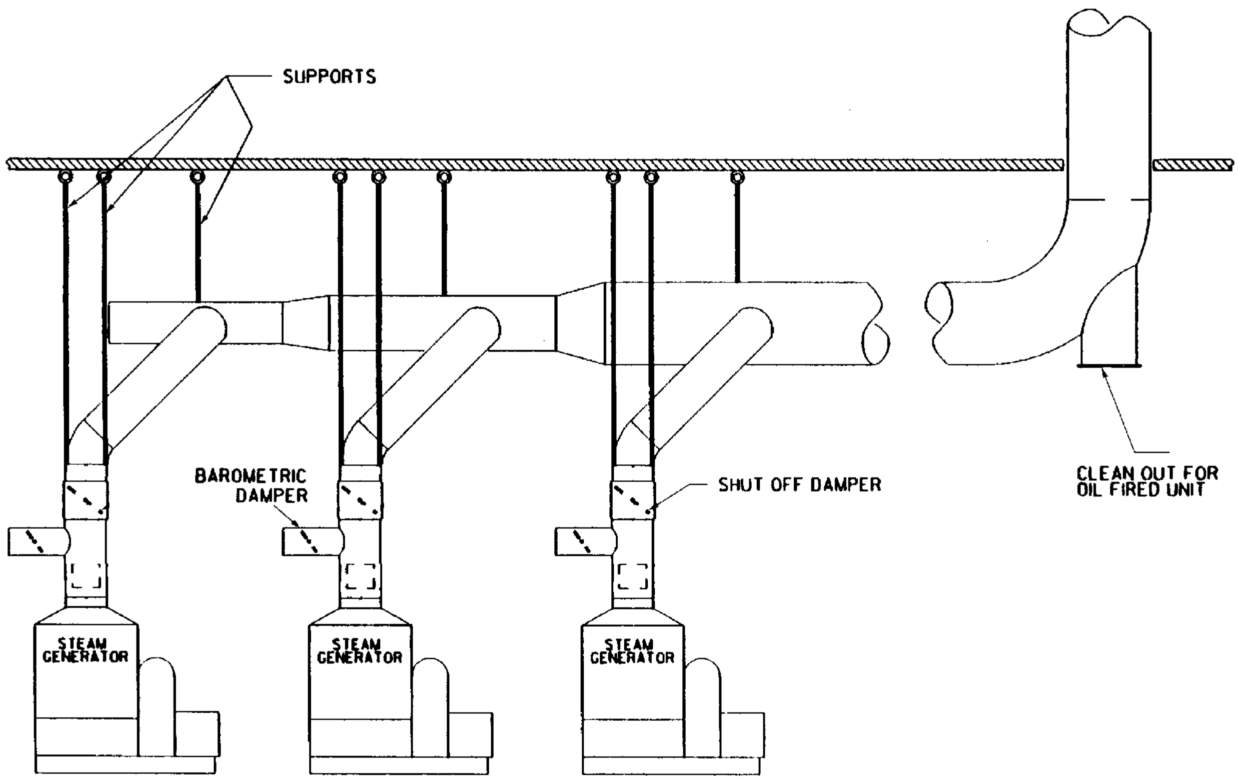
NOTE 1: Barometric dampers are recommended on all installations with stack heights over 20 feet (6 meters) and on any low NOx units.

NOTE 2: A removable, 4 feet (1.2 meters) minimum, stack section is recommended to facilitate steam generator/fluid heater maintenance and repair.

NOTE 3: A backdraft damper must be installed in the exhaust stack for installations in cold weather climates. All backdraft dampers must be air-tight and proof-of-position switches.

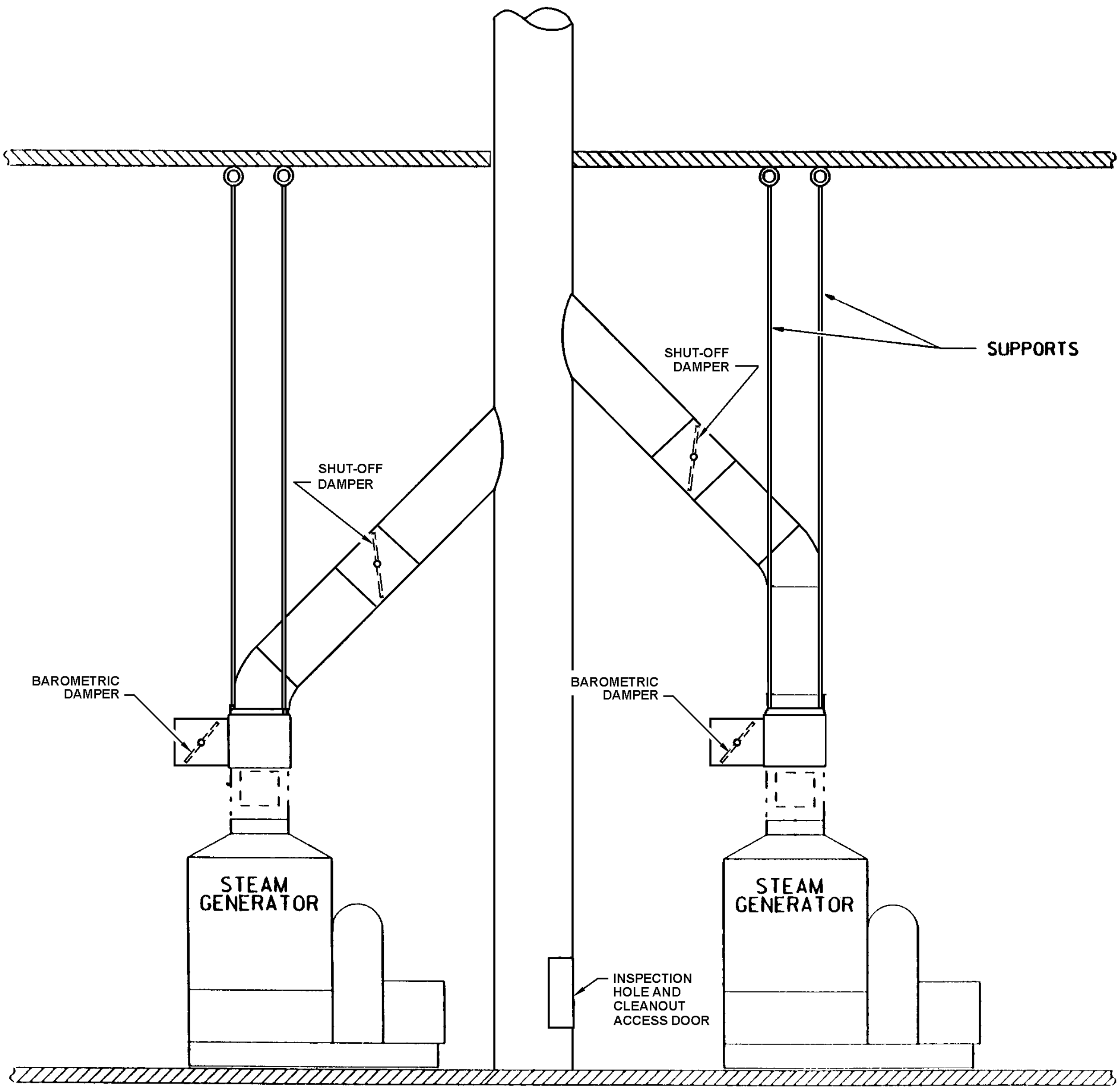
NOTE 4: Oil-fired units require a 2W x 3H feet (0.6W x 0.9H meter) access portal in the stack for inspection and water washing. A floor drain is required at the bottom of the generator under or close to the burner opening.

Figure 2-2 Standard exhaust stack layout for natural gas and light-oil installations only. Not recommended for heavy-oil machines.



***See Notes 1 – 4 in Figure 2-2.**

Figure 2-3 Alternate multi-unit exhaust stack layout for natural gas and light-oil installations only. Not recommended for heavy-oil units.



***See Notes 1 – 4 in Figure 2-2.**

NOTE: Exhaust stacks connecting to a common main stack must be offset from each other.

Figure 2-4 Recommended heavy-oil exhaust stack layout for single or multi-unit installations.

2.5.2 Installing Exhaust Stacks With External Condensing Economizer

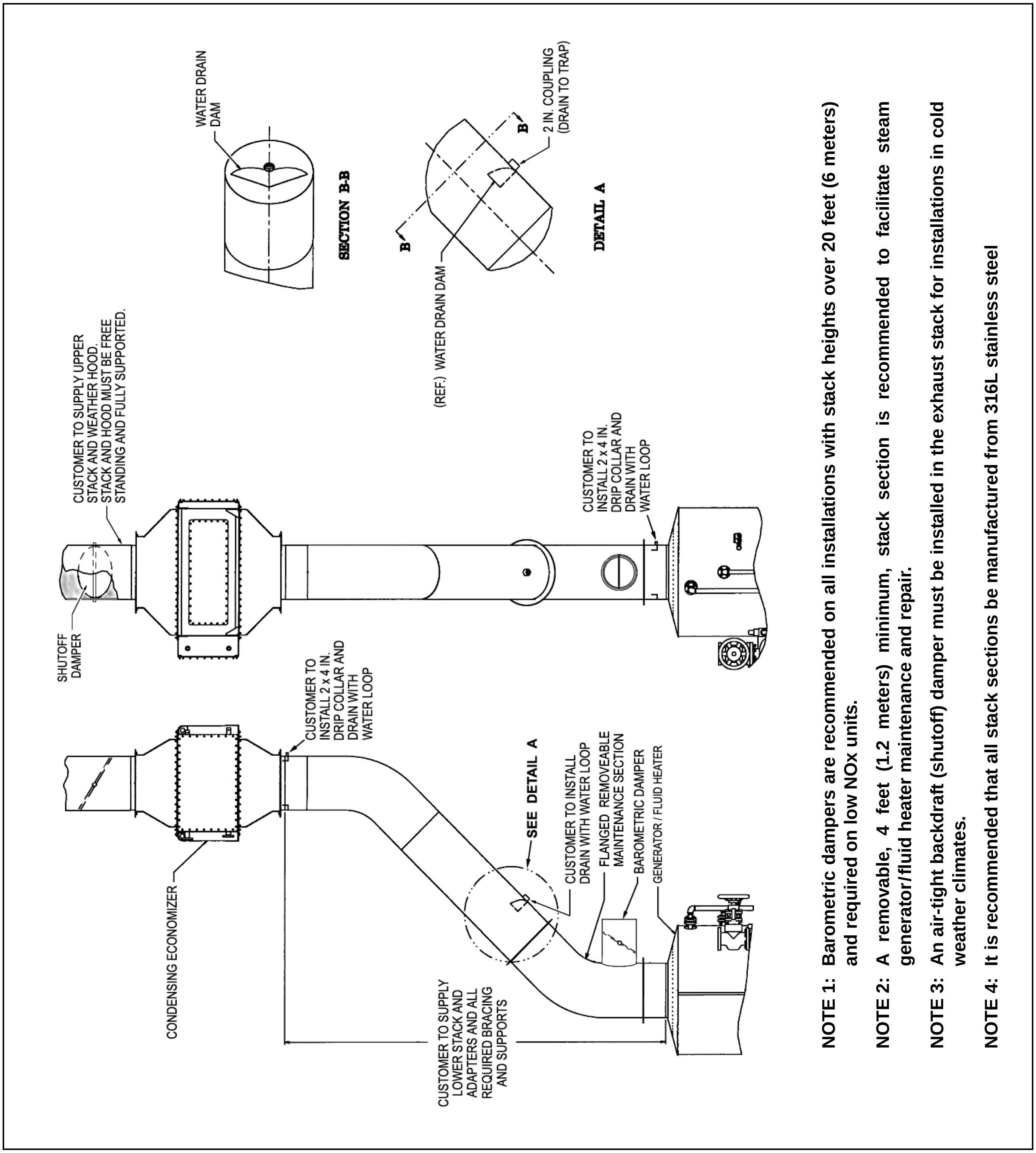
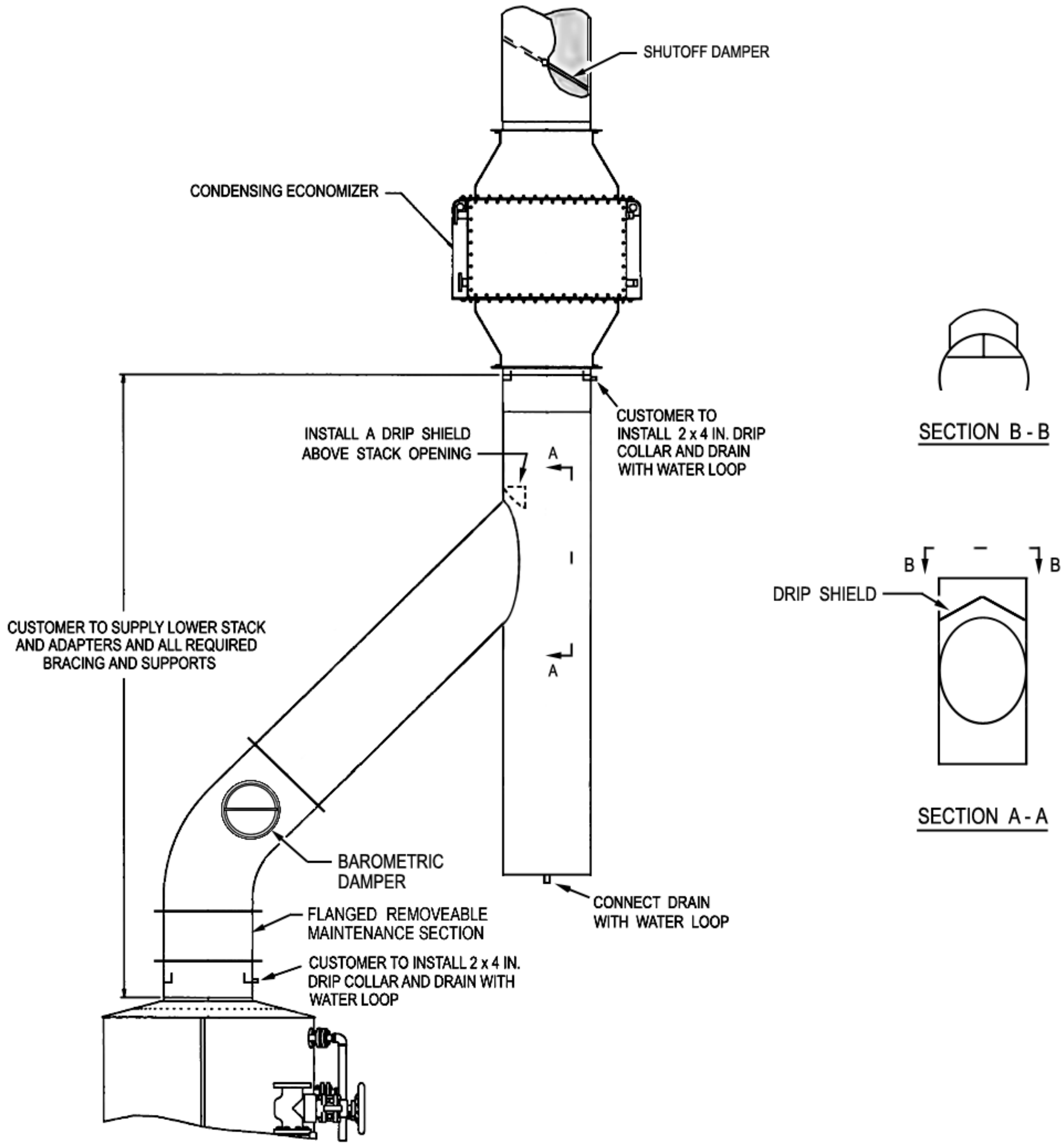


Figure 2-5 OPTION 1: Recommended exhaust stack installation for steam generator/fluid heaters with Clayton condensing economizer.



NOTE 1: Barometric dampers are recommended on all installations with stack heights over 20 feet (6 meters) and on low NOx units.

NOTE 2: A removable, 4 feet (1.2 meters) minimum, stack section is recommended to facilitate steam generator/fluid heater maintenance and repair.

NOTE 3: An air-tight backdraft (shut off) damper must be installed in the exhaust stack for installations in cold weather climates.

NOTE 4: It is recommended that all stack sections be manufactured from 316L stainless steel

Figure 2-6 OPTION 2: Recommended exhaust stack installation for steam generator/fluid heaters with Clayton condensing economizer.

2.6 Piping

2.6.1 General

Make sure no excessive strain or load is placed on any Clayton piping or their connections. Construct secure anchoring and support systems for all piping connected to the steam generator unit and associated water treatment package(s). Make sure anchoring and support systems keep motion and vibration to an absolute minimum. Ensure no extraneous vibrations are transferred to or from Clayton equipment. **DO NOT use Clayton connections as anchor points.**

Spring-loaded pipe hangers are **not** recommended. All customer connections are limited to +200 pounds (+90 kg) of load and +150 foot-pounds (+200 N•m) of torque in all directions (X, Y, and Z). Properly designed flex lines and anchoring may be used to meet loading requirements. Fuel, combustion exhaust ducts, and fresh air supply connections are not designed for loads.

Pipe routes must not be obstructive or create any potential safety hazards, such as a tripping hazard. Pipe trenches should be considered for minimizing pipe obstructions. Piping used to transfer a hot fluid medium must be adequately insulated.

Pipe unions or flanges should be used at connection points where it is necessary to provide sufficient and convenient disconnection of piping and equipment.

Steam, gas, and air connections should enter or leave a header from the top. Fluids, such as oil and water, should enter or leave a header from the bottom. A gas supply connection must have a 12–18 inch (30–45 cm) drip leg immediately before Clayton's fuel connection.

Prevent dissimilar metals from making contact with one another. Dissimilar metal contact may promote galvanic corrosion.

Globe valves are recommended at all discharge connections from Clayton equipment that may require periodic throttling, otherwise full port gate or ball valves should be used to minimize pressure drops.

2.6.2 Systems

Table 2-2 below is for steam generators rated below 250 psig (17.2 bar). It indicates the recommended material to be used for the various piping systems associated with the installation.

Table 2-2: Piping Recommendations

SYSTEM	RECOMMENDED MATERIAL/COMPONENTS
Steam and Condensate System	Steam and condensate system piping should be a minimum Schedule 40 black steel (seamless Grade B preferred). Refer to ASME guidelines for proper pipe schedules. Steam headers should contain a sufficient number of traps to remove condensed steam, and help prevent "water hammer." The separator discharge requires one positive shut off globe valve at the separator discharge flange.
Blowoff/Drain	ASME codes require that all blow-off piping be steel with a minimum Schedule 80 thickness and all fittings be steel and rated at 300 psi. Boiler blow off piping should not be elevated.

Table 2-2: Piping Recommendations

SYSTEM	RECOMMENDED MATERIAL/COMPONENTS
Steam Trap(s) Discharge	Steam trap(s) discharge piping should be Schedule 40 black steel. Pipe size should be the same as that of the separator trap(s) connection up to the first elbow. The pipe size must be increased one pipe size after the first elbow, and again after manifolding with additional units. It is preferable to have the trap return line installed so its entire run is kept below the feedwater receiver connection (to assist in wet layup). If this is not possible, then the line must be sloped downward toward the receiver at a rate of 1/8 inch per foot.
Fuel (gas or oil)	Schedule 40 black iron (See Section IV), local agencies/codes may require heavier pipe.
Atomizing Air (oil only)	Schedule 40 black iron (See Section IV)
Safety Relief Valve Discharge	Safety relief valves must discharge to atmosphere in a direction that will not cause harm to personnel or equipment. The discharge piping must not contain any valves or other obstruction that could in any way hinder the release of steam. A drip pan elbow with appropriate drains should be installed as shown in Figure 2-7.
Back Pressure Regulator	Installing a Back Pressure Regulator (BPR) on all installations is highly recommended by Clayton Industries. A BPR is required for all units sold with Auxiliary Pressure Control (APC), Master Lead-Lag, and automated startup controls. The BPR protects against drying-out and localized overheating of the heating coil during large steam pressure changes.

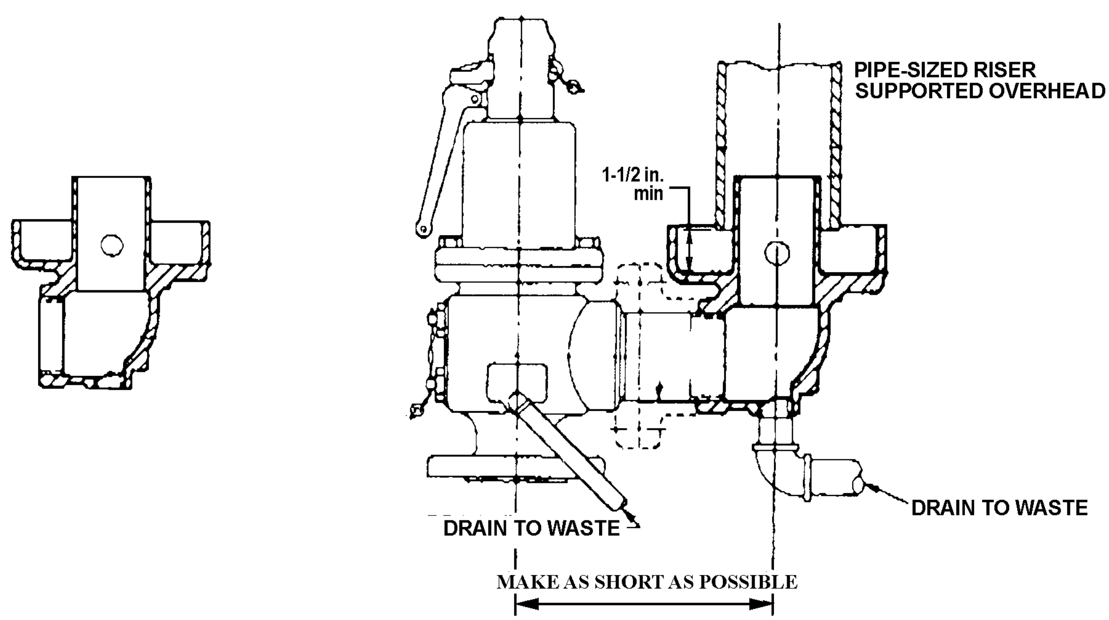


Figure 2-7 Safety Relief Valve Discharge

NOTE

It is the responsibility of the installer to ensure that all piping and fittings are properly rated (material type, thickness, pressure, temperature) for the intended system application. It is also the responsibility of the installing party to design all piping systems so as to ensure that Clayton specified flow and pressure requirements (See Section VI, Table 1) are satisfied.

2.6.3 Atmospheric Test Valve

An important, yet often overlooked, function of a properly installed steam piping system is the ability to perform full load testing of the steam generator(s) when the main steam header is restricted from accepting steam. This is most commonly encountered during the initial start-up when commissioning a steam generator. This condition will also occur when it is necessary to test or tune a steam generator during periods of steam header or end-user equipment repairs, when header pressure must be maintained to prevent cycling the generator off, or when an overpressure condition exists while in manual operation.

To facilitate full load testing of a steam generator, an easily accessible or chain operated, globe-type, atmospheric test valve **must be installed** in the steam header (downstream of a back pressure regulator, if so equipped, and upstream of at least one steam header isolation valve). The atmospheric test valve must be capable of passing 100 percent of the generator’s capacity.

WARNING

A discharging atmospheric test valve produces extremely high noise levels. Extended exposure to a discharging atmospheric test valve can lead to hearing loss. Installing a silencer is strongly recommended.

2.6.4 Steam Header and Steam Sample Points

Clayton requires appropriately constructed steam header connections, and at least one steam sample point per generator. All steam header connections from and to Clayton’s equipment must originate from the steam header vertically upward prior to changing direction toward Clayton’s equipment.

Clayton requires all steam sample connections used to measure steam quality, or efficiency, originate from the steam header vertically upward prior to heading to any sample cooler, water quality, or efficiency testing/measuring equipment. Clayton requires the equivalent of three (3) pipe diameters of uninterrupted straight lengths of steam header prior to and after the sample point.

2.7 Feedwater Treatment

The importance of proper feedwater treatment cannot be over-emphasized. The Clayton steam generator is a forced-circulation, monotube, single pass, watertube-type packaged boiler requiring continuous feedwater treatment and monitoring. The water in the feedwater receiver is actually boiler feedwater.

NOTE

It is imperative that proper feedwater treatment chemicals and equipment are in place and operational prior to filling the heating coil.

The Clayton Feedwater Treatment Manual, furnished with each new unit, provides detailed information regarding Clayton feedwater treatment requirements, products, and equipment.

In general, the feedwater supplied to your Clayton steam generator must:

- Hardness: 0 ppm (4 ppm maximum)
- pH 10.5–11.5 (normal range), maximum of 12.5
- Oxygen free with an excess sulfite residual of 50–100 ppm during operation (>100 ppm during wet lay-up)
- Maximum TDS of 8,550 ppm (normal range 3,000–6,000 ppm)
- Maximum dissolved iron of 5 ppm
- Free of suspended solids
- Maximum silica of 120 ppm with the proper OH alkalinity

NOTE

Review the Clayton Industries Feedwater Treatment Reference Manual (P/N: R15216) for additional feedwater quality requirements, or contact your local Clayton Chemical Sales Representative.

2.7.1 Water Softeners

Refer to the Clayton Water Softener Instruction Manual for detailed information regarding the installation, dimensions, and operation of Clayton water softening equipment. Some general guidelines are provided below.

Cold water piping to the water softener(s), and from the water softeners to the makeup water control valve should be Schedule 40 galvanized steel or Schedule 80 PVC.

Install anti-siphon device (if required by local health regulations) in the raw water supply line.

2.7.2 Make-up Water Line Sizing

Table 2-3 shows the pipe sizes required from the water softener to hot-well. The supply pressure must be at least 65 psi (450 kPa).

Table 2-3: Makeup water valve and pipe sizes

BHP	Make-up Valve (in.)	Minimum Line Size (in.)	BHP	Make-up Valve (in.)	Minimum Line Size (in.)	BHP	Make-up Valve (in.)	Minimum Line Size (in.)
25	3/4	3/4	150	3/4	1	500	1	1 1/2
35	3/4	3/4	200	3/4	1 1/4	600	1	1 1/2
50	3/4	3/4	250	1	1 1/4	700	2	2
75	3/4	3/4	300	1	1 1/4	1000	2	2 1/2
100	3/4	1	350	1	1 1/4	1500	2 1/2	3
125	3/4	1	400	1	1 1/4	2000	3	4

Note 1: All models use a makeup water solenoid valve.

Note 2: Water flow is based on 44 lb. per hour per bhp (boiler horsepower).

2.8 Feedwater Supply Requirements

The feedwater supply line sizing will be a minimum of one line size larger than the inlet connection size of the Clayton reciprocating, positive displacement (PD), feedwater pump. Fractional dimensions will be rounded up to the larger whole-sized dimension.

NOTE

Clayton takes advantage of the limited length and lower velocities to minimize its internal line sizes. This common industry practice works well on Clayton's internal piping and pump head designs. The very short equivalent pipe lengths and quickly dividing flows (lower velocities) within our pump designs yields lower velocities and acceleration head.

Unfortunately, the customer and installing contractor experience the reverse when designing their feedwater piping system. They are usually faced with much longer equivalent length pipe runs and/or have to deal with a pipe required to carry more than one generator's flow. Therefore, it is critical for the installation designer to increase supply line sizes to meet Clayton's requirements for velocity and acceleration head. See paragraph 2.8.2 and 2.8.3.

2.8.1 Multi-unit Systems

In a multi-unit installation, Clayton recommends running separate supply lines to each feedwater pump. However, in some situations, it may be impractical to run separate supply lines. If a common supply line is chosen, Clayton suggests the following:

- Make proper calculations to ensure velocities and head acceleration requirements are maintained.
- If two or more pumps operate in parallel, with a common suction line, calculate the acceleration head for the common line by assuming that all pumps are synchronized, acting as one large pump.

(The capacities of all pumps are added to determine line velocity.)

- Whenever possible, install the suction line header closer to the booster pumps, rather than closer to the individual feedwater pumps.

2.8.2 Velocity Requirements and Calculation

Clayton requires the feedwater supply line maintain all flow velocities under one feet per second (1 ft/s). Customers must ensure their line sizing calculations clearly show that supply pipe sizes are sufficiently large to maintain the less than 1 ft/s under all operational conditions. Refer to the charts in Figure 2-8 and 2-9 for velocity requirements.

Velocity of a fluid is the amount of fluid **F**low passing through an **A**rea, and the formula is V=F/A. Velocity is required in ft/sec for our use, so we must express our generators water flow in cubic feet and divide that by an area expressed in square feet. Clayton's generator water flows are all based on 44 lbs per boiler horsepower per hour; therefore, we must convert the pounds of water to cubic feet of water, and then convert the hour to seconds.

Let us find the velocity of 3 x 150 bhp generators running at 100% in a common manifold. This can be done by first calculating the total flow of water at the maximum firing rate. Since Clayton wants a minimum of 44 lbs/bhp-hr, the total flow required is:

$$F = (3 \times 150 \text{ bhp} \times 44 \text{ lbs/bhp-hr}) = \underline{19{,}800 \text{ lbs/hr}}$$

Next, we need to convert the flow from lbs/hr to ft^3/hr by multiplying the flow by the conversion factor of 0.01602 **ft^3/lb** of water. The converted flow is:

$$F = 19{,}800 \text{ lbs/hr} \times 0.01602 \text{ ft}^3\text{/lb} = \underline{317.2 \text{ ft}^3\text{/hr}}$$

Then, we need to convert hours to seconds. Since one hour has 3600 seconds, we simply divide the 317.2 ft^3/hr by 3600. The converted flow is:

$$F = (317.2 \text{ ft}^3\text{/hr}) \div (3600 \text{ sec/hr}) = \underline{0.0881 \text{ ft}^3\text{/sec}}$$

Now that we have the flow (F), we need to know the area through which it will flow. Area is calculated by the formula $A = \pi r^2$ were π is a constant equal to 3.14159, and r is the radius of the pipe ID being used. For this example, we will use 3-inch pipe. We will discount the differences between the ID of varying pipe schedules, water temperature, etc., to make this simple for the field. These are not meaningful for a quick check of the installation. To successfully complete the velocity calculation, we need to work with feet, so a conversion from inches to feet is required.

A 3 inch ID pipe has a radius of 1.5 inch. To convert inches to feet, divide the inches by 12 in./ft; therefore, in our example the radius is 1.5 in. ÷ 12 in./ft = 0.125 ft

$$A = \pi r^2 = 3.14159 \times (0.125 \text{ ft})^2 = 0.049 \text{ ft}^2$$

Now that we have both the desired **flow** (0.088 ft^3/sec) and the available **area** (0.049 ft^2) of the 3-inch pipe it must pass through, we can calculate the **velocity**.

$$V = F \div A = (0.0881 \text{ ft}^3\text{/sec}) \div (0.049 \text{ ft}^2) = 1.8 \text{ ft/sec}$$

NOTE: Unfortunately, the velocity (V) in our example exceeds Clayton's maximum ft/sec.

TYPICAL FEEDWATER PIPE VELOCITIES — sheet 1 of 2

SCHEDULE 40/std PIPE — PIPE VELOCITY ft/sec

Velocity requirement not satisfied / Velocity requirement satisfied

PIPE SIZE \ BHP-->	25	35	50	75	100	125	150	200	250	300	350	400	500	600	650	700	800	1000
3/4"	1.32	1.85	2.64	3.97														
1"	0.82	1.14	1.63	2.45	3.26	4.08												
1-1/4"	0.47	0.66	0.94	1.41	1.89	2.36	2.83	3.77										
1-1/2"	0.35	0.48	0.69	1.04	1.39	1.73	2.08	2.77	3.46	4.16	4.85							
2"	0.21	0.29	0.42	0.63	0.84	1.05	1.26	1.68	2.10	2.52	2.94	3.36	4.20					
2-1/2"		0.21	0.29	0.44	0.59	0.74	0.88	1.18	1.47	1.77	2.06	2.36	2.95	3.53	3.83	4.12		
3"			0.19	0.29	0.38	0.48	0.57	0.76	0.95	1.14	1.34	1.53	1.91	2.29	2.48	2.67	3.05	3.82
3-1/2"			0.14	0.21	0.29	0.36	0.43	0.57	0.71	0.86	1.00	1.14	1.43	1.71	1.85	2.00	2.28	2.85
4"						0.28	0.33	0.44	0.55	0.66	0.78	0.89	1.11	1.33	1.44	1.55	1.77	2.22
5"							0.21	0.28	0.35	0.42	0.49	0.56	0.70	0.85	0.92	0.99	1.13	1.41
6"								0.20	0.24	0.29	0.34	0.39	0.49	0.59	0.63	0.68	0.78	0.98
8"										0.17	0.19	0.22	0.28	0.33	0.36	0.39	0.44	0.55
10"												0.14	0.17	0.21	0.22	0.24	0.28	0.35
12" (.375w)														0.15	0.16	0.17	0.20	0.25

SCHEDULE 80/XS PIPE — PIPE VELOCITY ft/sec

Velocity requirement not satisfied / Velocity requirement satisfied

PIPE SIZE \ BHP-->	25	35	50	75	100	125	150	200	250	300	350	400	500	600	650	700	800	1000
3/4"	1.63	2.28	3.26	4.89														
1"	0.98	1.37	1.96	2.94	3.92	4.90												
1-1/4"	0.55	0.77	1.10	1.65	2.20	2.75	3.30	4.40										
1-1/2"	0.40	0.56	0.80	1.20	1.60	2.00	2.39	3.19	3.99	4.79	5.59							
2"	0.24	0.33	0.48	0.72	0.96	1.19	1.43	1.91	2.39	2.87	3.34	3.82	4.78					
2-1/2"		0.23	0.33	0.50	0.67	0.83	1.00	1.33	1.66	2.00	2.33	2.66	3.33	3.99	4.33	4.66		
3"			0.21	0.32	0.43	0.53	0.64	0.85	1.07	1.28	1.49	1.71	2.14	2.56	2.78	2.99	3.42	4.27
3-1/2"			0.16	0.24	0.32	0.40	0.48	0.63	0.79	0.95	1.11	1.27	1.59	1.90	2.06	2.22	2.54	3.17
4"						0.31	0.37	0.49	0.61	0.74	0.86	0.98	1.23	1.47	1.59	1.72	1.96	2.45
5"							0.23	0.31	0.39	0.47	0.54	0.62	0.78	0.93	1.01	1.09	1.24	1.55
6"								0.22	0.27	0.32	0.38	0.43	0.54	0.65	0.70	0.76	0.87	1.08
8"										0.19	0.22	0.25	0.31	0.37	0.40	0.43	0.49	0.62
10" (.500w)												0.15	0.19	0.23	0.25	0.26	0.30	0.38
10" (.593w)												0.16	0.20	0.24	0.26	0.27	0.31	0.39
12" (.500w)														0.16	0.17	0.18	0.21	0.26

Figure 2-8 Velocity requirements for 25–1,000 bhp

TYPICAL FEEDWATER PIPE VELOCITIES — sheet 2 of 2

SCHEDULE 40/std PIPE — PIPE VELOCITY ft/sec

PIPE SIZE / BHP-->	1200	1300	1400	1500	1600	1800	2000	2100	2200	2400	2500	2600	2700	2800	3000	3200	3600	4000
3"	4.58																	
3-1/2"	3.42	3.71																
4"	2.66	2.88	3.10	3.32	3.54	3.99	4.43											
5"	1.69	1.83	1.97	2.11	2.26	2.54	2.82	2.96	3.10	3.38	3.52	3.67	3.81	3.95	4.23			
6"	1.17	1.27	1.37	1.46	1.56	1.76	1.95	2.05	2.15	2.34	2.44	2.54	2.64	2.73	2.93	3.12	3.51	3.91
8"	0.66	0.72	0.77	0.83	0.88	0.99	1.10	1.16	1.21	1.32	1.38	1.43	1.49	1.54	1.65	1.76	1.98	2.21
10" (.365w)	0.43	0.46	0.50	0.54	0.57	0.64	0.72	0.75	0.79	0.86	0.89	0.93	0.97	1.00	1.07	1.14	1.29	1.43
12" (.375w)	0.30	0.32	0.35	0.37	0.40	0.45	0.50	0.52	0.55	0.60	0.62	0.65	0.67	0.70	0.75	0.80	0.90	1.00
12" (.406w)	0.30	0.33	0.35	0.38	0.40	0.45	0.50	0.53	0.55	0.60	0.63	0.66	0.68	0.71	0.76	0.81	0.91	1.01
14" (.375w)					0.33	0.37	0.41	0.43	0.45	0.49	0.51	0.53	0.55	0.57	0.61	0.65	0.74	0.82
14" (.438w)					0.33	0.38	0.42	0.44	0.46	0.50	0.52	0.54	0.56	0.58	0.63	0.67	0.75	0.83

Velocity requirement not satisfied (upper region) / *Velocity requirement satisfied* (lower region)

SCHEDULE 80/XS PIPE — PIPE VELOCITY ft/sec

PIPE SIZE / BHP-->	1200	1300	1400	1500	1600	1800	2000	2100	2200	2400	2500	2600	2700	2800	3000	3200	3600	4000
3"	5.12																	
3-1/2"	3.81	4.13																
4"	2.94	3.19	3.43	3.68	3.93	4.42												
5"	1.86	2.02	2.17	2.33	2.48	2.79	3.10	3.26	3.41	3.72	3.88	4.03	4.19	4.34	4.65			
6"	1.30	1.41	1.51	1.62	1.73	1.95	2.16	2.27	2.38	2.60	2.71	2.81	2.92	3.03	3.25	3.46	3.90	4.33
8"	0.74	0.80	0.86	0.93	0.99	1.11	1.24	1.30	1.36	1.48	1.54	1.61	1.67	1.73	1.85	1.98	2.22	2.47
10" (.500w)	0.45	0.49	0.53	0.57	0.60	0.68	0.76	0.79	0.83	0.91	0.94	0.98	1.02	1.06	1.13	1.21	1.36	1.51
10" (.593w)	0.47	0.51	0.55	0.59	0.63	0.71	0.79	0.82	0.86	0.94	0.98	1.02	1.06	1.10	1.18	1.26	1.41	1.57
12" (.500w)	0.31	0.34	0.36	0.39	0.42	0.47	0.52	0.55	0.57	0.62	0.65	0.68	0.70	0.73	0.78	0.83	0.94	1.04
12" (.687w)	0.33	0.36	0.39	0.42	0.44	0.50	0.55	0.58	0.61	0.67	0.69	0.72	0.75	0.78	0.83	0.89	1.00	1.11
14" (.500w)					0.34	0.38	0.42	0.45	0.47	0.51	0.53	0.55	0.57	0.59	0.64	0.68	0.76	0.85
14" (.750w)					0.37	0.41	0.46	0.48	0.51	0.55	0.57	0.60	0.62	0.64	0.69	0.74	0.83	0.92

Velocity requirement not satisfied (upper region) / *Velocity requirement satisfied* (lower region)

Figure 2-9 Velocity requirements for 1,200–4,000 bhp

The more relevant issue for this example is what size pipe manifold, as a minimum, do the 3 x 150 bhp generators need to meet Clayton's 1 ft/sec maximum flow velocity. This can be calculated using the same velocity equation V = F÷A. To find and area, we solve the equation for A (area), which is done by multiplying both sides of the equation by A, and dividing both sides of the equation by V; therefore, the area is equal to the flow divided by the velocity, or A = F÷V.

From our example above, we know that the flow is 0.0881 ft^3/sec, and the maximum velocity Clayton requires is 1 ft/sec; therefore, we simply divide them get the area.

$$A = F \div V = 0.0881\ ft^3/sec \div 1\ ft/sec = 0.0881\ ft^2$$

But we want a pipe size so we must convert an area in ft^2 backwards to a diameter in inches. To accomplish this we simply work the area of a circle backwards. From above we learned that the area of a pipe ID is $A = \pi r^2$ so to find the r (radius) we simply divide both side by π, and then take the square root of the result, $r = \sqrt{(A \div \pi)}$.

$$R = \sqrt{(A \div \pi)} = \sqrt{(.0881\ ft^2 \div 3.14159)} = \sqrt{0.028} = 0.1675\ ft$$

Remember this is a radius in feet, so we need to convert it to a diameter by multiplying by 2 and converting feet to inches for pipe sizes.

$$\text{Pipe diameter size in feet} = 0.1675\ ft \times 2 = 0.3349\ ft$$

Now feet to inches:

$$0.3349\ ft \times 12\ in./ft = 4.02\ \text{inch pipe}$$

This shows that the 3 x 150 bhp generators require at least a 4-inch pipe size to manifold all 3 x 150s and meet Clayton's maximum flow velocity of 1 ft/sec. Remember that this must be done for each leg of the entire supply piping system using the specific flows in each leg.

2.8.3 Acceleration Head (H_a) Requirements

On feedwater supply runs longer than 15 feet, or with multiple pump sets, customers must complete acceleration head loss calculations to show acceleration head losses are less than 0.75 foot/foot of equivalent pipe run for open hot-well systems (water temperatures less than 210° F {99° C}), and less than 0.5 foot/foot of equivalent pipe run for deaerator or semi-closed systems (water temperatures over 212° F {100° C}). UNDER NO CIRCUMSTANCES SHOULD THE IMPACT FROM H_a TO $NPSH_A$ BE IGNORED (See paragraph 2.11.1.).

NOTE

All water flow calculations must be based on 44 lb. per hour per boiler horsepower adjusted for hot-well tank temperature.

2.9 Flexible Feedwater Hose Connection And Connection Sizing

A two-foot flexible hose is required for connecting directly to the inlet of a Clayton reciprocating PD pump from the feedwater supply line. In some cases, a two-foot flexible hose may also be required at the reciprocating PD pump discharge outlet. The flexible section must be appropriately rated to satisfy pressure and temperature requirements.

2.9.1 Supply Side Connections

Clayton's reciprocating PD pumps require that the connection made directly to the pump's inlet be a flexible hose section. This hose section should be a bellows-type hose protected by a stainless steel wire mesh sleeve. It must have at least a 24 inch (61 cm) length with a minimum 18 inch (45.5 cm) long-live length. This flexible hose section must be appropriately rated to meet the pressure and temperature requirements of the feedwater supply system. The supply-side piping system must include a pipe anchor directly at the inlet (hot-well/DA) side of the flexible connector.

2.9.2 Discharge Side Connections

A flexible hose section is required at the reciprocating PD pump discharge outlet whenever it is relocated from its original, factory-designed, installation location. This hose section should be a bellows-type hose protected by a stainless steel wire mesh sleeve. It must have at least a 24 inch (61 cm) length with a minimum 18 inch (45.5 cm) long-live length. Because Clayton's mono-flow heating coil design usually increases feedwater discharge pressures from Clayton's reciprocating PD pump, this flexible hose section must be appropriately rated to meet the pressure and temperature requirements of the reciprocating PD pump output. The flexible hose rating requirements for the discharge will differ from the rating requirements for the inlet flexible hose section. Contact Clayton Engineering for the feedwater pressure of the specific generator model.

2.10 Pump Suction and Discharge Piping System Design

The suction piping system is a vital area of the piping supply system. Therefore, its design requirements deserves more careful planning.

2.10.1 General Layout Guidelines

- Lay out piping so no high points occur where vapor pockets may form. Vapor pockets reduce the effective flow area of the pipe and consequently make pump priming and operation difficult. Vent any unavoidable high points and provide gauge and drain connections adjacent pump.
- Install eccentric-type pipe reducers when required. Make sure these reducers are installed with the flat side up.
- Keep piping short and direct.
- Keep the number of turns to a minimum.
- Keep friction losses to a minimum by incorporating smooth fluid flow transitions in the piping layout. This can be accomplished with long radius elbows, two 45° elbows, or 45° branch laterals instead of tees.
- DO NOT use Clayton equipment for pipe support or pipe anchoring. It is the responsibility of the installation contractor and the customer to provide adequate and proper pipe supports and anchors. Clayton recommends all steam/fluid heaters, PD feedwater pumps, and water treatment skid pipe supports and anchors use floor-mounted structural steel.

2.10.2 Pipe Sizing Guidelines

2.10.2.1 Suction Piping

Clayton tends to follow the guidelines set forth by the Hydraulic Institute (HI) for positive displacement piston pumps. Equivalent pipe lengths for pipe fittings (elbows, tees, etc.) can be found in the HI reference charts.

NOTE

While Clayton cannot assume responsibility for the piping system into which our pump is installed, we can provide valuable guidelines for designing a piping system properly.

Suction line sizing is a major factor in the successful operation of any pump. Many pump problems result from a suction line that is too small in diameter, or too long. A properly designed piping system can prevent problems, such as:

- Fluid flashing—Entrained fluid gases effuse when pressure in piping or pump falls below fluid vapor pressure.
- Cavitation—Free gases in a fluid being forced back into the fluid. These implosions cause severe pressure spikes that pit and damage pump internal parts.
- Piping vibration—This can result from improper piping support, cavitation, or normal reciprocating pump hydraulic pulses.
- Noisy operation—Most present when pump is cavitating.
- Reduced capacity—Can result from fluid flashing. If it is, this is an indication that the pumping chambers are filling up with gases or vapors.

These problems can reduce a pump's life and are a potential hazard to associated equipment and personnel. It is possible to fracture piping and damage the pump components with high pressure surges occurring when fluid is flashing or cavitating.

Suction piping must be a minimum of one size larger than the pump suction connection. The actual line sizes will depend on meeting flow velocity maximums (see Figure 2-8 and 2-9 on pages 2-19 and 2-20, respectively), acceleration head calculations (see paragraph 2.11.3), and NPSH requirements (see Table 2-4 on page 2-25).

2.10.2.2 Discharge Piping

Normally, discharge pipe sizing is not an issue for a standard Clayton generator installation. But, when floor space is limited at the installation site, Clayton's close-coupled reciprocating PD pump will require relocating from its originally-designed location. In these cases, certain precautionary changes must be made to the pipe runs between the reciprocating PD pump and the heating coil inlet. Clayton recommends contacting a factory engineer to discuss any piping changes and obtain the generator's necessary feedwater pressure requirement.

The required piping changes are as follows:

- Connect a flexible hose section directly to the reciprocating PD pump's discharge outlet. (See paragraph 2.9.2 for flexible hose section requirements.)
- Keep discharge lines as short and direct as possible, well supported, and firmly anchored. This will ensure minimal pipe vibration, whether hydraulic or mechanical, that can be detrimental to the pump and generator. Avoid "dead ends" and abrupt direction changes as much as possible.
- Always incorporate 45° angles in the discharge pipe runs by using lateral tees and 45° elbows. DO NOT connect the pump's discharge piping directly to a 90° tee/elbow pipe, or other acute-angled piping. These types of connections will create "standing wave" or "bounce-back," either audible or sub-audible, that causes excessive vibration and noise.
- Use laterals in place of tees with the bottom of the Y facing the direction of pumped water flow. Use long radius elbows, or two 45° elbows, throughout the discharge piping system from the flexible hose discharge connection to the heating coil inlet connection.
- Increase the pipe sizes by at least one full size over the reciprocating PD feedwater pump's discharge connection (i.e.: a 1 1/2 or 2 inch discharge requires an increase to 3 inches minimum).
- Use of butt-weld pipe with weld-neck flange construction throughout the discharge pipe run is recommended.
- Discharge flow velocities must be maintained below 5 ft/sec. maximum.
- DO NOT install angle valves, globe valves, reduced port regular opening valves, restricting plug valves, flow restriction orifices, or small ventures in the discharge pipe run.
- DO NOT install any quick-closing valves, which can cause hydraulic shock (water hammering) in the discharge piping run.
- Connect the pressure relief valve and pressure gauge with snubber ahead of any block valve so that the pump discharge pressure is always reflected at the relief valve. The relieving capacity of the valve must exceed the full capacity of the pump to avoid excessive pressure while relieving flow. Use only full-sized relief line design with no restrictions.
- Should the Clayton reciprocating PD pump's pressure relief valve be removed, it must be replaced with a properly sized and correctly set pressure relief valve. Relief valve discharge must not be piped to reciprocating PD pump's suction line.
- Install a 2-inch NPTF weld couplet vertically upward, as close as possible, to the reciprocating PD pump's discharge connector to allow the addition of nitrogen-filled pulsation dampeners.
- All discharge pipe and pipe fittings must be at minimum Schedule 80.

2.11 Net Positive Suction Head (NPSH)

NPSH relates to the fluid pressure (generally in terms of "head" of water, or psi) that a pump needs to prevent flashing or cavitation within the pump, primarily in the suction check-valve area. Flashing and cavitation will reduce necessary flow rates and cause damage to the internal pump components and coil.

NPSH is divided into two important aspects, (A) what is available ($NPSH_A$) from the suction vessel, booster pump(s), and piping, and (B) what is required by the pump ($NPSH_R$).

2.11.1 $NPSH_A$

Pump $NPSH_A$ is the usable pressure (usually expressed in feet of water column or psi) available at the inlet of the pump. For Clayton systems that typically operate with near-boiling water, $NPSH_A$ is determined by the elevation difference between the operating hot-well tank water level and the inlet to the pump, minus frictional losses and minus acceleration head losses.

NOTE

If a hot-well tank cannot be sufficiently elevated to supply the required $NPSH_A$, a booster pump is required. To convert booster pump pressure (psi) to foot of head, use the following formula: psi (2.3067) = ft of water.

Booster pumps should be placed adjacent to the feedwater supply (suction) vessel. The total suction system's $NPSH_A$ must be greater than the booster pump's $NPSH_R$. The discharge head of the booster pump must be sufficient to provide a pressure of at least 25% greater than Clayton's reciprocating PD pump's $NPSH_R$, plus pipe friction losses, plus acceleration head losses, and plus 2.5 ft. Velocity and acceleration head design requirements are specified in paragraphs 2.8.2, page 2-18, and 2.8.3, page 2-21, and velocity charts in Figures 2-8 and 2-9, pages 2-19 and 2-20, respectively.

1) **Suction System: $NPSH_A$ = Receiver Elevation Head or Booster Pump Head – Friction Loss – Acceleration Head Loss – Pump Head Elevation (Typically 2.5 ft. [0.76 m] above ground.)**

2) **$NPSH_R$ = Clayton Feedwater Pump Net Positive Suction Head Required (See Table 2-4.).**

3) **$NPSH_A$ must be at least 25% greater than $NPSH_R$. ($NPSH_A > 1.25\ NPSH_R$)**

NOTE: $NPSH_A$ is increased by increasing receiver head, booster pump head, or line size.

A suction pulsation dampener or stabilizer directly adjacent to the Clayton feedwater pump connection is required.

2.11.2 $NPSH_R$

Pump $NPSH_R$ is the pressure (usually expressed in feet of water column or psi) required at the inlet of the pump that will enable the pump to operate at rated capacity without loss of flow due to flashing or cavitation in the pump. The $NPSH_R$ is relative to the pump inlet (suction) connection. The $NPSH_R$ number for a Clayton pump was determined experimentally by Clayton (see Table 2-4).

Table 2-4: Clayton's NPSH height requirements[a]

Model	Feet	Meters	Model	Feet	Meters
E-154	18	5.5	E-504	15	4.6
E-204	13	4.0	E-604	18	5.5
E-254	13	4.0	E-654	18	5.5
E-304	18	5.5	E-704	30	9.2
E-354	30	9.2	E-804	10	3.0
E-404	15	4.6	E-1004	10	3.0

[a] Requirements shown are based on Clayton's standard reciprocating PD pump usage. Alternate pumps that require higher $NPSH_R$ are used on some generators. Check Clayton's P & I D drawing for specific requirements.

NOTE

Water flow is based on 44 lb. per hour per bhp. $NPSH_R$s shown are for 150 psi design steam pressure. Higher steam pressures could change these numbers.

2.11.3 Acceleration Head (H_a)

Unlike centrifugal pumps that provide a smooth continuous flow, positive displacement pumps (typically used by Clayton) cause an accelerating and decelerating fluid flow as a result of the reciprocating motion and suction valves opening and closing. This accelerated and decelerated pulsation phenomenon is also manifested throughout the suction pipe. The energy required to keep the suction pipe fluid from falling below vapor pressure is called acceleration head. For installations with long piping sections, this becomes a significant loss to overcome and must be carefully considered. If sufficient energy is absent, then fluid flashing, cavitation, piping vibration, noisy operation, reduced capacity, and shortened pump life can occur.

To calculate the H_a required to overcome the pulsation phenomenon, use the following empirical equation:

$$H_a = \frac{LVNC}{gk}$$

where:

H_a = Head in feet (meters) of liquid pumped to produce required acceleration

L = Actual suction pipe length in feet (meters)

V = Mean flow velocity in suction line in feet per second (m/s) (See Figure 2-8 and 2-9, page 2-19 and 2-20, respectively.)

N = Pump speed in rpm (See Table 2-5, below.)

C = Pump constant factor of ...

0.400 for simplex single acting

0.200 for duplex single acting (J2 pump)

0.066 for triplex single acting

0.082 for quadplex single acting (J4 pump)

0.041 for octoplex single acting (2xJ4 pump) g = Acceleration of gravity = 32.2 ft/s^2 (9.8 m/s^2)

k = Liquid factor of ...

1.5 for water

1.4 for deaerated water

1.3 for semi-closed receiver water

Table 2-5: Clayton Pump Speeds

Generator	E154	E204	E254	E304	E354	E404	E504	E604	E654	E704	E804	E1004
Pump Speed (RPM)	432	288	360	432	510	288	372	450	512	552	n/a[a]	n/a[a]

[a] These calculations do not apply to the multistage centrifugal pumps used by E804 and E1004 generators.

Since this equation is based on ideal conditions of a relatively short, non-elastic suction line, calculated values of H_a should be considered as approximations only.

NOTE

As pump speed (N) is increased, mean flow velocity (V) also increases. Therefore, acceleration head (H_a) varies as the square of pump speed.

NOTE

Acceleration head varies directly with actual suction pipe length (L).

IMPORTANT

ACCELERATION HEAD IS A SUCTION PIPING SYSTEM FACTOR THAT MUST BE ACCOUNTED FOR BY THE PIPING SYSTEM DESIGNER. MANUFACTURERS CANNOT ACCOUNT FOR THIS IN THEIR DESIGNS BECAUSE OF THE LARGE VARIETY OF APPLICATIONS AND PIPING SYSTEMS PUMPS ARE INSTALLED IN.

NOTE

If acceleration head is ignored or miscalculated, significant pump and piping system problems (suction and discharge) may result.

Clayton recommends placing a suction pulsation dampener or stabilizer adjacent to the positive displacement reciprocating pump suction connection. This will help to protect the booster pump from the pulsating fluid mass inertia of the reciprocating PD pump and to reduce the effect of acceleration head.

2.12 General Installation Concerns

2.12.1 Charge Pumps

Charge (booster) pumps should be sized to 150% of rated Clayton pump volume. Charge pumps must be centrifugal-type pumps—not positive displacement pumps.

2.12.2 Charge Pumps Are Not A Substitute

Charge pumps are not a good substitute for short, direct, oversized, suction lines. They are also not a substitute for the computation of available NPSH, acceleration head (Ha), frictional head (HF), vapor pressure, and submergence effects being adequately considered.

2.12.3 Multiple Pump Hookup

The preferred configuration for connecting two or more reciprocating pumps in a system is to provide each pump with their own piping system. This will ensure each pump is isolated from the effects of another pump's cyclical demands.

Connecting two or more reciprocating pumps to a common suction header IS NOT recommended. Designing such a pump system can frequently cause severe pump pounding, vibration, and premature check-valve and diaphragm failure. In addition, attempting to analyze the operation of multiple pumps connected to a common suction header through mathematical calculations becomes impossible.

2.12.4 Pumphead Cooling Water System (Clayton Feedwater Pumps)

Clayton feedwater pumps require pumphead cooling water in the following applications:

- high coil feed pressures - for pump discharge pressures above 500 psi (34.5 bar), typically for E354s, E654s, and E704s
- high pump speeds - for pump speeds greater than 450 rpm, typically for E354s, E654s, and E704s (see Table 2-5)
- high-temperature supply water - supply water from a DA, SCR, or receiver with temperatures above 210° F (98° C)

The cooling water temperature must be below 75° F (24° C). The supplied water pressure should be 35–65 psi (2.4–4.5 bar) with a flow rate of 1.5 gpm (5.7 lpm) minimum.

2.13 Electrical

All customer-supplied electrical wiring must be properly sized for the voltage and amperage rating of the intended application. Full load amperage (FLA at 460V) requirements for each model are provided in Table 6-1 of Section VI. Use the appropriate multiplier, provided in the table below, to determine the full load amperage requirements for other voltages (FLA at 460V times the multiplier).

VOLTAGE	MULTIPLIER
208	2.2
230	2.0
380	1.1
575	0.8

A fused disconnect switch (customer furnished) must be installed in accordance with NEC 430 and should be located within view of the steam generator. The switch should be easily accessible to operating personnel. Clayton provides a set of terminals in the steam generator electrical control cabinet for wiring an emergency stop device (customer furnished).

NOTE

Additional access holes are located in the bottom of the electrical control cabinet(s). DO NOT make any holes in the sides or top of the electrical cabinet(s).

Clayton strongly recommends surge protection for all its equipment. Isolation transformers are recommended for areas subject to electrical variations due to weather, weak or varying plant power, or old systems.

Isolation transformers are required on all electrical systems that are based on delta distribution systems. Clayton recommends electrical connections be made through a grounded wire system only.

Clayton electronics cabinet devices are rated to function properly at typical boiler room temperatures not exceeding 120° F (49° C). For boiler room installations where temperatures are expected to rise above 120° F (49° C), installation of a Clayton electronics cabinet cooler is required. This cooler requires a supply of clean, dry compressed air at 40 scfm (1.13 m^3/min.) at 100 psi (6.9 bar).

2.14 Electrical Grounding

Clayton's steam generator, fluid heater, and water skid installations must have an electrical grounding network with a resistance no higher than 2 Ohms to earth ground when measured at its control box(es). Clayton requires a separate, direct earth ground at each of its unit installations.

Grounding wires must be routed directly with electrical power supply wiring and sized according to the connected amperage, but never less than 8 awg. A separate ground wire must be run to each steam generator/fluid heater frame and water skid frame.

(This page intentionally left blank.)

SECTION III - CLAYTON FEEDWATER PUMPS AND WATER SYSTEMS

3.1 GENERAL

Clayton steam generator feedwater systems are designed with an open (hotwell), deaerator (D/A), or Semi-closed Receiver (SCR). The selection of the proper feedwater system is determined by the steam generator's application, the installation environment, and other factors. Each system is discussed in detail in later paragraphs in this section.

The feedwater system's pipes, as well as the heating coil, are susceptible corrosion if proper feedwater treatment is neglected. Corrosion in the pipes are due to three fundamental factors—dissolved oxygen content, low pH, and temperature. Oxygen is required for most forms of corrosion. The dissolved oxygen content is a primary factor in determining the severity of the corrosion. Removing oxygen, and carbon dioxide, from the feedwater is essential for proper feedwater conditioning. Temperature and low pH affects the aggressiveness of the corrosion.

Deaerators are designed to remove most of the corrosive gases from the feedwater. Deaeration can be defined as the mechanical removal of dissolved gases from a fluid. There are many types of deaerators; however, the ones most commonly used for deaerating boiler feedwater are the open (atmospheric), pressurized jet spray, and tray type. To effectively release dissolved gases from any liquid, the liquid must be kept at a high temperature. Deaerators are pressurized above atmospheric pressure (typically 3–15 psig) to maintain the feedwater at a higher boiling point. The increased pressure and temperature releases the dissolved gases from the feedwater and those gases are vented to atmosphere.

There are four skid package options available depending on the feedwater system (all options are not available for all models - contact your Clayton Sales Representative). The systems, skid package options, and required customer connections are described below.

3.2 SKID PACKAGES

A. Individual Components The steam generator unit and all water treatment components are furnished separately. Placement of each component and its assemblies and interconnections are determined by the installer. See Section 3.3 for customer connections.

B. Feedwater Receiver Skid A separate skid consisting of the feedwater receiver, booster pump(s), and electrical control box mounted on a common frame is provided along with the steam generator. Interconnecting piping between the feedwater receiver and booster pump(s), if applicable, and feedwater receiver trim component mounting, are included. If applicable (>200 bhp), electrical connections between the water level control, makeup water valve, and skid electrical control box are also included. No other water treatment components or interconnections are provided on this skid.

C. Water Treatment Skid All water treatment components are mounted on a skid and provided along with the steam generator. Components include receiver, softeners, chemical pumps, blowdown tank, control box, and booster pumps if applicable. Skid piping and electrical interconnections between the skid components are included.

NOTE

All Clayton-supplied water skids must be fully grouted in place once leveling and anchoring are complete.

D. Generator Skid The steam generator(s) and water treatment components as listed in “C” above, are all mounted on a single skid. Skid piping and electrical interconnections between components are included.

NOTE

On SCR system skids, the SCR is mounted and piped, but removed for shipment for reassembly by the installing contractor.

NOTE

Clayton reserves the right to ship loose any equipment that cannot be safely shipped or installed. Some skid components may require re-installation on site.

NOTE

All Clayton-supplied water skids must be fully grouted in place once leveling and anchoring are complete.

E. Clayton Feedwater Pump Skids Clayton feedwater pumps are designed to fulfill the needed water volume and water pressure requirements of the heating unit. These pumps are mounted on a skid frame that includes all the equipment needed to operate the pump, such as motors and oil pumps. These feedwater pump skids are standard equipment for all steam generators and fluid heaters. Piping, piping assemblies, valves, and other plumbing components connecting the feedwater pump skid and the heating unit are supplied by Clayton.

Water supply piping to the feedwater pump skid are the responsibility of the installer, with the exception of a generator skid. On generator skids, water supply piping to the feedwater pump skid are part of the generator skid package. For determining the proper water supply pipe sizing, see Section 2.12.

F. Clayton-RotoJet Feedwater Pump Skids Because of the size requirements of this centrifugal-style feedwater pump, this feedwater pump skid must be installed independent of any water skid package that Clayton offers. For customer connection requirements, see Table 3-1.

Water supply piping to the feedwater pump skid are the responsibility of the installer. For determining the proper water supply pipe sizing, see Section 2.12.

3.3 CUSTOMER CONNECTIONS

The required customer connections for the typical water system components and feedwater pump supply included with open and deaerator feedwater receiver systems are identified in Tables 3-1 and 3-2 below. The type and size of each is provided on supplemental drawings and instructional literature.

Table 3-1: Hot-well (Open) and Deaerator Systems

Customer Connection / Skid Type	Feedwater[a] Outlet	Vent	Drain	Overflow	Overflow/ Drain	Condensate Returns	Traps Returns	Steam Heating	Chemical Injection	Makeup Water	Feedwater Pump Supply	Clayton-RotoJet Feedwater Pump Supply
None	X	X	X	X		X	X	X	X	X	X	X
Condensate Skid	X	X	X	X		X	X	X	X	X	X	X
Water Skid	X	X			X	X	X	X	X	X	X	X
Generator Skid		X			X	X		X		X		X

[a] Feedwater outlet connections apply only on Condensate and Water Skids without Booster Pumps.

Table 3-2: Hot-well (Open) and Deaerator Systems

											D/A ONLY		
Customer Connections	Booster Pump(s)			Water Softener(s)			Blowdown Tank						
Skid Type	Inlet	Outlet	Recirc	Inlet	Outlet	Drain	Inlet	Outlet	Vent	Cooling Water Inlet	Safety Valve Out	BPR Outlet	PRV Inlet
None	X	X	X	X	X	X	X	X	X	X	X	X	X
Condensate Skid		X		X	X	X	X	X	X	X	X	X	X
Water Skid				X		X		X	X		X	X	X
Generator Skid				X		X		X	X		X	X	X

3.4 OPEN SYSTEM

(Refer to P&ID Drawings R-16099 and R-16100.)

An Open System is one in which the makeup water, condensate returns (system and separator trap returns), chemical treatment, and heating steam are blended in an atmospheric Feedwater Receiver Tank, (vented to atmosphere - under no pressure). Open Feedwater Receiver Systems are sized to provide the necessary volume of feedwater and sufficient retention time for the chemical treatment to react. Condensate, separator trap returns and feedwater treatment chemicals are injected at the opposite end of the tank as the feedwater outlet connection. This helps to avoid potential feedwater delivery problems to the Booster or Feedwater Pump(s), and to provide sufficient reaction time for the chemical treatment.

If not skid mounted, the Feedwater Receiver should be installed horizontally, as shown in Drawing R-16099. If the Feedwater Receiver cannot be elevated to provide the required NPSH, Booster Pumps must be used. The Feedwater Receiver can be insulated to maximize heat retention.

Installation guidelines for the Feedwater Receiver are provided below. Descriptions for the other water treatment and accessory components, shown in R-16099, are provided in Section VII (Optional Equipment) and/or in the Clayton Feedwater Treatment Manual.

NOTE

All piping to and from the feedwater receiver must remain the same or larger size as the tank connection and not reduced. See Table 3-3 below for connection requirements.

Table 3-3: Feedwater Receiver Connections

Feedwater Outlet	This is the supply connection for properly-treated feedwater to the booster pump(s) or feedwater pump(s). Depending on the tank size, this connection may be either on the bottom or on the side of the tank. A valve and strainer (0.125 mesh) must be installed in the feedwater supply piping at the inlet to each pump (shipped loose if Clayton furnished - except on Skids). Follow the guidelines outlined in Section 2.8 through 2.12. **Feedwater line must be constructed to provide the required NPSH, velocity under 1 ft/s, and acceleration head losses less than 0.75 ft/ft to the feedwater pump inlet.** Restrictions in this line will cause water delivery problems that may result in pump cavitation and water shortage problems in the heating coil.
Gravity Fill	Install a pipe tee in the feedwater outlet line just below the feedwater outlet connection. On an elevated receiver system, this pipe tee provides a connection for the gravity fill plumbing coming from the heating coil.
Vent	Vent piping must be installed so as not create back pressure on the hotwell. The vent pipe should be as short as possible, contain no valves or restrictions, and run straight up and out. Ninety degree elbows are to be avoided. A 45° offset should be provided at the end of the vent line to prevent system contamination during severe weather conditions and/or during shutdown periods.
Chemical Injection	One common feedwater chemical injection connection is provided into which all feedwater treatment chemicals are introduced. A check-valve must be installed in the discharge line of each chemical pumping system.
Overflow	No valves are to be installed in the overflow piping. Overflow piping must be plumbed to the blowdown tank discharge piping at a point prior to the temperature valve sensor. The overflow line must be full size, not reduced. Clayton recommends installing a “P-trap” on all overflow lines.

Table 3-3: Feedwater Receiver Connections

Drain	A valve must be provided in the drain line. As indicated above, the drain line can be tied into the overflow line as long as the line size downstream of the merge remains at least the size of the overflow connection on the tank.
NOTE The Feedwater Receiver drain and overflow lines (run independently or tied together) may contain up to 212° F (100° C) water and must be routed to the Blowdown Tank discharge piping at a point prior to the temperature valve sensor.	
Condensate Returns, Temperature Control & Sparger Tube(s)	The condensate return connection is the point where all system condensate returns, separator trap discharge, and heating steam are introduced. The Hotwell may use one or two condensate return connections, depending on the tank size and return volume. This injection point is located below the water line and connected to a sparger tube(s). Introducing the steam and hot condensate below the water line in conjunction with using the sparger tube reduces the velocity and turbulence created at the injection point, while minimizing flash steam losses and noise. On tanks containing two condensate return connections one is used for system condensate returns, the other is used for the separator trap discharge and heating steam. In all cases, a check-valve must be installed in the separator trap discharge, condensate return, and steam supply lines, to prevent back-feeding. The check-valve must be located as close to the feedwater tank as possible. When installing a Sparger Tube(s) it must be installed so that the holes are in a horizontal position. This is confirmed on Clayton manufactured Hotwells (up to 200 bhp) by visual verification that the "X" stamping on the external section is in the "12 o'clock" position. Refer to Drawing R-16099 for the proper temperature control valve configuration.

NOTE

Clayton feedwater receivers are sized for proper flow and chemical mixture. If a customer's condensate system creates large surges in returns at start up or while in operation, it may cause the feedwater receiver to overflow. Proper evaluation of the condensate return system and final feedwater receiver sizing is the customer's responsibility.

3.5 DEAERATOR (D/A)

(Refer to P&ID Drawing R-16595.)

Effective control of the pressure in the deaerator is essential to proper performance and operation of the Clayton steam generator system. Most deaerators have high and low pressure condensate return inlet connections. The high temperature condensate should be introduced into the D/A through a sparger tube. Condensate returns affect the pressure and water temperature in the D/A. Introducing condensate return increases the pressure in the D/A and, conversely, reducing the amount of condensate return decreases the pressure in the D/A.

CAUTION

When the quantity of condensate return is insufficient to maintain the desired water level in the D/A, relatively cool makeup water is admitted. This results in a pressure drop (sometimes sudden) in the D/A. This distorts the saturation pressure-temperature relationship causing the high temperature water in the D/A to flash, releasing steam. Some amount of the water in the supply line to the feedwater pump also flashes. This condition may result in cavitation of the feedwater pump, impeding feedwater delivery to, and resulting in an overheat condition of the heating coil.

If the water in the D/A is overheated due to an excessive amount of condensate return, some of this heat is vented off as steam to prevent over-pressurizing the D/A.

Pressure regulating valves, PRV/BPR, are used to maintain a stable pressure in the D/A. A Pressure Regulating Valve (PRV) is used to inject steam into the D/A when a pressure drop is sensed. The PRV for this service is typically pilot operated. The downstream sensing line should be connected to the deaerator head rather than the PRV downstream pipe line. This will prevent any control variations due to the pressure loss in the line. A Back Pressure Regulator (BPR) is used to vent steam during periods of overpressure. When large amounts of hot condensate are returned, an amount of steam will be released momentarily—this is normal. Clayton uses a separator with dual steam traps on deaerator applications to minimize this condition. With intermittent conditions of condensate returns at different temperatures and cold makeup, it may not be possible to absorb all the heat from the hot condensate. Deaerator pressure fluctuations should be controlled to within 2-3 psig maximum.

The deaerator should be installed horizontally. The higher the D/A can be elevated above the booster pump(s) the less sensitive the feedwater delivery system will be to pressure variations. Other factors, such as friction loss in the feedwater supply line and the Net Positive Suction Head (NPSH) characteristics of the booster pump(s), should be considered when planning the deaerator installation. Clayton requires booster pumps for most D/A installations. The D/A can be insulated to maximize heat retention.

Descriptions for the water treatment and accessory components, as shown in drawing R-16595 are provided in Section VII (Optional Equipment) and/or in the Clayton Feedwater Treatment Manual.

NOTE

All piping to and from the deaerator must remain the same size or larger than the tank connection. Always check feedwater pump pipe size requirements and follow the larger pipe size. See Table 3-4 below and the feedwater supply requirements and pipe sizing guidelines discussed in Sections 2.8, 2.9, 2.10, and 2.11.

Table 3-4: Deaerator Connections

Feedwater Outlet	This connection is used to deliver properly treated feedwater to the booster pump(s) it is typically on the bottom of the tank. A valve and strainer must be provided in the feedwater supply piping at the inlet to each pump. The feedwater line must be constructed so as to provide the required NPSH to the feedwater pump inlet. Follow the guidelines outlined in Section 2.8 through 2.12. Restrictions in this line will cause water delivery problems that result in pump cavitation and water shortage problems in the heating coil. **Feedwater line must be constructed to provide the required NPSH, velocity under 1 ft/s, and acceleration head losses less than 0.5 ft/ft to the feedwater pump inlet.** ***Do not insulate this line. Cooling in the pump suction line is beneficial during periods of fluctuating pressure in the deaerator.*** See Section 2.10.
Gravity Fill	A pipe tee should be installed in the feedwater outlet line just below the feedwater outlet connection. On an elevated D/A System, this pipe tee provides a connection for the gravity fill plumbing. On a receiver system which uses booster pumps, install a pipe plug in the gravity fill tee connection.
Vent	The deaerator must vent the liberated gases to be effective. Some steam is always vented with these gases.
Chemical Injection	One common feedwater chemical injection connection is provided into which all feedwater treatment chemicals are introduced. A check valve must be installed in the discharge line of each chemical pumping system.
Overflow Trap	No valves are to be installed in the overflow trap piping. The overflow trap piping must be plumbed to the blowdown tank discharge piping at a point prior to the temperature valve sensor.
Drain	A drain valve must be provided in the drain line. As indicated above, the drain line can be tied into the overflow line as long as the line size downstream of the merge remains at least the size of the overflow connection on the tank.

NOTE

The deaerator drain and overflow lines (run independently or tied together) typically contain water at >230° F (110° C) and must be routed to a blowdown tank discharge piping at a point prior to the temperature valve sensor.

Condensate Returns & Sparger Tube	Most deaerators have a high and low pressure condensate return connection. The high pressure condensate return connection is where all system condensate return and separator trap discharge is introduced. Low pressure returns are typically pumped from a condensate collection tank to the low pressure return connection. The high pressure condensate return connection(s) is located below the water line with a sparger tube installed internally. Introducing the steam and hot condensate below the water line in conjunction with using the sparger tube reduces the velocity and turbulence created at the injection point, while minimizing flash steam losses and noise. In all cases a check valve must be installed, as close to the D/A as possible, in the separator trap discharge and condensate return lines to prevent back-feeding. When installing a Sparger Tube(s) it must be installed so that the holes are in a horizontal position.
Pressure Regulating Valve	Steam is injected into the high pressure side of the tank to maintain the desired operating pressure. A Pressure Regulating Valve (PRV) is used for pressure regulation.

Table 3-4: Deaerator Connections

Safety Relief Valve	Each deaerator is equipped with a safety relief valve to prevent overpressurizing of the tank. This valve is typically rated at 50 psi. The safety relief valve must discharge to atmosphere and in a direction that will not cause harm to personnel or equipment. The discharge piping must not contain any valves or other obstructions that could hinder the release of steam.
Back Pressure Regulation Valve	A back pressure regulator is used to help maintain a steady operating pressure in the D/A. This valve is set below the safety valves and will vent during minor periods of over pressurization.

NOTE

BPR sensing line must be plumbed directly to D/A pressure sensing port at the gauge connection on top of the D/A tank.

3.6 SEMI-CLOSED RECEIVER (SCR)

Semi-closed receiver systems are used only in applications that return a large amount (typically > 50%) of high pressure, high temperature, condensate. The SCR is a pressurized vessel that is maintained at a pressure that will minimize venting (wasting) of the excess system heat contained in the hot condensate returns. Feedwater outlet line sizing is critical. See Section 2.10.

Each semi-closed receiver system is unique and requires individual attention to ensure proper application, installation and operation.

Due to the nature and selected use of SCR systems, the system details are addressed in Supplement I - SCR, pages SI-1 through SI-4.

3.7 SEMI-CLOSED RECEIVER SKIDS

These skids must be shipped with the SCR tank loose. Tank and interconnecting piping must be assembled by the installer. See Supplement I - SCR (pages SI-1 through SI-4) for detailed information.

3.8 HEAD TANK

A 10-gallon head tank is required when proper receiver tank elevation is unavailable. A head tank provides the necessary positive coil feed pressure during wet layup. The tank must be installed at least two (2) feet above the steam generator coil inlet connection.

SECTION IV - FUEL SYSTEM

4.1 GENERAL

Clayton steam generators are designed to fire on natural gas, propane, or fuel oils (ranging from No. 2 distillate light oil to No. 6 residual heavy oil). A standard combination burner is designed to support both gas and oil firing. This burner can remain installed when switching between gas and oil firing. Characteristics of, and installation guidelines for, both gas and oil fuel systems are described in detail in the following paragraphs.

NOTE

The installing contractors are responsible for ensuring that all piping and fittings are rated for the intended system installation (material type, thickness, pressure, temperature). The installing contractors are also responsible for ensuring the steam system design meets the flow and pressure requirements of a Clayton steam generator (see Section VI, Table 1).

4.2 NATURAL GAS

The Clayton gas train on modulating steam generators is designed and built in accordance with UL (Underwriters Laboratories), IRI (Industrial Risk Insurers), and FM (Factory Mutual) guidelines. It consists of a “double block-and-bleed” valve arrangement with proof-of-closure switches in both safety shut off gas valves. High and low gas pressure switches (with manual reset) are also provided.

Unless otherwise stated (liquid petroleum and other gas operation requires engineering evaluation), the standard Clayton gas burner is designed for operation using pipe line quality natural gas. Gas supply connection sizes and rated gas flows for each model are provided in Tables 1and 2 of Section VI. The gas supply line must be sized to provide both the supply pressure ***and*** full rated flow indicated in Table 1 of Section VI without “sagging” (pressure drop). The gas supply pressure must not vary more than ± 5% of Clayton’s required supply pressure. All gas supply connections must include a 12-inch drip leg immediately before the gas train.

Pressure regulation is required if supply pressures are expected to exceed the 10 psi (0.69 bar) supply pressure limit. Regulators should be sized to pass 25% excess gas at full open position with minimal pressure drop.

Vent lines are required for both the high and low gas pressure switches (1/8 inch) and vent valve (size varies with model - see generator P & ID drawing by specific model number.)

NOTE

Some gas trains are ventless. But, when gas train vent lines exist, they must be vented to atmosphere.

NOTE

All gas supply piping must include a minimum 12-inch drip leg immediately before Clayton's gas train connection, and be fully self-supporting.

4.3 OIL

4.3.1 General

Clayton modulating, oil-fired, steam generators are designed with air atomizing-type oil burners. Either instrument air or compressed air is used for oil atomization. This air supply must be free of contaminants and moisture; therefore, an in-line air dryer should be installed in the atomizing air supply line. Atomizing air supply pressure and flow requirements are provided in Table 1 of Section VI. The atomizing air supply connection size for all models is 1/2 inch.

NOTE

All Clayton liquid fuel systems require a fuel return line in addition to the fuel supply line. Clayton recommends fuel return lines have no isolation valve, or only valves with position open locking mechanisms.

NOTE

It is the customer's responsibility to implement and meet state, local and EPA code requirements for fuel oil storage.

4.3.2 Light Oil

The Clayton light oil burner is designed for operation with No. 2 fuel oil as defined by ASTM D 396 - Standard Specifications for Fuel Oils. A Table of Specifications indicating the limits of the light oil fuel constituents and characteristics is provided, refer to Document R-8751 (Heavy Oil Specifications) at the end of Supplement III of this manual.

NOTE

A fusible-link-actuated shutoff valve is required in the fuel oil supply line when a machine is installed within FM (Factory Mutual) jurisdiction. This is not within the Clayton scope of supply and must be provided by the installing party.

The Clayton light oil burner can be furnished with either a light oil (No. 2) or gas pilot system. Gas pilot is supplied as standard equipment. The gas pilot fuel can be either natural gas or LPG. Clayton step-fired fuel systems uses a direct-fire ignition.

4.3.3 Heavy Oil

Heavy oil operation requires special consideration with regard to storage, handling, maintenance, and proper operation. Supplemental Instructions pertaining to heavy oil operation have been developed for each model and should be used as guidelines for heavy oil applications, refer to Supplement II for an overview of heavy oil installations.

(This page intentionally left blank.)

SECTION V - TRAP SEPARATORS

5.1 GENERAL

Clayton steam generators require the same basic boiler feedwater treatment as any other water-tube or fire-tube boiler. All require soft water with little or no dissolved oxygen, a sludge conditioner, and a moderate to high pH. The water supplied from the condensate receiver should meet these conditions.

The primary distinction between a Clayton steam generator and drum type boiler is how and where the desired pH levels are achieved. The feedwater in the Feedwater Receiver is boiler water for the Clayton but similar to makeup water for the drum type boiler. Conventional boilers concentrate the boiler feedwater in the drum and maintain Total Dissolved Solids (TDS) levels and pH through blowdown. A system consisting of only Clayton steam generators uses the Feedwater Receiver much the same way conventional boilers use drums except that blowdown is taken off the separator trap discharge. Typically, drum type boilers cannot tolerate the higher pH levels that must be maintained in the feedwater receiver to satisfy Clayton feedwater requirements. Both systems work well independently, however feedwater chemical treatment problems arise when the two are operated in tandem with a common feedwater receiver - Clayton with conventional boiler(s).

The Clayton trap separator was designed to remedy the boiler compatibility problem. Using a trap separator allows both the Clayton and conventional boiler(s) to operate together while sharing the same feedwater receiver. Each system receives feedwater properly treated to suit its respective operating requirements. If a trap separator is not used, pH is either too high for the conventional boiler(s) or too low for the Clayton.

5.2 OPERATION

The separator trap returns from the Clayton steam generator(s) contain a high concentration of TDS. This high concentration of TDS is undesirable to conventional boilers because the blowdown rate would have to be increased (and could not be increased enough if the feedwater TDS level was over 3000 ppm). By routing the separator trap returns to the trap separator, rather than to the common feedwater receiver, the high concentration of TDS in the trap returns is isolated to the Clayton system. This not only eliminates the conventional boiler blowdown problems, but also satisfies the higher pH requirement of the Clayton feedwater. The construction of a trap separator is very similar to that of a blowdown tank. Separator trap return enters tangentially creating a swirling action. Flash steam is vented out the top and low pressure condensate is fed to the booster pump(s) from the outlet.

This relatively small amount of concentrated water blends with the larger volume of less concentrated feedwater being supplied from the feedwater receiver (ideally, the chemical treatment for both systems is injected into the feedwater receiver) to produce a mixture of properly treated feedwater entering the Clayton heating coil(s). The other boiler(s) receive feedwater containing the pH and TDS levels they require.

5.3 INSTALLATION

(Refer to Figures 5-1, 5-2, and 5-3.)

5.3.1 General

As shown in Figures 5-3, three sizes of trap separators have been designed to handle a broad range of boiler horsepowers. Typical dimensions for each trap separator are provided in Figure 3. Line sizes for the trap separator connections are provided and should be kept full size (no reductions). The trap separator and connected piping must be properly supported. The trap separator is maintained at the same pressure and water level as the feedwater receiver and should be installed at an elevation that puts the water level midpoint in the sight glass.

5.3.2 Trap Separator Vent

The trap separator vent line must be large enough to handle the flash steam with little or no pressure drop and without affecting the water level. Proper vent line sizes for specific horsepower ranges are indicated in Figures 5-1 and 5-2 and must not be reduced. On Deaerator (D/A) applications the vent flash steam should be introduced into the same section of the Deaerator as the Pressure Regulating Valve (PRV) steam injection. On open system applications, the vent line should be introduced to the top of the feedwater receiver. Refer to Figure 5-1.

The trap separator outlet is tied into the booster pump(s) feedwater supply line from the common feedwater receiver. The outlet piping should be constructed so as to provide the required NPSH to the booster pump(s) inlet. (any frictional loss subtracts from the available NPSH). The outlet piping should contain a minimum number of elbows and fittings, and no valves or check valves.

5.3.3 Feedwater Receiver Supply Lines

Provisions should be made for the feedwater receiver to have independent feed lines for the Clayton and conventional boiler feedwater supply. If not isolated, there is a potential for the larger feedwater pumps of the conventional boiler system to draw the water out of the trap separator and away from the Clayton feedwater supply system. This disrupts the chemical treatment in both systems and may cause water shortage and pump cavitation problems in the Clayton system. If independent feed lines are not possible, a swing check valve must be installed in the feedwater supply line to prevent backflow away from the Clayton system. (Refer to Figure 5.1)

SPECIFICATIONS: TRAP SEPARATOR - ALL GENERATORS

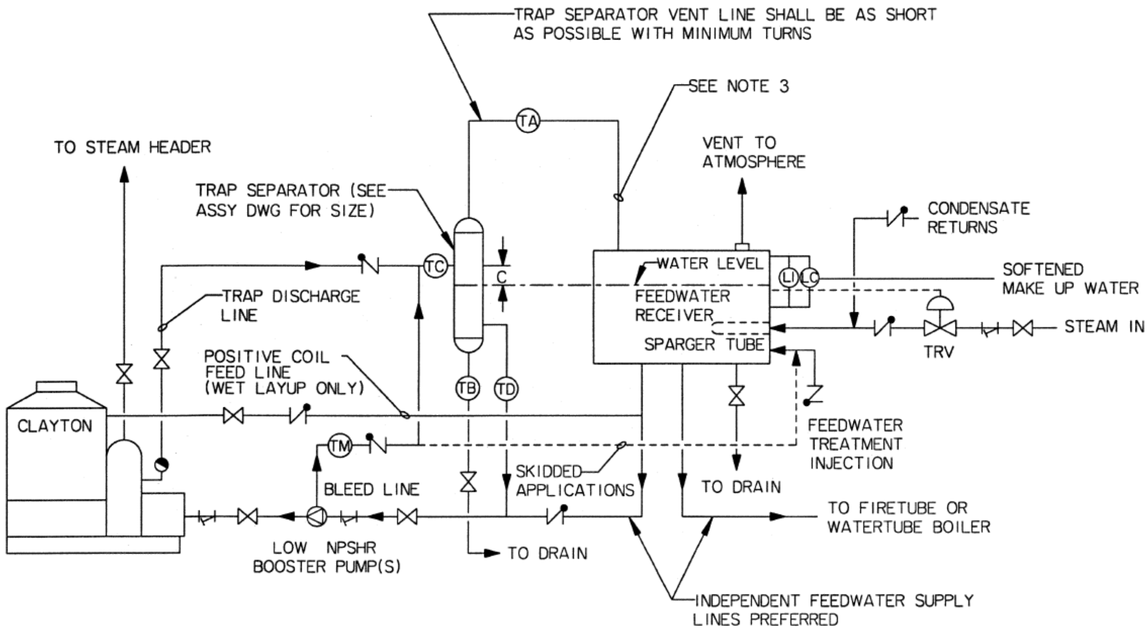


DIAGRAM OF CLAYTON TRAP SEPARATOR HOOKUP W/ OTHER BOILER AND COMMON FEEDWATER RECEIVER

LINE SIZES				
LETTER	DESCRIPTION	P/N UH33572 UP TO 300 BHP	P/N UH33566 350 TO 1000 BHP	P/N UH33574 1100 TO 1800 BHP
TC	TRAP RETURN	2" FLG.	3" FLG.	4" FLG.
TA	TRAP SEPARATOR VENT	3" FLG.	6" FLG.	8" FLG.
TD	FEEDWATER LINE TO CLAYTON	2" FLG.	3" FLG.	4" FLG.
TB	TRAP SEPARATOR DRAIN	1-1/2" FPT.	2" FPT	2" FPT
TM	BLEED LINE	1/4" FPT.	1/4" FPT.	1/4" FPT.

NOTES:

1. LOCATE TRAP SEPARATOR AS CLOSE AS POSSIBLE TO THE HOTWELL TO SUSTAIN COMMON WATER LEVEL CONTROL AND PRESSURE EQUILIBRIUM.
2. TRAP SEPARATOR USES HEAT FROM CLAYTON TRAP RETURNS TO ISOLATE HIGH TDS CONCENTRATIONS TO THE CLAYTON FEEDWATER CIRCUIT ONLY.
3. HOTWELL MAY REQUIRE AN ADDITIONAL VENT CONNECTION.

R20202A

Figure 5-1 Trap separator hookup with hotwell

SPECIFICATIONS: TRAP SEPARATOR - ALL GENERATORS

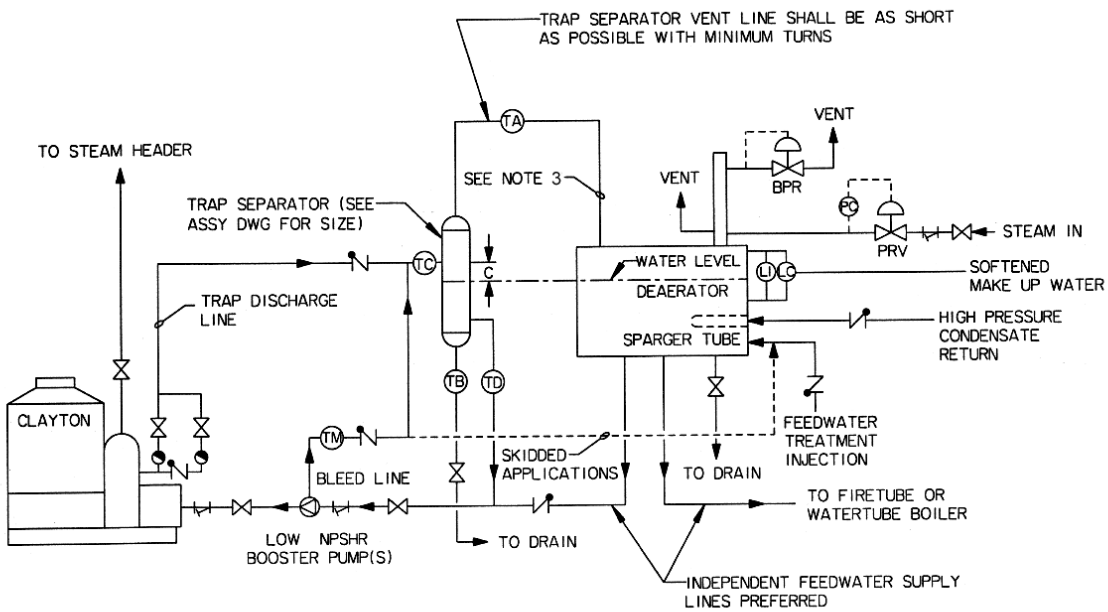


DIAGRAM OF CLAYTON TRAP SEPARATOR HOOKUP W/ OTHER BOILER AND COMMON DEAERATOR

LINE SIZES				
LETTER	DESCRIPTION	P/N UH33572 UP TO 300 BHP	P/N UH33566 350 TO 1000 BHP	P/N UH33574 1100 TO 1800 BHP
TC	TRAP RETURN	2" FLG.	3" FLG.	4" FLG.
TA	TRAP SEPARATOR VENT	3" FLG.	6" FLG.	8" FLG.
TD	FEEDWATER LINE TO CLAYTON	2" FLG.	3" FLG.	4" FLG.
TB	TRAP SEPARATOR DRAIN	1-1/2" FPT.	2" FPT.	2" FPT.
TM	BLEED LINE	1/4" FPT.	1/4" FPT.	1/4" FPT.

NOTE:

1. LOCATE TRAP SEPARATOR AS CLOSE AS POSSIBLE TO DEAERATOR TO SUSTAIN COMMON WATER LEVEL CONTROL AND PRESSURE EQUILIBRIUM.
2. TRAP SEPARATOR USES HEAT FROM CLAYTON TRAP RETURNS TO ISOLATE HIGH TDS CONCENTRATIONS TO THE CLAYTON FEEDWATER CIRCUIT ONLY.
3. DEAERATOR MAY REQUIRE AN ADDITIONAL VENT CONNECTION.

R20202A

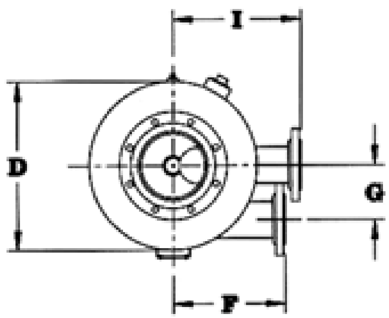
Figure 5-2 Trap separator hookup with deaerator

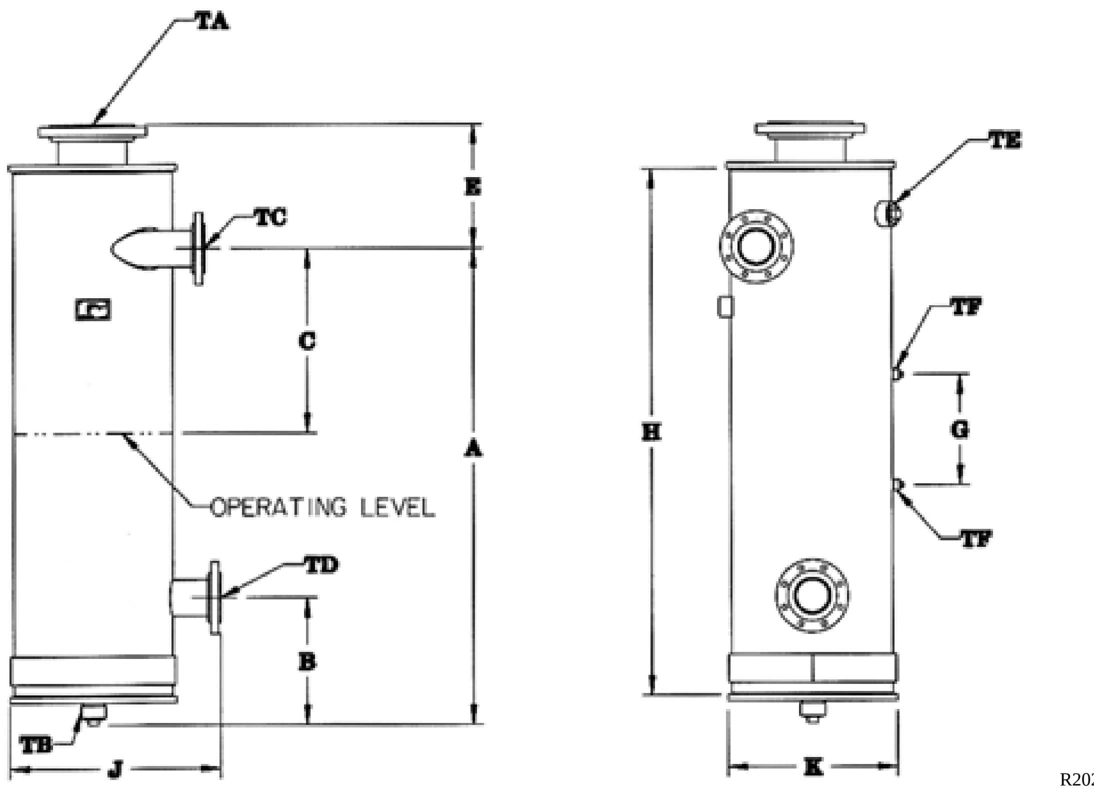
SPECIFICATION: TRAP SEPARATOR - ALL GENERATOR

TA - (TRAP SEPARATOR VENT)
TB - (CLEANOUT)
TC - (TRAP SEPARATOR INLET)
TD - (TRAP SEPARATOR DRAIN)
TE - (INSPECTION PORT)
TF - (GAUGE GLAS CONNECTION)

NOTE: ALL FLANGES ARE 150# R.F.

BHP	0-300	350-1000	1100-1800
OPERATING VOLUME	12 GAL	24 GAL	49 GAL
FULL VOLUME	18 GAL	38 GAL	83 GAL
PART #	UH33572	UH33566	UH33574
A	27.94	35.79	59.26
B	13.19	13.19	15.76
C	9.88	13.80	23.00
D	14.00	18.00	20.00
E	9.63	11.38	15.50
F	12.38	12.38	14.00
G	5.06	6.80	6.80
H	29.75	37.60	65.50
I	12.38	13.76	16.00
J	19.88	23.26	26.50
K	15.00	19.00	21.00





R20202A

Figure 5-3 Trap separator dimensions

(This page intentionally left blank.)

SECTION VI - TECHNICAL SPECIFICATIONS

6.1 GENERAL

The following pages contain Tables with general reference information intended to assist in the installation of your Clayton steam generator. The information is provided only for standard Clayton thermal products. Specially designed equipment, such as Clayton steam generators with Low NOx burners, are excluded from these Tables, but are addressed in Supplemental Instructions.

6.2 AGENCY APPROVALS

All standard modulating Clayton steam generators are designed and built to meet ANSI, ASME, Boiler Pressure Vessel Code Section I, ASME CSD-1, IRI, FM, and UL requirements.

The marine listings ABS, USCG, DNV, and CCG, are available.

6.3 CONSTRUCTION MATERIALS

Only high quality materials are used in the manufacturing of the Clayton steam generator.

The heating coil in the generator is manufactured by Clayton using ASME SA178 steel tubing. All welds are performed by Clayton ASME certified welders and stress relieved. The coil is then hydrostatically tested to 1.5 times the design pressure or 750 psig (52 bars) which ever is greater. The coil is encased in a mild steel jacket that contains all combustion gases.

The steam separator shell is constructed of SA53 seamless black pipe. The heads are made of ASME SA 285 carbon steel. The separator also has openings for steam safety relief valves.

6.4 FLAME SAFEGUARD

Burner flame control is managed by the Electronic Safety Control (ESC). The ESC is a microprocessor-based burner management system designed to control and supervise forced draft burners. It provides a proven burner purge period prior to each firing sequence. This control monitors both pilot and main flames. It cycles automatically each time the operating pressure setpoint is achieved. In the event of a flame failure during a firing cycle, all fuel valves are de-energized. The ESC will then lock out and total burner shutdown will be indicated on the display and operating unit. Before the burner can be started again, a manual reset of the ESC is required.

The ESC has a safety checking circuit that is operative on each start. If a flame is detected prior to a firing sequence or during the purge period, the burner controls will not energize. Total safety shutdown will occur requiring a manual reset of the ESC.

Operating and programming of the ESC, diagnosis of burner operations, and readouts of ESC settings and operating states are executed from a display and operating unit, which is mounted on the right-hand door to the electrical control box. The display and operating unit features a 4 x 16 character LCD display, 4 silicon user buttons, and communication ports for external device interfacing.

6.5 SAFETY CONTROLS

In addition to the combustion safety control, the following safety devices are continuously monitored during the steam generator operation.

6.5.1 Temperature Control Devices

There are three temperature control devices that continuously monitor the machine. The first device monitors the temperature of the steam to prevent against a superheat condition. The second and third temperature devices are a dual element thermocouple that provides continuous monitoring of the coil face temperature in the combustion chamber.

6.5.2 Regulator Approvals

Fuel systems are designed to comply with Underwriters Laboratory (UL) and FM approval with IRI available.

6.5.3 Steam Limit Pressure Switch

A steam limit pressure switch protects against an over-pressure condition.

6.5.4 Combustion Air Pressure Switch

A combustion air pressure switch is used to prove that sufficient air is present for proper combustion.

6.5.5 Atomizing Oil Nozzles

Modulating oil units use air atomizing oil nozzles, atomizing air customer supplied. Stepfired models use pressure atomizing oil nozzles, no pressurized air supply required.

6.5.6 Pump Oil Level Switch

A switch is available that monitors the Clayton feedwater pump crankcase oil level for both a high and low oil level condition.

6.5.7 Overcurrent Protection

The electrical circuits (primary and secondary) and all motors are protected against an overcurrent condition.

6.6 EQUIPMENT SPECIFICATIONS

6.6.1 Modulating Generators

Table 6-1[a]

SPECS / MODEL	E-154	E-204	E-254	E-304	E-354	E-404	E-504	E-604	E-704	E-1004	E-1104
A. Net heat output (Btu/hr)	5,021,250	6,695,000	8,368,750	10,042,500	11,716,250	13,390,000	16,737,500	20,085,000	23,432,500	33,475,000	36,822,500
B. Gross steam output (lb/hr)	5,175	6,900	8,625	10,350	12,075	13,800	17,250	20,700	24,150	34,500	37,950
Design pressure (psi)	15–500	15–500	15–500	15–500	15–500	65–500	65–500	65–500	65–500	65–500	65–500
Steam operating pressure (psi)	12–450	12–450	12–450	12–450	12–450	60–450	60–450	60–450	60–450	60–450	60–450
C. Thermal efficiencies at 100% firing rate (%): Oil (without SE/SE)	85/87	84/87	84/87	84/87	84/87	83/87	83/86	85/87	84/86	84/87	84/87
Gas (without SE/SE)	83/85	82/85	82/85	82/85	82/85	82/85	82/85	83/85	82/84	83/85	83/85
D. Motor sizes (up to -3 design) Blower (hp)	7 1/2	10	10	10	25	20	25	40	50	75	n/a
Feedwater pump(s) (hp)	5	7 1/2	10	10	15	15	20	30	40	100	n/a
E. Full load amperage (at 460 V) (up to -3 design): standard	25	35	40	45	70	70	80	110	145	277	n/a
FGR/LNOx	35	40	40	50	80	80	90	125	160	287	n/a
F1. Oil consumption w/o SE (gph)	41	57	71	85	99	115	143	168	198.5	290	312
F2. Oil consumption w/ SE (gph)	41	55	68	82	96	110	138	164	193.8	280	301
G1. Natural gas consumption w/o SE (ft^3/hr)	6,050	8,167	10,206	12,247	14,288	16,329	20,412	24,199	28,588	40,824	43,837
G2. Natural gas consumption w/ SE (ft^3/hr)	5,907	7,876	9,846	11,815	13,784	15,753	19,691	23,629	27,885	39,382	42,324
G3. Gas supply pressure (psi)	5–10	5–10	5–10	5–10	5–10	5–10	5–10	5–10	5–10	5–10	5–10
H. Water supply (gph)	795	1,065	1,325	1,590	1,855	2,120	2,651	3,181	3,711	5,302	n/a
Atomizing air (oil-fired only): pressure (psi)	70	70	70	70	70	70	70	70	70–100	100	100
flow (scfm)	25	25	25	25	25	30	30	30	30	50	50
Area of free air intake (sq. ft.)	4.5	6	7.5	9	10.5	12	15	18	21	30	30
Exhaust Stack diameter (in.)	18	18	24	24	24	32	32	32	36	45	45
Heating surface (sq. ft.)	473	473	473	594	594	912	912	1,230	1,522	2,806.8	n/a

[a] Values shown are nominal and are **not** guaranteed.

6.6.2 Table 6-1 Supplemental Information

NOTE

All values are rated at maximum continuous firing rate.

A. Net heat output is calculated by multiplying boiler horsepower by 33,475 Btu/hr. Net heat input can be calculated by dividing net heat output by the rated efficiency.

B. Gross steam output, from and at 212^{o} F, is calculated by multiplying boiler horsepower by 34.5 lb/hr.

C. Thermal efficiencies are based on high heat or gross caloric (Btu) values of the fuel. Efficiencies shown are nominal. Small variations may occur due to manufacturing tolerances. Consult factory for guaranteed values.

D. Consult factory for motor horsepowers for Units with design pressures above 300 psi.

E. Except where noted, indicated full load amperage (FLA) is for 460 VAC primary voltage supply. See paragraph 2.12, Section II, to obtain FLA for other voltages. Consult factory for FLA for Units with design pressures above 300 psi.

F. Oil consumption based on 140,600 Btu/gal. of commercial standard grade No. 2 oil (ASTM D396).

$$\text{Oil Consumption} = \left(\frac{33{,}475\ \text{Btu/hr}}{\text{bhp}}\right)(\text{bhp})\left(\frac{100}{\text{efficiency}}\right)\left(\frac{1\ \text{gal.}}{140{,}600\ \text{Btu}}\right)$$

G. Natural Gas consumption based on 1000 Btu/ft^3 gas. Use the following formula to determine gas consumption for gases with other heat values:

$$\text{Gas Consumption} = \left(\frac{33{,}475\ \text{Btu/hr}}{\text{bhp}}\right)(\text{bhp})\left(\frac{100}{\text{efficiency}}\right)\left(\frac{1\ \text{ft}^3}{1{,}000\ \text{Btu}}\right)$$

H. Water supply is based on 44 lb/hr per boiler horsepower.

6.7 EQUIPMENT LAYOUT AND DIMENSIONS

NOTE

The steam generator layouts and dimensions given in this section are approximate. The illustration in each figure is a general outline that depicts multiple steam generator models. Refer to the corresponding tables that follow each figure for the specific steam generator model dimensions.

6.7.1 Modulating Steam Generators

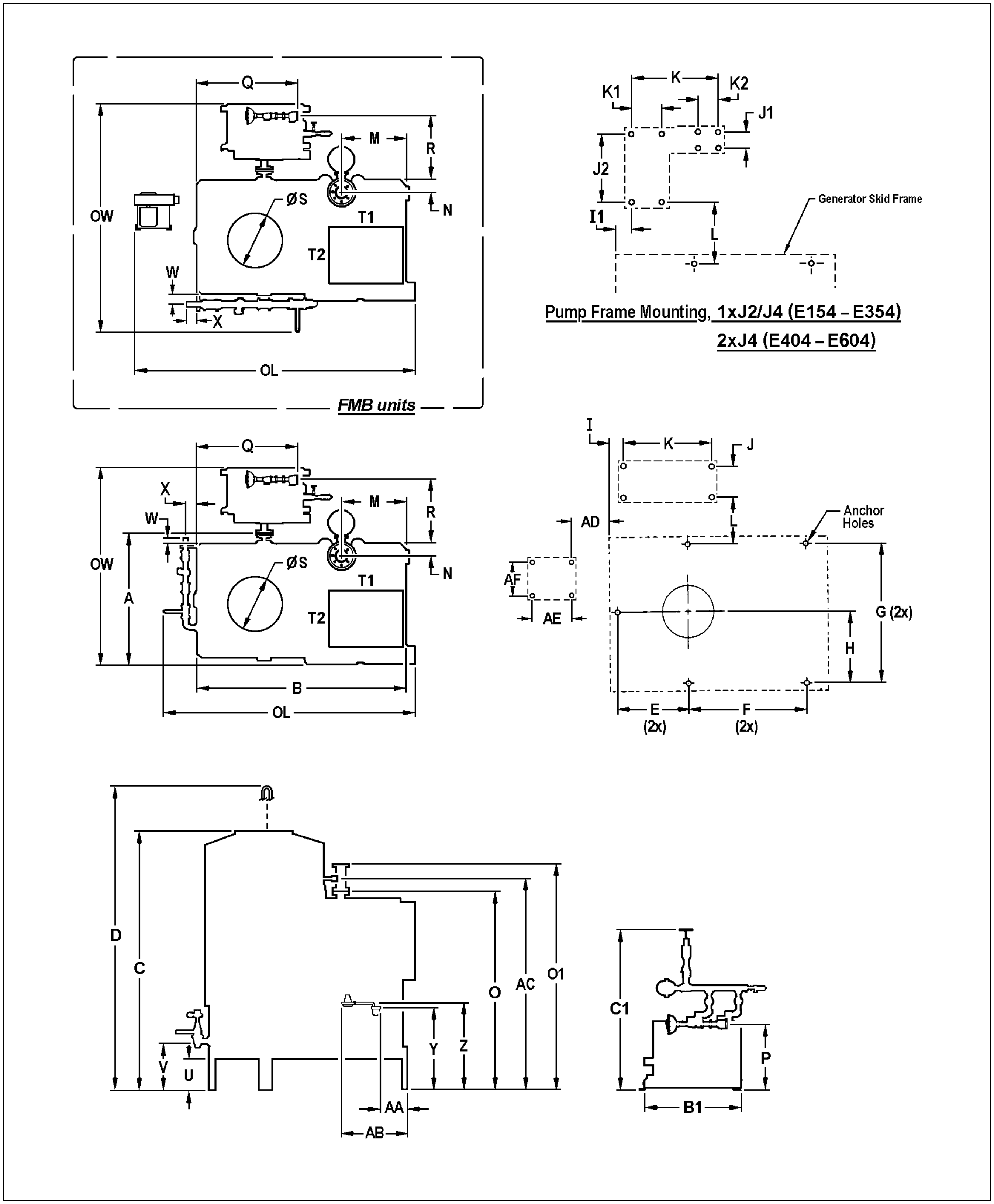


Figure 6-1 Equipment layout for E154–E604 modulating steam generators

Table 6-2: Equipment layout and dimensions for E154–E254 modulating steam generators (refer to Figure 6-1 for layout and item callouts)

	Item	Model: Specification	E-154	E-204	E-254
Layout & Dimensions	A	Generator width; in. (cm)	61.25 (155.58)	61.25 (155.58)	61.25 (155.58)
	B	Generator length (gas); in. (cm)	98.63 (250.52)	98.63 (250.52)	98.63 (250.52)
	B1	Pump length; in. (cm)	39.74 (100.94)	39.74 (100.94)	41.72 (105.97)
	C	Generator height, w/o SE; in. (cm)	101.88 (258.78)	101.88 (258.78)	101.88 (258.78)
	C	Generator height, w/ SE; in. (cm)	120.75 (306.71)	120.75 (306.71)	120.75 (306.71)
	C1	Pump height; in. (cm)	52.43 (133.17)	52.43 (133.17)	55.72 (141.53)
	D	Coil removal height, w/o SE; in. (cm)	109 (276.86)	109 (276.86)	109 (276.86)
	D	Coil removal height, w/ SE; in. (cm)	128 (325.12)	128 (325.12)	128 (325.12)
	OW	Overall generator width; in. (cm)	92.75 (235.59)	92.75 (235.59)	103.13 (261.95)
	OL	Overall generator length (gas); in. (cm)	114.38 (290.53)	114.38 (290.53)	114.38 (290.53)
	E	Frame mounting, generator; in. (cm)	26.88 (68.28)	26.88 (68.28)	26.88 (68.28)
	F	Frame mounting, generator; in. (cm)	60.56 (153.82)	60.56 (153.82)	60.56 (153.82)
	G	Frame mounting, generator; in. (cm)	53.88 (136.86)	53.88 (136.86)	53.88 (136.86)
	H	Frame mounting, generator; in. (cm)	26.88 (68.28)	26.88 (68.28)	26.88 (68.28)
	I	Frame mounting, pump to generator; in. (cm)	7.88 (20.02)	7.88 (20.02)	9 (22.86)
	J	Frame mounting, pump; in. (cm)	9 (22.86)	9 (22.86)	14.75 (37.47)
	K	Frame mounting, pump; in. (cm)	31.5 (80.01)	31.5 (80.01)	30.5 (77.47)
	L	Frame mounting, pump to generator; in. (cm)	16 (40.64)	16 (40.64)	16.5 (41.91)
	M	Steam outlet; in. (cm)	35.63 (90.5)	35.63 (90.5)	35.63 (90.5)
	N	Steam outlet; in. (cm)	4.13 (10.49)	4.13 (10.49)	4.13 (10.49)
	O	Steam outlet; in. (cm)	91.88 (233.38)	91.88 (233.38)	91.88 (233.38)
	O1	Steam outlet, w/ sootblow; in. (cm)	105.75 (268.61)	105.75 (268.61)	105.75 (268.61)
	P	Feedwater inlet; in. (cm)	24.25 (61.6)	24.25 (61.6)	27.63 (70.18)
	Q	Feedwater inlet; in. (cm)	46.88 (119.08)	46.88 (119.08)	43.5 (110.49)
	R	Feedwater inlet; in. (cm)	25.75 (65.41)	25.75 (65.41)	36 (91.44)
	S	Flue diameter, o.d.; in. (cm)	17.88 (45.42)	17.88 (45.42)	23.88 (60.66)
	T1	Air inlet connection; in. (cm)	24.44 (62.08)	24.44 (62.08)	24.44 (62.08)
	T2	Air inlet connection; in. (cm)	20.13 (51.13)	20.13 (51.13)	20.13 (51.13)
	U	Leg height; in. (cm)	15 (38.1)	15 (38.1)	15 (38.1)
	V	Main Gas inlet; in. (cm)	23.38 (59.39)	23.38 (59.39)	23.38 (59.39)
	W	Gas inlet; in. (cm)	1.25 (3.18)	1.25 (3.18)	1.25 (3.18)
	X	Gas inlet; in. (cm)	5.5 (13.97)	5.5 (13.97)	5.5 (13.97)
	Y	Oil inlet; in. (cm)	37.88 (96.22)	37.88 (96.22)	37.88 (96.22)
	Z	Oil return; in. (cm)	41 (104.14)	41 (104.14)	41 (104.14)
	AA	Oil inlet; in. (cm)	20.5 (52.07)	20.5 (52.07)	20.5 (52.07)
	AB	Oil return; in. (cm)	34.5 (87.63)	34.5 (87.63)	34.5 (87.63)
	AC	Gravity fill; in. (cm)	95.63 (242.9)	95.63 (242.9)	95.63 (242.9)
Connection Sizes & Types		Feedwater inlet (FPT); in.	2	2	2
		Separator discharge outlet (300# R. F. flng); in.	4	4	4
		Separator drain (FPT); in.	1-1/2	1-1/2	1-1/2
		Steam Trap discharge outlet (FPT); in.	1	1-1/4	1-1/4
		Coil blowdown drain, w/o SE (FPT); in.	1-1/2	1-1/2	1-1/2
		Coil blowdown drain, w/ SE (FPT); in.	1-1/4	1-1/4	1-1/4
		Coil gravity drain (FPT); in.	2-1/2	2-1/2	2-1/2
		Upper waterwall drain, SE only; in.	1-1/4	1-1/4	1-1/4
		Pilot gas inlet (FPT); in.	1/2	1/2	1/2
		Main gas inlet (FPT); in.	1	1-1/2	1-1/2
		Fuel oil inlet (FPT); in.	1/2	1/2	1/2
		Fuel oil return (FPT); in.	1/2	1/2	1/2
		Atomizing Air Inlet-oil units (FPT); in.	1/2	1/2	1/2
		Gravity fill inlet (FPT); in.	3/4	3/4	3/4
		Sootblow connection (MPT); in.	1-1/2	1-1/2	1-1/2
		Safety Valve outlet	See Plan Installation Drawing for Relief Valve connections.		
Approximate Shipping Weights		Generator shipping weight w/o SE; lb (kg)	7,390 (3,352)	7,410 (3,361)	7,410 (3,361)
		Generator shipping weight w/ SE; lb (kg)	8,360 (3,792)	8,390 (3,806)	8,390 (3,806)
		Pump shipping weight; lb (kg)	850 (386)	1,050 (476)	1,050 (476)

Table 6-2: Equipment layout and dimensions for E304–E354 modulating Steam Generators (refer to Figure 6-1 for layout and item callouts)

		Model:	E-304	E-354
	Item	Specification		
Layout & Dimensions	A	Generator width; in. (cm)	61.25 (155.58)	61.25 (155.58)
	B	Generator length (gas); in. (cm)	93.63 (237.82)	93.63 (237.82)
	B1	Pump length; in. (cm)	41.72 (105.97)	41.72 (105.97)
	C	Generator height, w/o SE; in. (cm)	114.38 (290.53)	114.38 (290.53)
		Generator height, w/ SE; in. (cm)	137 (347.98)	137 (347.98)
	C1	Pump height; in. (cm)	55.72 (141.53)	55.72 (141.53)
	D	Coil removal height, w/o SE; in. (cm)	121.75 (309.25)	121.75 (309.25)
		Coil removal height, w/ SE; in. (cm)	144.38 (366.73)	144.38 (366.73)
	OW	Overall generator width; in. (cm)	103.13 (261.95)	103.13 (261.95)
	OL	Overall generator length (gas); in. (cm)	113.5 (288.29)	113.5 (288.29)
	E	Frame mounting, generator; in. (cm)	26.88 (68.28)	26.88 (68.28)
	F	Frame mounting, generator; in. (cm)	60.56 (153.82)	60.56 (153.82)
	G	Frame mounting, generator; in. (cm)	53.88 (136.86)	53.88 (136.86)
	H	Frame mounting, generator; in. (cm)	26.88 (68.28)	26.88 (68.28)
	I	Frame mounting, pump to generator; in. (cm)	9 (22.86)	9 (22.86)
	J	Frame mounting, pump; in. (cm)	14.75 (37.47)	14.75 (37.47)
	K	Frame mounting, pump; in. (cm)	30.5 (77.47)	30.5 (77.47)
	L	Frame mounting, pump to generator; in. (cm)	16.63 (42.24)	16.63 (42.24)
	M	Steam outlet; in. (cm)	30.75 (78.11)	30.75 (78.11)
	N	Steam outlet; in. (cm)	4.13 (10.49)	4.13 (10.49)
	O	Steam outlet; in. (cm)	98.38 (249.89)	98.38 (249.89)
	O1	Steam outlet, w/ sootblow; in. (cm)	112.25 (285.12)	112.25 (285.12)
	P	Feedwater inlet; in. (cm)	27.63 (70.18)	27.63 (70.18)
	Q	Feedwater inlet; in. (cm)	43.5 (110.49)	43.5 (110.49)
	R	Feedwater inlet; in. (cm)	36 (91.44)	36 (91.44)
	S	Flue diameter, o.d.; in. (cm)	23.88 (60.66)	23.88 (60.66)
	T1	Air inlet connection; in. (cm)	24.31 (61.75)	24.31 (61.75)
	T2	Air inlet connection; in. (cm)	21.04 (53.44)	21.04 (53.44)
	U	Leg height; in. (cm)	15 (38.1)	15 (38.1)
	V	Main Gas inlet; in. (cm)	23.38 (59.39)	23.38 (59.39)
	W	Gas inlet; in. (cm)	1.75 (4.45)	1.75 (4.45)
	X	Gas inlet; in. (cm)	5.5 (13.97)	5.5 (13.97)
	Y	Oil inlet; in. (cm)	37.88 (96.22)	37.88 (96.22)
	Z	Oil return; in. (cm)	41 (104.14)	41 (104.14)
	AA	Oil inlet; in. (cm)	15.5 (39.37)	15.5 (39.37)
	AB	Oil return; in. (cm)	29.5 (74.93)	29.5 (74.93)
	AC	Gravity fill; in. (cm)	103 (261.62)	103 (261.62)
Connection Sizes & Types		Feedwater inlet (FPT); in.	2	2
		Separator discharge outlet; in.	4 (300# R.F. flng.)	4 (300# R.F. flng.)
		Separator drain (FPT); in.	1-1/2	1-1/2
		Steam Trap discharge outlet (FPT); in.	1-1/4	1-1/2
		Coil blowdown drain, w/o SE (FPT); in.	1-1/2	1-1/2
		Coil blowdown drain, w/ SE (FPT); in.	1-1/4	1-1/4
		Coil gravity drain (FPT); in.	2-1/2	2-1/2
		Upper waterwall drain, SE only; in.	1-1/4	1-1/4
		Pilot gas inlet (FPT); in.	1/2	1/2
		Main gas inlet (MPT); in.	1-1/2	1-1/2
		Fuel oil inlet (FPT); in.	1/2	1/2
		Fuel oil return (FPT); in.	1/2	1/2
		Atomizing Air Inlet-Oil Units (FPT); in.	1/2	1/2
		Gravity fill inlet (FPT); in.	3/4	3/4
		Sootblow connection-Oil Units (MPT); in.	1-1/2	1-1/2
		Safety Valve outlet	See Plan Installation Drawing for Relief Valve connections.	
Approximate Shipping Weights		Generator shipping weight w/o SE; lb (kg)	9,140 (4,146)	9,140 (4,146)
		Generator shipping weight w/ SE; lb (kg)	10,530 (4,776)	10,530 (4,776)
		Pump shipping weight; lb (kg)	1,150 (522)	1,150 (522)

Table 6-2: Equipment layout and dimensions for E404–E604 modulating Steam Generators (refer to Figure 6-1 for layout and item callouts)

		Model:	E-404	E-504	E-604
	Item	Specification			
Layout & Dimensions	A	Generator width; in. (cm)	68.75 (174.63)	68.75 (174.63)	68.75 (174.63)
	B	Generator length (EG/EOG); in. (cm)	117.38 (298.15)	117.25 (298.15)	117.25 (298.15)
	B1	Pump length, single J4; in. (cm)	41.72 (106)	na	na
		Pump length, dual J4; in. (cm)	59.26 (150.52)	59.26 (150.52)	59.26 (150.52)
	C	Generator height, w/o SE; in. (cm)	130.75 (332.11)	130.75 (332.11)	180.5 (458.47)
		Generator height, w/ SE; in. (cm)	156.25 (396.88)	156.25 (396.88)	na
	C1	Pump height, single J4; in. (cm)	55.72	na	na
		Pump height, dual J4; in. (cm)	61.86 (157.12)	61.86 (157.12)	61.86 (157.12)
	D	Coil removal height, w/o SE; in. (cm)	134.5 (341.63)	134.5 (341.63)	188.75 (479.43)
		Coil removal height, w/ SE; in. (cm)	164.5 (417.83)	164.5	na
	OW	Overall generator width, single J4; in. (cm)	104 (264.16)	na	na
		Overall generator width, dual J4; in. (cm)	130.63 (331.8)	130.63 (331.8)	130.63 (331.8)
	OL	Overall generator length (gas); in. (cm)	133.13 (338.15)	133.13 (338.15)	133.13 (338.15)
	E	Frame mounting, generator; in. (cm)	32.13 (81.61)	32.13 (81.61)	32.13 (81.61)
	F	Frame mounting, generator; in. (cm)	62 (157.48)	62 (157.48)	62 (157.48)
	G	Frame mounting, generator; in. (cm)	64.25 (163.2)	64.25 (163.2)	64.25 (163.2)
	H	Frame mounting, generator; in. (cm)	32.13 (81.61)	32.13 (81.61)	32.13 (81.61)
	I	Frame mounting, pump to generator; in. (cm)	21 (53.34)	na	na
	I1	Frame mounting, pump to generator; in. (cm)	10.38 (26.37)	10.38 (26.37)	10.38 (26.37)
	J	Frame mounting, pump; in. (cm)	14.75 (37.47)	na	na
	J1	Frame mounting, pump; in. (cm)	7.38 (18.75)	7.38 (18.75)	7.38 (18.75)
	J2	Frame mounting, pump; in. (cm)	30.5 (77.47)	30.5 (77.47)	30.5 (77.47)
	K	Frame mounting, pump, single J4; in. (cm)	30.5 (77.47)	na	na
		Frame mounting, pump, dual J4; in. (cm)	41.38 (105.11)	41.38 (105.11)	41.38 (105.11)
	K1	Frame mounting, pump, dual J4; in. (cm)	14.75 (37.47)	14.75 (37.47)	14.75 (37.47)
	K2	Frame mounting, pump, dual J4; in. (cm)	12 (30.48)	12 (30.48)	12 (30.48)
	L	Frame mounting, pump to generator; in. (cm)	16.63 (42.24)	18 (45.72)	18 (45.72)
	M	Steam outlet; in. (cm)	30.69 (77.95)	30.69 (77.95)	30.75 (78.11)
	N	Steam outlet; in. (cm)	9 (22.86)	9 (22.86)	9.13 (23.19)
	O	Steam outlet; in. (cm)	118.25 (300.36)	118.25 (300.36)	118.25 (300.36)
	O1	Steam outlet, w/ sootblow (EO/EOG); in. (cm)	134.37 (341.3)	134.37 (341.3)	134.37 (341.3)
	P	Feedwater inlet; in. (cm)	27.5 (69.85)	27.5 (69.85)	27.5 (69.85)
	Q	Feedwater inlet, single J4; in. (cm)	55.5 (140.97)	na	na
		Feedwater inlet, dual J4; in. (cm)	54.63 (138.76)	54.63 (138.76)	54.63 (138.76)
	R	Feedwater inlet, single J4; in. (cm)	35.75 (90.81)	na	na
		Feedwater inlet, dual J4; in. (cm)	64.25 (163.2)	64.25 (163.2)	64.25 (163.2)
	S	Flue diameter, o.d.; in. (cm)	31.75 (80.65)	31.75 (80.65)	31.75 (80.65)
	T1	Air inlet connection; in. (cm)	24.31 (61.75)	24.31 (61.75)	24.31 (61.75)
	T2	Air inlet connection; in. (cm)	21.04 (53.44)	21.04 (53.44)	21.04 (53.44)
	U	Leg height; in. (cm)	13 (33.02)	13 (33.02)	13 (33.02)
	V	Main gas inlet; in. (cm)	25.25 (64.14)	25.25 (64.14)	25.25 (64.14)
	W	Gas inlet; in. (cm)	2.25 (5.72)	2.25 (5.72)	2.25 (5.72)
	X	Gas inlet; in. (cm)	8.38 (21.29)	8.38 (21.29)	8.38 (21.29)
	Y	Oil inlet; in. (cm)	38.88 (98.76)	38.88 (98.76)	38.88 (98.76)
	Z	Oil return; in. (cm)	42 (106.68)	42 (106.68)	42 (106.68)
	AA	Oil inlet; in. (cm)	26 (66.04)	26 (66.04)	26 (66.04)
	AB	Oil return; in. (cm)	37.38 (94.95)	37.38 (94.95)	37.38 (94.95)
	AC	Gravity fill; in. (cm)	126.13 (320.37)	126.13 (320.37)	142.13 (361.01)
Connection Sizes & Types		Feedwater inlet (FPT), dual J4; in.	2 x 3	2 x 3	2 x 3
		Separator discharge outlet (300# R. F. flng); in.	6	6	6
		Separator drain (FPT); in.	1-1/2	1-1/2	1-1/2
		Steam Trap discharge outlet (FPT); in.	1-1/2	1-1/2	1-1/2
		Coil blowdown drain, w/o SE (FPT); in.	1-1/2	1-1/2	1-1/2
		Coil blowdown drain, w/ SE (FPT); in.	1-1/2	1-1/2	1-1/2
		Coil gravity drain (FPT); in.	2-1/2	2-1/2	2-1/2
		Upper waterwall drain (FPT), SE only; in.	1-1/2	1-1/2	1-1/2
		Pilot gas inlet (FPT); in.	1/2	1/2	1/2

Table 6-2: Equipment layout and dimensions for E404–E604 modulating Steam Generators (refer to Figure 6-1 for layout and item callouts)

	Model:	E-404	E-504	E-604
Connection Sizes & Types	Main gas inlet (MPT); in.	2	2	2
	Fuel oil inlet (FPT); in.	1/2	1/2	1/2
	Fuel oil return (FPT); in.	1/2	1/2	1/2
	Atomizing Air Inlet-Oil Units (FPT); in.	1/2	1/2	1/2
	Gravity fill inlet (FPT); in.	3/4	3/4	3/4
	Sootblow connection-Oil Units (MPT); in.	2-1/2	2-1/2	2-1/2
	Safety Valve outlet	See Plan Installation Drawing for Relief Valve connections.		
Approximate Shipping Weights	Generator shipping weight w/o SE; lb (kg)	14,650 (6,645)	14,790 (6,709)	17,980 (8,156)
	Generator shipping weight w/ SE; lb (kg)	17,040 (7,729)	17,190 (7,797)	na
	Pump shipping weight; lb (kg)	1,970 (894)	2,000 (907)	2,200 (998)

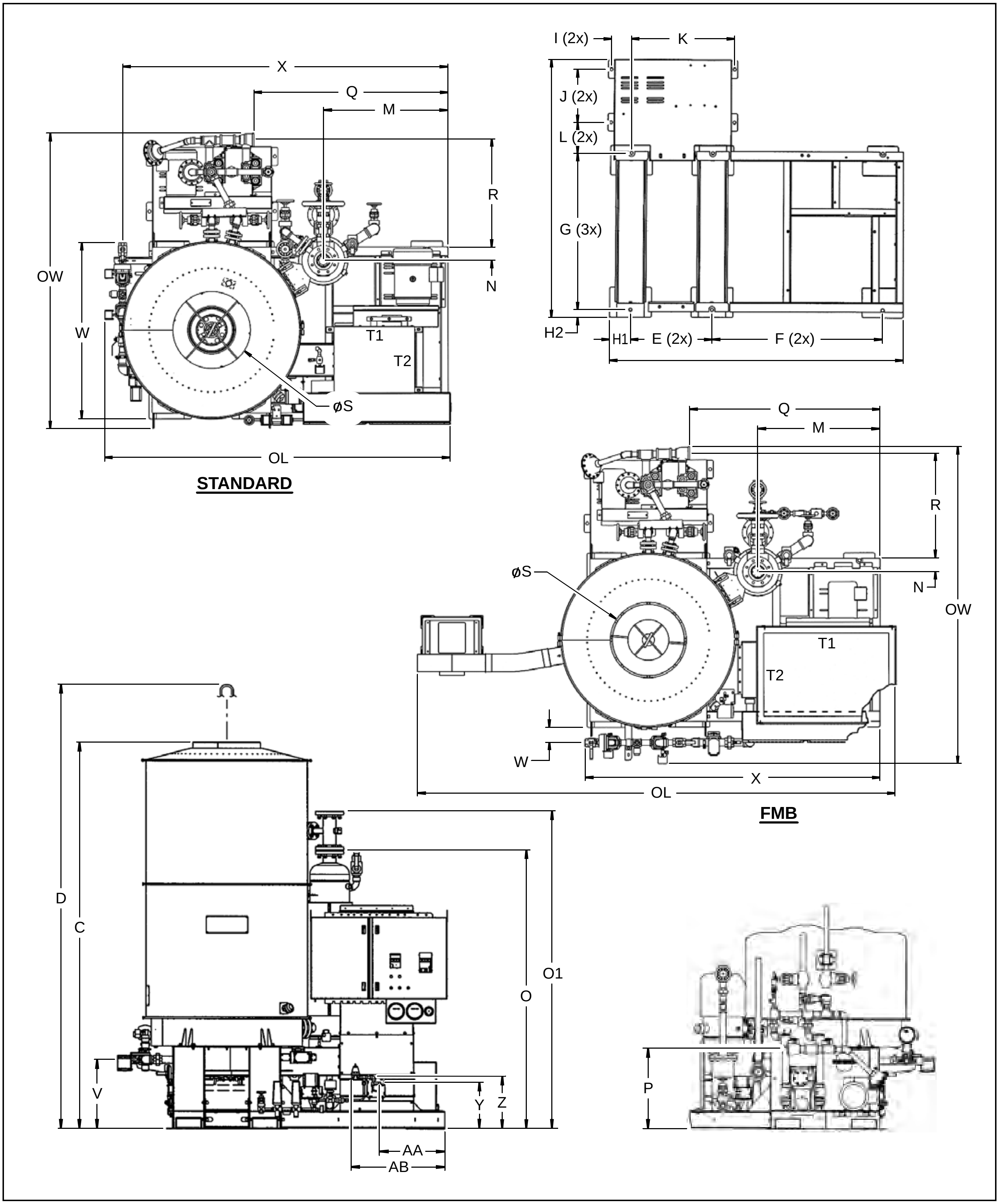


Figure 6-2 Equipment layout for E154–E354 flush-floor frame, modulating, steam generators

Table 6-3: Equipment layout and dimensions for E154–E204FMB modulating steam generators with flush-floor frame (refer to Figure 6-2 on previous page for layout and item callouts)

	Item	Model: Specification	E-154	E-204	E-204FMB
Layout & Dimensions	C	Generator height, w/o SE; in. (cm)	102 (259)	102 (259)	109.1 (277)
	C	Generator height, w/ SE; in. (cm)	120.75 (306.7)	120.75 (306.7)	127.9 (325)
	D	Coil removal height, w/o SE; in. (cm)	109 (277)	109 (277)	116 (294.6)
	D	Coil removal height, w/ SE; in. (cm)	127.5 (324)	127.5 (324)	135 (343)
	OW	Overall generator width; in. (cm)	96.38 (244.8)	96.38 (244.8)	105.38 (267.7)
	OL	Overall generator length (gas); in. (cm)	112.5 (285.8)	112.5 (285.8)	158.5 (402.6)
	E	Frame mounting, generator; in. (cm)	26.88 (68.3)	26.88 (68.3)	26.88 (68.3)
	F	Frame mounting, generator; in. (cm)	56.63 (143.8)	56.63 (143.8)	56.63 (143.8)
	G	Frame mounting, generator; in. (cm)	53 (134.6)	53 (134.6)	53 (134.6)
	H1	Frame mounting, generator; in. (cm)	6.88 (17.5)	6.88 (17.5)	6.88 (17.5)
	H2	Frame mounting, generator; in. (cm)	2.5 (6.4)	2.5 (6.4)	2.5 (6.4)
	I	Frame mounting, pump to generator; in. (cm)	6.88 (17.5)	6.88 (17.5)	6.88 (17.5)
	J	Frame mounting, pump; in. (cm)	17.88 (45.4)	17.88 (45.4)	17.88 (45.4)
	K	Frame mounting, pump; in. (cm)	33.88 (86)	33.88 (86)	33.88 (86)
	L	Frame mounting, pump; in. (cm)	12.38 (31.4)	12.38 (31.4)	12.38 (31.4)
	M	Steam outlet; in. (cm)	40.63 (103.2)	40.63 (103.2)	40.63 (103.2)
	N	Steam outlet; in. (cm)	4.38 (11)	4.38 (11)	4.38 (11)
	O	Steam outlet; in. (cm)	89.5 (227.3)	89.5 (227.3)	89.5 (227.3)
	O1	Steam outlet, w/ sootblow; in. (cm)	103.5 (263)	103.5 (263)	103.5 (263)
	P	Feedwater inlet; in. (cm)	28.75 (73)	28.75 (73)	28.75 (73)
	Q	Feedwater inlet; in. (cm)	63.13 (160.4)	63.13 (160.4)	63.13 (160.4)
	R	Feedwater inlet; in. (cm)	63.13 (160.4)	63.13 (160.4)	63.13 (160.4)
	S	Flue diameter, o.d.; in. (cm)	18 (46)	18 (46)	18 (46)
	T1	Air inlet connection; in. (cm)	25.75 (65.4)	25.75 (65.4)	31.9 (81.0)
	T2	Air inlet connection; in. (cm)	21.25 (54.0)	21.25 (54.0)	20.9 (53.0)
	V	Main Gas inlet; in. (cm)	24.38 (62)	24.38 (62)	19.75 (50.2)
	W	Gas inlet; in. (cm)	57.63 (146.4)	57.63 (146.4)	5.25 (13.3)
	X	Gas inlet; in. (cm)	105.88 (269)	105.88 (269)	97.75 (248.3)
	Y	Oil inlet; in. (cm)	16.5 (42)	16.5 (42)	N/A
	Z	Oil return; in. (cm)	19.75 (50.2)	19.75 (50.2)	N/A
	AA	Oil inlet; in. (cm)	23.38 (59.4)	23.38 (59.4)	N/A
	AB	Oil return; in. (cm)	33.75 (85.7)	33.75 (85.7)	N/A
Connection Sizes & Types		Feedwater inlet (FPT); in.	2	3	3
		Separator discharge outlet (300# R. F. flng); in.	4	4	4
		Separator drain (FPT); in.	1-1/2	1-1/2	1-1/2
		Steam Trap discharge outlet (FPT); in.	1	1-1/4	1-1/2
		Coil blowdown drain, w/o SE (FPT); in.	1-1/2	1-1/2	1-1/2
		Coil blowdown drain, w/ SE (FPT); in.	1-1/4	1-1/4	1-1/4
		Coil gravity drain (FPT); in.	2-1/2	2-1/2	2-1/2
		Upper waterwall drain, SE only; in.	1-1/4	1-1/4	1-1/4
		Pilot gas inlet (FPT); in.	1/2	1/2	1/2
		Main gas inlet (FPT); in.	1	1-1/2	1-1/2
		Fuel oil inlet (FPT); in.	1/2	1/2	N/A
		Fuel oil return (FPT); in.	1/2	1/2	N/A
		Atomizing Air Inlet-oil units (FPT); in.	1/2	1/2	N/A
		Gravity fill inlet (FPT); in.	3/4	3/4	3/4
		Sootblow connection (MPT); in.	1-1/2	1-1/2	N/A
		Safety Valve outlet	See Plan Installation Drawing for Relief Valve connections.		
Approximate Shipping Weights		Generator shipping weight w/o SE; lb (kg)	7,390 (3,352)	7,500 (3,402)	7,500 (3,402)
		Generator shipping weight w/ SE; lb (kg)	8,360 (3,792)	8,400 (3,810)	8,400 (3,810)
		Pump shipping weight; lb (kg)	1,100 (499)	1,200 (545)	1,200 (545)

Table 6-3: Equipment layout and dimensions for E254FMB–E304 modulating Steam Generators with flush-floor frame (refer to Figure 6-2 for layout and item callouts)

	Item	Model: / Specification	E-254	E-254FMB	E-304
Layout & Dimensions	C	Generator height, w/o SE; in. (cm)	102 (259)	109.1 (277)	114.63 (291)
	C	Generator height, w/ SE; in. (cm)	120.75 (307)	127.9 (325)	137.13 (348)
	D	Coil removal height, w/o SE; in. (cm)	109 (277)	116 (294.6)	122 (310)
	D	Coil removal height, w/ SE; in. (cm)	127.5 (324)	135 (343)	144.5 (367)
	OW	Overall generator width; in. (cm)	96.38 (244.8)	105.38 (267.7)	96.38 (244.8)
	OL	Overall generator length (gas); in. (cm)	112.5 (285.8)	158.5 (402.6)	112.5 (285.8)
	E	Frame mounting, generator; in. (cm)	26.88 (68.3)	26.88 (68.3)	26.88 (68.3)
	F	Frame mounting, generator; in. (cm)	56.63 (143.8)	56.63 (143.8)	56.63 (143.8)
	G	Frame mounting, generator; in. (cm)	53 (134.6)	53 (134.6)	53 (134.6)
	H1	Frame mounting, generator; in. (cm)	6.88 (17.5)	6.88 (17.5)	6.88 (17.5)
	H2	Frame mounting, generator; in. (cm)	2.5 (6.4)	2.5 (6.4)	2.5 (6.4)
	I	Frame mounting, pump to generator; in. (cm)	6.88 (17.5)	6.88 (17.5)	6.88 (17.5)
	J	Frame mounting, pump; in. (cm)	17.88 (45.4)	17.88 (45.4)	17.88 (45.4)
	K	Frame mounting, pump; in. (cm)	33.88 (86)	33.88 (86)	33.88 (86)
	L	Frame mounting, pump; in. (cm)	12.38 (31.4)	12.38 (31.4)	12.38 (31.4)
	M	Steam outlet; in. (cm)	40.63 (103.2)	40.63 (103.2)	40.63 (103.2)
	N	Steam outlet; in. (cm)	4.38 (11)	4.38 (11)	4.38 (11)
	O	Steam outlet; in. (cm)	89.5 (227.3)	89.5 (227.3)	89.5 (227.3)
	O1	Steam outlet, w/ sootblow; in. (cm)	103.5 (263)	103.5 (263)	103.5 (263)
	P	Feedwater inlet; in. (cm)	28.75 (73)	28.75 (73)	28.75 (73)
	Q	Feedwater inlet; in. (cm)	63.13 (160.4)	63.13 (160.4)	63.13 (160.4)
	R	Feedwater inlet; in. (cm)	63.13 (160.4)	63.13 (160.4)	63.13 (160.4)
	S	Flue diameter, o.d.; in. (cm)	24 (61)	24 (61)	24 (61)
	T1	Air inlet connection; in. (cm)	25.75 (65.4)	31.9 (81.0)	25.75 (65.4)
	T2	Air inlet connection; in. (cm)	21.25 (54.0)	20.9 (53.0)	21.25 (54.0)
	V	Main Gas inlet; in. (cm)	24.38 (62)	19.75 (50.2)	24.38 (62)
	W	Gas inlet; in. (cm)	57.63 (146.4)	5.25 (13.3)	57.63 (146.4)
	X	Gas inlet; in. (cm)	105.88 (269)	97.75 (248.3)	105.88 (269)
	Y	Oil inlet; in. (cm)	16.5 (42)	N/A	16.5 (42)
	Z	Oil return; in. (cm)	19.75 (50.2)	N/A	19.75 (50.2)
	AA	Oil inlet; in. (cm)	23.38 (59.4)	N/A	23.38 (59.4)
	AB	Oil return; in. (cm)	33.75 (85.7)	N/A	33.75 (85.7)
Connection Sizes & Types		Feedwater inlet (FPT); in.	3	3	3
		Separator discharge outlet; in. (300# R.F. flng.)	4	4	4
		Separator drain (FPT); in.	1-1/2	1-1/2	1-1/2
		Steam Trap discharge outlet (FPT); in.	1-1/4	1-1/2	1-1/4
		Coil blowdown drain, w/o SE (FPT); in.	1-1/2	1-1/2	1-1/2
		Coil blowdown drain, w/ SE (FPT); in.	1-1/4	1-1/4	1-1/4
		Coil gravity drain (FPT); in.	2-1/2	2-1/2	2-1/2
		Upper waterwall drain, SE only; in.	1-1/4	1-1/4	1-1/4
		Pilot gas inlet (FPT); in.	1/2	1/2	1/2
		Main gas inlet (FPT); in.	1-1/2	1-1/2	1-1/2
		Fuel oil inlet (FPT); in.	1/2	N/A	1/2
		Fuel oil return (FPT); in.	1/2	N/A	1/2
		Atomizing Air Inlet-Oil Units (FPT); in.	1/2	N/A	1/2
		Gravity fill inlet (FPT); in.	3/4	3/4	3/4
		Sootblow connection-Oil Units (MPT); in.	1-1/2	N/A	1-1/2
		Safety Valve outlet	See Plan Installation Drawing for Relief Valve connections.		
Approximate Shipping Weights		Generator shipping weight w/o SE; lb (kg)	7,500 (3,402)	7,500 (3,402)	9,200 (4,173)
		Generator shipping weight w/ SE; lb (kg)	8,400 (3,810)	8,400 (3,810)	10,530 (4,776)
		Pump shipping weight; lb (kg)	1,200 (545)	1,200 (545)	1,200 (545)

Table 6-3: Equipment layout and dimensions for E304FMB–E354FMB modulating Steam Generators with flush-floor frame (refer to Figure 6-2 for layout and item callouts)

	Item	Model: / Specification	E-304FMB	E-354	E-354FMB
Layout & Dimensions	C	Generator height, w/o SE; in. (cm)	121.88 (310)	114.63 (291)	121.88 (310)
	C	Generator height, w/ SE; in. (cm)	144.38 (367)	137.13 (348)	144.38 (367)
	D	Coil removal height, w/o SE; in. (cm)	129 (327.7)	122 (310)	129 (327.7)
	D	Coil removal height, w/ SE; in. (cm)	152 (386.1)	144.5 (367)	152 (386.1)
	OW	Overall generator width; in. (cm)	105.38 (267.7)	96.38 (244.8)	105.38 (267.7)
	OL	Overall generator length (gas); in. (cm)	158.5 (402.6)	115 (292.1)	158.5 (402.6)
	E	Frame mounting, generator; in. (cm)	26.88 (68.3)	26.88 (68.3)	26.88 (68.3)
	F	Frame mounting, generator; in. (cm)	56.63 (143.8)	56.63 (143.8)	56.63 (143.8)
	G	Frame mounting, generator; in. (cm)	53 (134.6)	53 (134.6)	53 (134.6)
	H1	Frame mounting, generator; in. (cm)	6.88 (17.5)	6.88 (17.5)	6.88 (17.5)
	H2	Frame mounting, generator; in. (cm)	2.5 (6.4)	2.5 (6.4)	2.5 (6.4)
	I	Frame mounting, pump to generator; in. (cm)	6.88 (17.5)	6.88 (17.5)	6.88 (17.5)
	J	Frame mounting, pump; in. (cm)	17.88 (45.4)	17.88 (45.4)	17.88 (45.4)
	K	Frame mounting, pump; in. (cm)	33.88 (86)	33.88 (86)	33.88 (86)
	L	Frame mounting, pump; in. (cm)	12.38 (31.4)	12.38 (31.4)	12.38 (31.4)
	M	Steam outlet; in. (cm)	40.63 (103.2)	40.63 (103.2)	40.63 (103.2)
	N	Steam outlet; in. (cm)	4.38 (11)	4.38 (11)	4.38 (11)
	O	Steam outlet; in. (cm)	89.5 (227.3)	89.5 (227.3)	89.5 (227.3)
	O1	Steam outlet, w/ sootblow; in. (cm)	103.5 (263)	103.5 (263)	103.5 (263)
	P	Feedwater inlet; in. (cm)	28.75 (73)	28.75 (73)	28.75 (73)
	Q	Feedwater inlet; in. (cm)	63.13 (160.4)	63.13 (160.4)	63.13 (160.4)
	R	Feedwater inlet; in. (cm)	63.13 (160.4)	63.13 (160.4)	63.13 (160.4)
	S	Flue diameter, o.d.; in. (cm)	24 (61)	24 (61)	24 (61)
	T1	Air inlet connection; in. (cm)	37.83 (96.0)	25.75 (65.4)	37.83 (96.0)
	T2	Air inlet connection; in. (cm)	23.84 (60.6)	21.25 (54.0)	23.84 (60.6)
	V	Main Gas inlet; in. (cm)	19.75 (50.2)	24.38 (62)	19.75 (50.2)
	W	Gas inlet; in. (cm)	5.25 (13.3)	57.63 (146.4)	5.25 (13.3)
	X	Gas inlet; in. (cm)	97.75 (248.3)	105.88 (269)	97.75 (248.3)
	Y	Oil inlet; in. (cm)	N/A	16.5 (42)	N/A
	Z	Oil return; in. (cm)	N/A	19.75 (50.2)	N/A
	AA	Oil inlet; in. (cm)	N/A	23.38 (59.4)	N/A
	AB	Oil return; in. (cm)	N/A	33.75 (85.7)	N/A
Connection Sizes & Types		Feedwater inlet (FPT); in.	3	3	3
		Separator discharge outlet; in. (300# R.F. flng.)	4	4	4
		Separator drain (FPT); in.	1-1/2	1-1/2	1-1/2
		Steam Trap discharge outlet (FPT); in.	1-1/2	1-1/2	1-1/2
		Coil blowdown drain, w/o SE (FPT); in.	1-1/2	1-1/2	1-1/2
		Coil blowdown drain, w/ SE (FPT); in.	1-1/4	1-1/4	1-1/4
		Coil gravity drain (FPT); in.	2-1/2	2-1/2	2-1/2
		Upper waterwall drain, SE only; in.	1-1/4	1-1/4	1-1/4
		Pilot gas inlet (FPT); in.	1/2	1/2	1/2
		Main gas inlet (FPT); in.	1-1/2	1-1/2	1-1/2
		Fuel oil inlet (FPT); in.	N/A	1/2	N/A
		Fuel oil return (FPT); in.	N/A	1/2	N/A
		Atomizing Air Inlet-Oil Units (FPT); in.	N/A	1/2	N/A
		Gravity fill inlet (FPT); in.	3/4	3/4	3/4
		Sootblow connection-Oil Units (MPT); in.	N/A	1-1/2	N/A
		Safety Valve outlet	See Plan Installation Drawing for relief valve connections.		
Approximate Shipping Weights		Generator shipping weight w/o SE; lb (kg)	9,200 (4,173)	9,200 (4,173)	9,200 (4,173)
		Generator shipping weight w/ SE; lb (kg)	10,530 (4,776)	10,530 (4,776)	10,530 (4,776)
		Pump shipping weight; lb (kg)	1,200 (545)	1,200 (545)	1,200 (545)

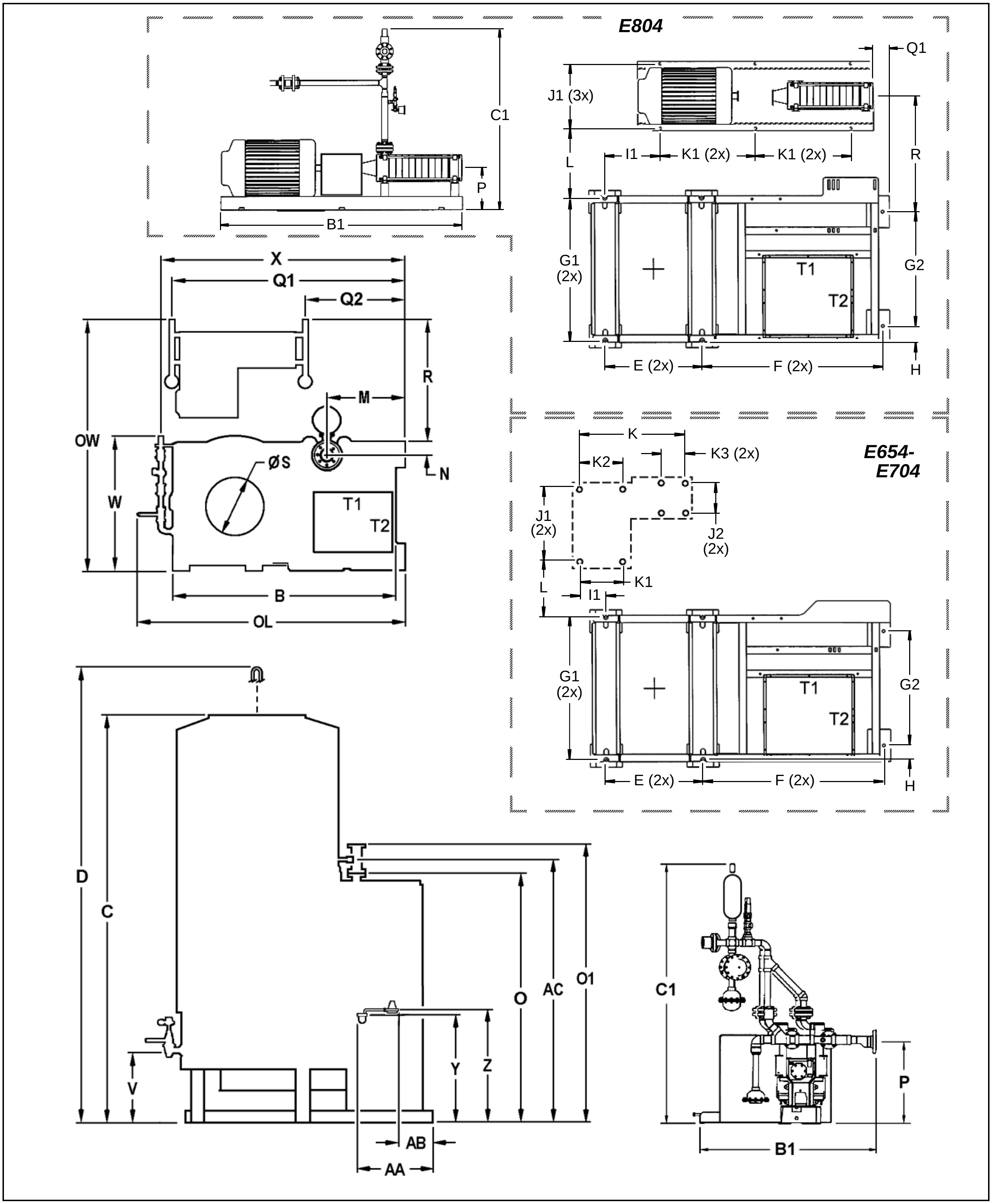


Figure 6-3 Equipment layout for E654−E804 modulating steam generators

Table 6-4: Equipment layout and dimensions for E654–E804 modulating Steam Generators (refer to Figure 6-3 for layout and item callouts)

	Item	Model: Specification	E654	E-704	E804
Layout & Dimensions	OW	Generator width, overall; in. (cm)	151.88 (385.8)	151.88 (385.8)	132.13 (335.6)
	OL	Generator length, overall (gas); in. (cm)	138.75 (352.4)	138.75 (352.4)	150.63 (382.6)
	B1	Pump length; in. (cm)	52.75 (134)	52.75 (134)	102.38 (260)
	C	Generator height, w/o SE; in. (cm)	205.13 (521)	205.13 (521)	197.5 (501.7)
		Generator height, w/ SE; in. (cm)	215.13 (546.4)	215.13 (546.4)	223.75 (568.3)
	C1	Pump height; in. (cm)	98.9 (251.2)	98.9 (251.2)	70.88 (180)
	D	Coil removal height, w/o SE; in. (cm)	218.13 (554)	218.13 (554)	184.5 (468.6)
		Coil removal height, w/ SE; in. (cm)	219.63 (558)	219.63 (558)	229.75 (583.7)
	E	Frame mounting, generator; in. (cm)	42.13 (107)	42.13 (107)	42 (106.7)
	F	Frame mounting, generator; in. (cm)	62.75 (159.4)	62.75 (159.4)	78.5 (199.4)
	G1	Frame mounting, generator; in. (cm)	62.75 (159.4)	62.75 (159.4)	62.75 (159.4)
	G2	Frame mounting, generator; in. (cm)	52 (139.1)	52 (139.1)	50 (127)
	H	Frame mounting, generator; in. (cm)	5.38 (13.7)	5.38 (13.7)	7 (17.8)
	I1	Frame mounting, pump to generator; in. (cm)	6.13 (15.6)	6.13 (15.6)	24.25 (61.6)
	J1	Frame mounting, pump; in. (cm)	36 (91.4)	36 (91.4)	28.25 (71.6)
	J2	Frame mounting, pump; in. (cm)	12 (30.5)	12 (30.5)	n/a
	K	Frame mounting, pump; in. (cm)	43.13 (109.6)	43.13 (109.6)	n/a
	K1	Frame mounting, pump; in. (cm)	14.78 (37.5)	14.78 (37.5)	41.38 (105.1)
	K2	Frame mounting, pump; in. (cm)	16.38 (41.6)	16.38 (41.6)	41.38 (105.1)
	K3	Frame mounting, pump; in. (cm)	12 (30.5)	12 (30.5)	n/a
	L	Frame mounting, pump to generator; in. (cm)	22.5 (57.2)	22.5 (57.2)	30.13 (76.5)
	M	Steam outlet; in. (cm)	39.38 (100)	39.38 (100)	53.25 (135.3)
	N	Steam outlet; in. (cm)	10.88 (27.6)	10.88 (27.6)	7.5 (19.1)
	O	Steam outlet; in. (cm)	118.75 (301.6)	118.75 (301.6)	127.25 (323.2)
	O1	Steam outlet, w/ sootblow; in. (cm)	136.38 (346.4)	136.38 (346.4)	144.88 (368)
	P	Feedwater inlet; in. (cm)	27.13 (68.9)	27.13 (68.9)	17.5 (44.5)
	Q1	Feedwater inlet; in. (cm)	123.25 (313.1)	123.25 (313.1)	13.13 (33.4)
	Q2	Feedwater inlet; in. (cm)	60.75 (154.3)	60.75 (154.3)	n/a
	R	Feedwater inlet; in. (cm)	75.75 (192.4)	75.75 (192.4)	50.63 (128.6)
	S	Flue diameter, o.d.; in. (cm)	35.75 (90.8)	35.75 (90.8)	35.75 (90.8)
	T1	Air inlet connection; in. (cm)	n/a	37.64 (95.6)	n/a
	T2	Air inlet connection; in. (cm)	n/a	35.7 (90.7)	n/a
	V	Main Gas inlet; in. (cm)	28 (71.1)	28 (71.1)	27.88 (70.8)
	W	Gas inlet; in. (cm)	69.25 (175.9)	69.25 (175.9)	75 (190.5)
	X	Gas inlet; in. (cm)	123.75 (314.3)	123.75 (314.3)	142 (360.7)
	Y	Oil inlet; in. (cm)	24.63 (62.6)	24.63 (62.6)	20.75 (52.7)
	Z	Oil return; in. (cm)	27.88 (70.8)	27.88 (70.8)	24 (61)
	AA	Oil inlet; in. (cm)	31 (78.7)	31 (78.7)	36 (91.4)
	AB	Oil return; in. (cm)	22.63 (57.5)	22.63 (57.5)	22.88 (58.1)
	AC	Gravity fill; in. (cm)	82.63 (209.9)	82.63 (209.9)	87.25 (221.6)
Connection Sizes & Types		Feedwater inlet (r. f. flange); in.	(2x) 4	(2x) 4	4
		Separator/Standpipe discharge outlet; in.	6	6	6
		Separator drain (r. f. flange); in.	1.5	1.5	1.5
		Steam Trap discharge outlet (r. f. flange); in.	1.5	1.5	1.5
		Coil blowdown drain, w/o SE (r. f. flange); in.	1.5	1.5	2
		Coil blowdown drain, w/ SE (r. f. flange); in.	1.5	1.5	2
		Coil gravity drain (r. f. flange); in.	1	1	1
		Upper waterwall drain, SE only (r. f. flange); in.	1	1	1
		Pilot gas inlet (FPT); in.	.5	.5	.5
		Main gas inlet (MPT); in.	2.5	2.5	3
		Fuel oil inlet (FPT); in.	.5	.5	.5
		Fuel oil return (FPT); in.	.5	.5	.5
		Atomizing Air Inlet-Oil Units (FPT); in.	.5	.5	.5
		Gravity fill inlet (FPT); in.	.75	.75	.75
		Safety Valve outlet	See Plan Installation Drawing for safety valve connections.		
Shipping Weights		Generator shipping weight w/o SE; lb (kg)	24,500 (11,113)	24,500 (11,113)	22,750 (10,320)
		Generator shipping weight w/ SE; lb (kg)	27,800 (12,609)	27,800 (12,609)	n/a
		Pump shipping weight; lb (kg)	2,400 (1,089)	2,400 (1,089)	3,200 (1,452)

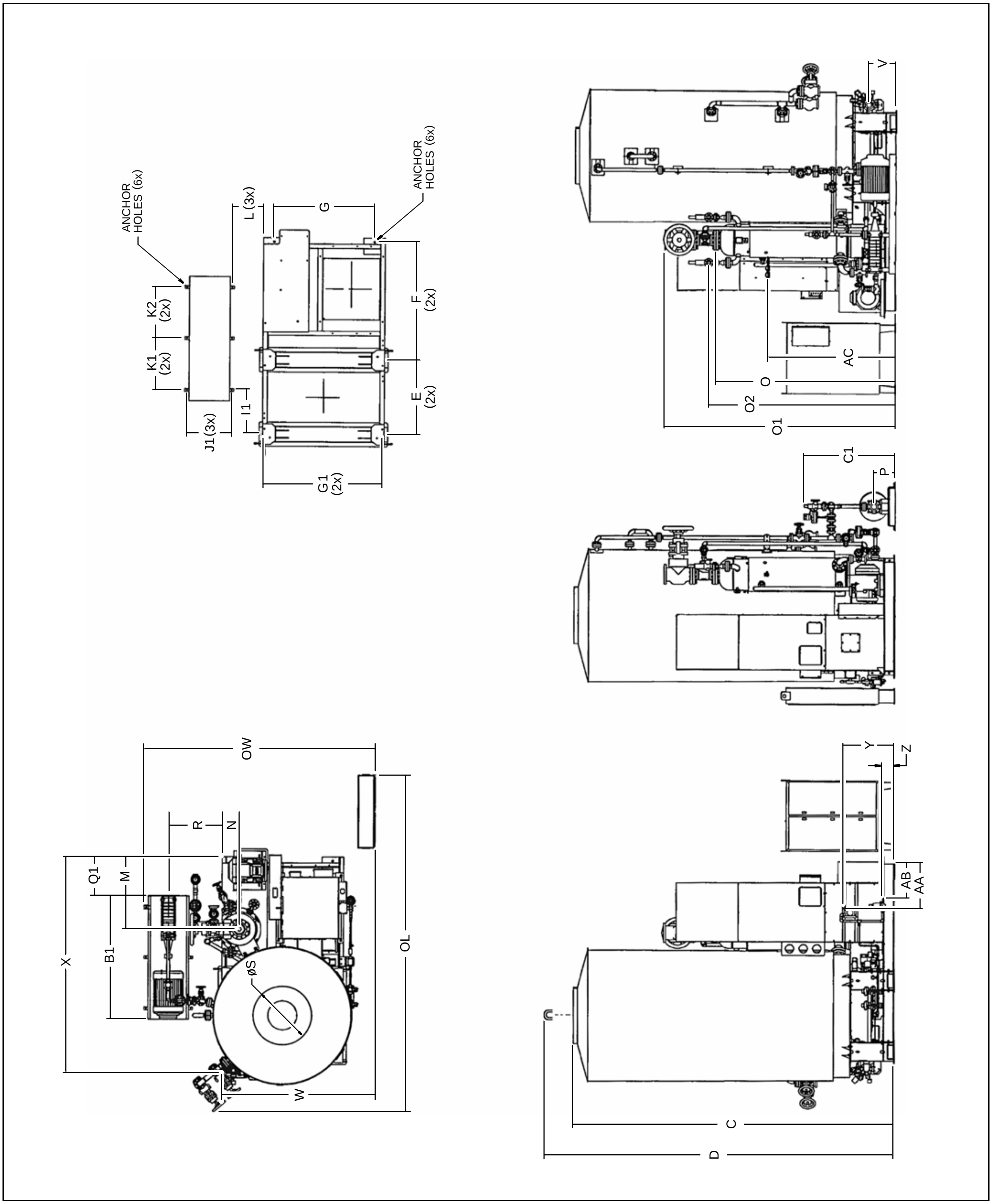
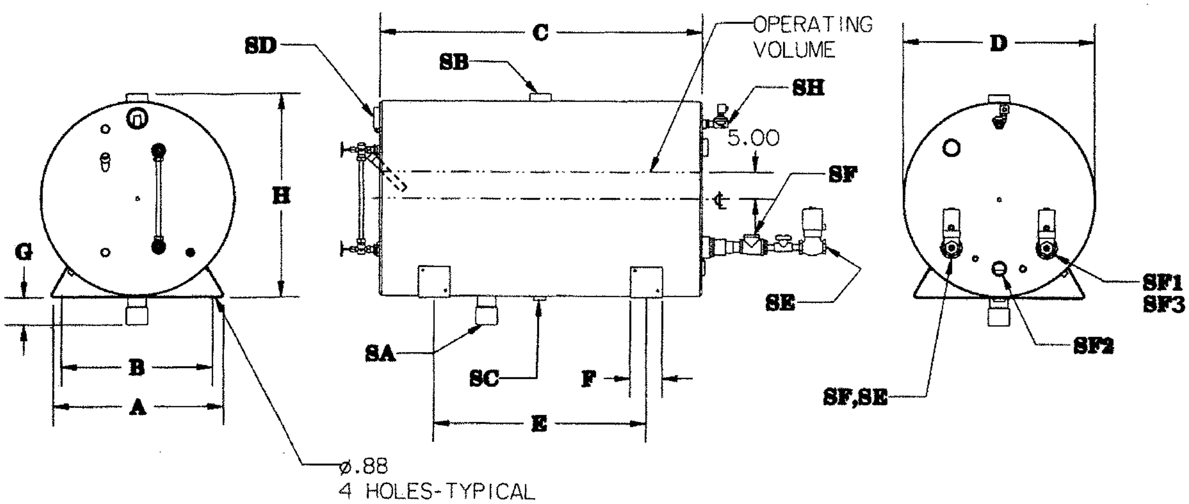


Figure 6-4 Equipment layout for E1004–1104 modulating steam generators

Table 6-5: Equipment layout and dimensions for E1004−E1104 modulating Steam Generators (refer to Figure 6-4 for layout and item callouts)

	Item	Model: Specification	E-1004	E-1104
Layout & Dimensions	OW	Generator width, overall; in. (cm)	170.9 (434.1)	170.9 (434.1)
	OL	Generator length, overall (gas); in. (cm)	254.4 (646.2)	237.8 (604)
	B1	Pump length; in. (cm)	92.0 (233.7)	92.0 (233.7)
	C	Generator height, w/o SE; in. (cm)	220.7 (560.6)	220.7 (560.6)
		Generator height, w/ SE; in. (cm)	233.7 (593.4)	233.7 (593.4)
	C1	Pump height; in. (cm)	69.81 (177.3)	69.81 (177.3)
	D	Coil removal height, w/o SE; in. (cm)	226.0 (574.0)	226.0 (574.0)
		Coil removal height, w/ SE; in. (cm)	239.0 (610.0)	239.0 (610.0)
	E	Frame mounting, generator; in. (cm)	55.3 (140.3)	55.3 (140.3)
	F	Frame mounting, generator; in. (cm)	87.5 (222.25)	87.5 (222.25)
	G	Frame mounting, generator; in. (cm)	74.1 (188.3)	74.1 (188.3)
	G1	Frame mounting, generator; in. (cm)	89.1 (226.4)	89.1 (226.4)
	H	Frame mounting, generator; in. (cm)	n/a	n/a
	I1	Frame mounting, pump to generator; in. (cm)	32.8 (83.3)	32.8 (83.3)
	J1	Frame mounting, pump; in. (cm)	33.0 (83.8)	33.0 (83.8)
	J2	Frame mounting, pump; in. (cm)	n/a	n/a
	K	Frame mounting, pump; in. (cm)	n/a	n/a
	K1	Frame mounting, pump; in. (cm)	38.0 (96.5)	38.0 (96.5)
	K2	Frame mounting, pump; in. (cm)	38.0 (96.5)	38.0 (96.5)
	L	Frame mounting, pump to generator; in. (cm)	23.0 (58.4)	23.0 (58.4)
	M	Steam outlet; in. (cm)	57.8 (146.8)	57.8 (146.8)
	N	Steam outlet; in. (cm)	12.9 (32.8)	12.9 (32.8)
	O	Steam outlet; in. (cm)	123.8 (314.4)	123.8 (314.4)
	O1	Steam outlet/sootblow/valve option; in. (cm)	178.4 (453.1)	178.4 (453.1)
	O2	Steam outlet-safety relief valves; in. (cm)	144.5 (367.0)	144.5 (367.0)
	P	Feedwater inlet; in. (cm)	16.5 (41.9)	16.5 (41.9)
	Q1	Feedwater inlet; in. (cm)	27.8 (70.6)	27.8 (70.6)
	Q2	Feedwater inlet; in. (cm)	n/a	n/a
	R	Feedwater inlet; in. (cm)	40.2 (102.0)	40.2 (102.0)
	S	Flue diameter, o.d.; in. (cm)	43.8 (111.3)	43.8 (111.3)
	V	Main Gas inlet; in. (cm)	21.3 (54.1)	21.3 (54.1)
	W	Gas inlet; in. (cm)	113.2 (287.5)	113.2 (287.5)
	X	Gas inlet; in. (cm)	157.5 (400.0)	157.5 (400.0)
	Y	Oil inlet; in. (cm)	37.7 (95.8)	37.7 (95.8)
	Z	Oil return; in. (cm)	6.8 (17.3)	6.8 (17.3)
	AA	Oil inlet; in. (cm)	34.9 (88.6)	34.9 (88.6)
	AB	Oil return; in. (cm)	30.8 (78.2)	30.8 (78.2)
	AC	Gravity fill; in. (cm)	99.0 (251.5)	99.0 (251.5)
Connection Sizes & Types		Feedwater inlet (FPT); in.	4	4
		Separator/Standpipe discharge outlet; in.	8	8
		Separator drain (FPT); in.	2	2
		Steam Trap discharge outlet (FPT); in.	2	2
		Coil blowdown drain, w/o SE (FPT); in.	2	2
		Coil blowdown drain, w/ SE (FPT); in.	3	3
		Coil gravity drain (FPT); in.	4	4
		Upper waterwall drain, SE only; in.	3	3
		Pilot gas inlet (FPT); in.	0.5	0.5
		Main gas inlet (MPT); in.	4	4
		Fuel oil inlet (FPT); in.	1	1
		Fuel oil return (FPT); in.	1	1
		Atomizing Air Inlet-Oil Units (FPT); in.	0.5	0.5
		Gravity fill inlet (FPT); in.	1	1
		Safety Valve outlet		
Shipping Weights		Generator shipping weight w/o SE; lb (kg)	47,500 (21,545)	47,500 (21,545)
		Generator shipping weight w/ SE; lb (kg)	50,000 (22,680)	50,000 (22,680)
		Pump shipping weight; lb (kg)	3,200 (1,452)	3,200 (1,452)

6.7.2 Condensate Receiver Tanks



BHP	250	350	750	900	1600
Operating Volume	180 GAL.	250 GAL.	425 GAL.	551 GAL.	757 GAL.
Full Volume	266 GAL.	372 GAL.	667 GAL.	865 GAL.	1,135 GAL.
Part No.	UH31909	UH32701	UH32791	UH32377	UH33814
A	31.33	31.33	41.12	41.12	48.00
B	28.34	28.34	36.00	36.00	44.00
C	60.83	84.69	93.12	120.62	145.12
D	36.36	36.36	46.36	46.50	63.00
E	40.00	40.00	60.00	84.00	101.00
F	6.00	6.00	6.00	6.00	6.00
G	5.09	5.16	3.29	6.48	3.80
H	37.92	37.83	51.98	53.48	68.52

SA - Feedwater Outlet
SB - Vent
SC - Drain
SE - Steam Heat
SF - Trap Return
SH - Make Up Return

SF1 - Condensate Return
SF2 - Low Pressure Condensate Return
SF3 - Optional HP condensate return, w/ sparger tube for 50% or higher return

Note: 1) Refer to applicable P&ID drawing for hotwell trim connections.
2) Sparger tube for SF1 optional. Recommended for condensate returns over 50%.

R019740

Figure 6-5 Horizontal hotwell dimensions and specifications

6.7.3 Blowdown Tanks

PART #	UH36760	UH35758
FULL VOLUME	35 GALLON	38 GALLON
MODEL	E154 / 354	E404/1004
BHP RATING	154 BHP 350 BHP	400 BHP 1000 BHP
DRY WEIGHT	200 LBS.	230 LBS.
A	18.63	21.07
B	11.25	17.00
C	10.63	10.63
D	11.38	11.38
E	23.50	26.32
F	29.88	38.07
G	N/A	N/A
H	33.13	40.88
I	44.56	52.75
J	37.21	44.46
K	Ø18.00	Ø18.00
L	7.38	7.19
M	8.25	10.00
N	10.28	10.28
P	9.81	9.81
R	45°	45°
S	30°	30°
T	22.5°	22.5°
U	Ø23.75	Ø23.75

TA = VENT

TB = DRAIN

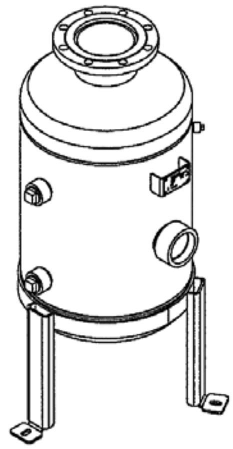
TC = HOTWELL OVERFLOW - NOT APPLICABLE

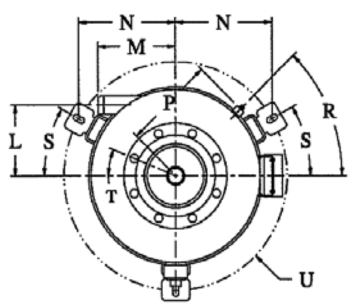
TD = WATER OUTLET

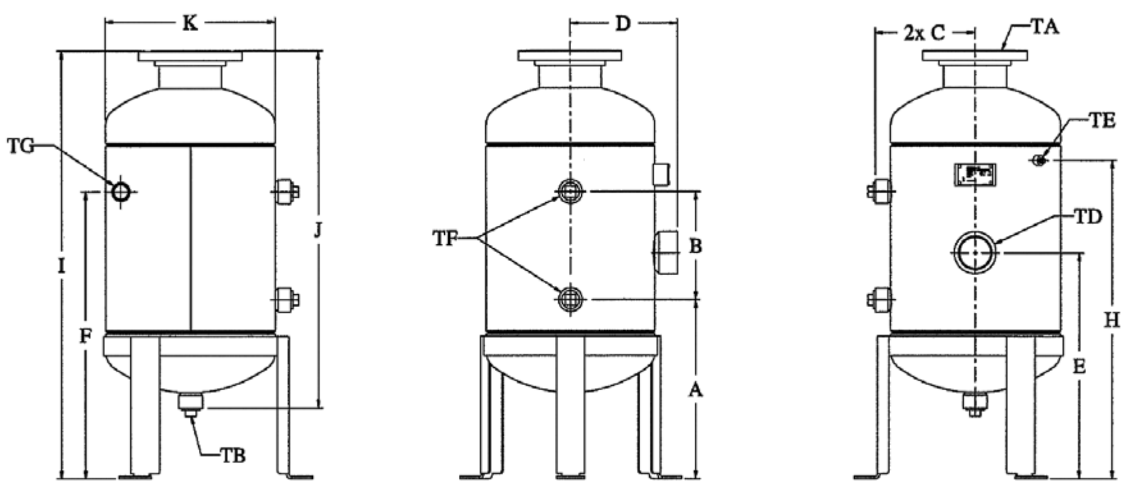
TE = WATER COOLER SAMPLE INLET

TF = INSPECTION

TG = BLOWOFF INLET







NOTES:

1. ALL FLANGES ARE 150# R.F.
2. ASME SECTION VIII, DIV I. ("U" STAMP)
3. MAWP TEST = 100 PSI @ 338° F MAX. / 0° MIN.
4. HYDROSTATIC TESTED @ 150 PSI.

Figure 6-6 Blowdown tank dimensions and specifications

(This page intentionally left blank.)

SECTION VII - OPTIONAL EQUIPMENT

7.1 BOOSTER PUMP(S)

Booster pumps are required on an open system when the required NPSH to the feedwater pump cannot be achieved from an elevated hot-well. In a deaerator (D/A) system, booster pumps are required for most installations. Due to the low NPSH characteristics of these pumps, they are less sensitive to feedwater delivery problems caused by fluctuating pressure in the D/A than the Clayton feedwater pump(s).

Booster pumps must be sized to provide 150 percent of the total system water flow at 150 percent of the total system head pressure. Total system head pressure includes the Clayton feedwater pump $NPSH_R$, plus calculated pipe losses, and plus acceleration head loss.

Most systems use two pumps. One of the two pumps is a standby pump, or the usage of the two pumps are alternated to balance operating hours. Only booster pumps with mechanical seals rated at a *minimum* of 250° F (121° C) should be used. The booster pumps cannot be rated at a discharge pressure that is lower than the system operating pressure

NOTE

Each booster pump must have a 1/4 inch (6 mm) recirculation line, with a check-valve, piped from the discharge side of the pump back to the condensate receiver. This prevents overheating during "dead head" conditions. Clayton recommends using this return line to facilitate chemical injection at a common manifold on the condensate receiver.

7.2 BLOWDOWN SYSTEM

7.2.1 Blowdown Tank

The Occupational Safety and Health Administration (OSHA) requires that high temperature discharges be cooled to a temperature below 140° F (60° C) prior to entering a drainage system. A blowdown tank is performs this function. All blowdown and high temperature drain lines are to be piped to the blowdown tank. A capillary tube-type temperature sensor, mounted in the blowdown tank discharge line, actuates a temperature control valve, also mounted in the discharge line, to inject cooling water into the hot fluid. The temperature control valve can be adjusted to achieve the desired discharge fluid temperature. The blowdown tank vent should be a straight run of full size iron or steel pipe.

7.2.2 Automatic TDS Controller

Total dissolved solids can be controlled automatically. This is accomplished by installing a TDS (conductivity) sensing probe in the feedwater line, this is connected to the Clayton Boiler Master controller that, in turn, controls a dump valve installed in the trap discharge line. The discharge from the dump valve is then piped to the blowdown tank. Refer to Drawing R016099. Feedwater testing is still required per the Clayton Feedwater Manual.

7.2.3 Continuous Blowdown Valve

The continuous blowdown valve, if used, is installed in the trap discharge line. It consists of a needle valve that is throttled for the proper flow rate to keep TDS within parameters. Refer to Drawing R016099.

7.3 VALVE OPTION KIT

The valve option kit consists of a separator drain valve, coil gravity drain valve, coil blowdown valve, and separator-trap discharge valve. The valve kit also includes the required hardware, such as nuts, bolts, gaskets, and pipe nipples, for the valve installation. With the exception of generator skids and the steam trap discharge valve, all valves are shipped loose for customer installation. If the valve option kit is not supplied by Clayton, it is the customers responsibility to provide these valves. All these valves are required for proper installation and operation.

7.4 SOOT BLOWER ASSEMBLY

For steam generators that burn oil, a provision for steam soot blowing is required. Clayton Industries can provide an optional steam pipe spool piece with all piping and valves required for the proper removal of accumulated soot. If this item is not purchased the customer must supply a valved line from the steam header to the soot blow inlet for this purpose.

7.5 PRESSURE REGULATING VALVES (BPR/PRV)

7.5.1 Back Pressure Regulators

Back Pressure Regulators (BPR) are required where the system requirements exceed the capacity of the steam generator/fluid heater, where there are rapidly cycling loads, such as those created from a fast-acting motorized valve, or on steam generators/fluid heaters that are started remotely or automatically, such as master lead-lag or auxiliary pressure control systems. It will control the minimum pressure within the steam generator/fluid heater during these periods and, as a result, prevent entrained liquid from flashing. This results in a more stable operation. The BPRs assure that sufficient pressure is maintained in the steam generator/fluid heater to protect the heating coil from a possible overheat condition. BPRs are recommended on all Clayton installations. On installations with multiple steam generators, a BPR must be installed at each steam generator.

7.5.2 Clayton Back Pressure Regulators

Clayton BPRs are spring-loaded, diaphragm-operated. The BPR must be installed in the separator discharge piping (as shown in Figure 1).

Install the Clayton BPR vertically with the outlet at the top.

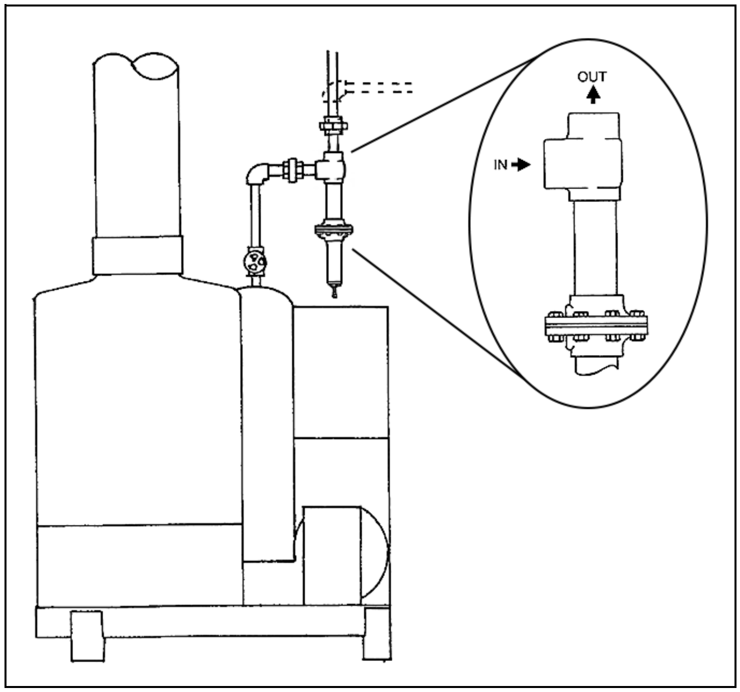


Figure 1 - Clayton BPR Installation

7.5.3 Buyout (non-Clayton) Back Pressure Regulators

For buyout BPRs, refer to the manufacturer's installation and operator instructions for proper installation.

7.5.4 Pilot-Operated and Electro-Pneumatic Back Pressure Regulators

Pilot-operated BPRs are designed to be mounted at the steam header top elevation, immediately next to the steam stop valves above Clayton's separator. They are not meant to be floor mounted. Fluid traps must be incorporated into the pilot lines to prevent BPR liquid lockout. Customers who desire mounting BPRs at floor level must use pilotless, electro-pneumatic BPRs.

Electro-pneumatic BPRs (Figure 2) may be purchased from Clayton Industries. Electro-pneumatic BPRs require additional PLC module hardware and control programming in the electrical control box.

7.5.5 Pressure Regulating Valves

Pressure Regulating Valves (PRV) control the pressure in the feedwater supply vessel, either D/A or Semi-closed Receiver (SCR) Systems. These valves ensure positive pressure is maintained on these vessels. The PRV receives steam from the main header and injects steam into the tank when a drop in pressure is detected. A check-valve must be installed in this line to protect the system in the event of flooding the tank.

Figure 2 - Electro-pneumatic BPR valve (for illustration purpose only, actual valve may be different)

(This page intentionally left blank.)

SUPPLEMENT I - SCR

1.1 SEMI-CLOSED RECEIVER SYSTEMS (SCR)

1.1.1 Requirements

A Semi-closed Receiver (SCR) system is used when condensate can be returned at relatively high pressure and temperature. The pressure of the receiver tank is determined by the condensate return system. When the system is warm and operating at its normal "balanced pressure" the back pressure regulator and pressure regulating valve may be set. The SCR systems typically operate between 50–125 psi and must be at least 50 psi below the anticipated steam pressure. Because of these higher operating pressures/temperature (feedwater will be between 300°–350° F) feedwater chemical treatment is reduced but not eliminated. Because of the elevated feedwater temperature, cooling water is circulated over the pump heads in the feedwater pump. This helps keep the pump diaphragms cool thereby extending the life. The pump head cooling water does not have to be softened water unless it is returned to the hot-well. Installation of cooling water lines to the pump head connections is the responsibility of the installing contractor.

1.1.2 Components of an SCR System refer to Drawing R-16596

The SCR must be sized to a total capacity of 1.5 gallons per boiler horsepower. Multiple generators may be operated from one receiver if the installation is operating at a common pressure. The receiver tank must comply with the ASME Section VIII Code specifications for unfired pressure vessels. There must also be a large valved drain line in the bottom of the receiver to permit periodic draining and flushing of the tank.

NOTE

Receiver must be installed to provide sufficient NPSH to the feedwater pump(s). See Section 2.11.

1.1.3 Water Level Gauge Glass

A sight glass must be mounted on the receiver for visual verification of the operating water level. This glass must be rated for the operating pressure/temperature and be at least one foot long.

1.1.4 Steam Trap

An overflow steam trap is required to control the maximum water level, when above normal amounts of condensate are being returned. The trap inlet must have a priming drip leg at least eighteen inches long. The trap discharge must be piped to the make-up tank.

1.1.5 Vent

The receiver must have a vent to discharge non-condensible gases from the feedwater. The Clayton vent most often provided is a 3/4 inch orifice union with a 1/8 inch orifice. This will continuously vent a small amount of steam with the gases.

1.1.6 Level Control

A liquid level controller is mounted on the receiver to control the make-up water pump. This control starts and stops the make-up pump as required. The differential between the high and low levels is a narrow band (2 to 3 inches). The water level should be maintained approximately one quarter from the top of the tank, and at the proper height for the required NPSH of the generator feedwater pump.

1.1.7 Steam Relief Valve

The SCR must have a steam safety relief valve with a setting not greater than the design pressure of the tank. This valve must comply with all safety codes and must be capable of relieving at least 25 percent of the connected generator steaming capacity at the SCR operating pressure. The discharge from this valve must be piped to atmosphere and in a direction that will not cause harm to equipment or personnel.

1.1.8 Sparger Tube

The high pressure condensate returns must be injected into the SCR through a sparger tube. The sparger tube inlet must be 8–12 inches below the lowest water level so the heat will be transferred from the condensate to the liquid in the SCR with the least possible noise and vibration. The trap returns from the Clayton separator should also be piped into the sparger tube.

1.1.9 Back Pressure Regulator

A Back Pressure Regulator (BPR) must be installed on the receiver to help control the tank pressure during large load swings, or in the event of system traps malfunction. The BPR should be set at 3–5 psi above the normal operating pressure.

1.1.10 Pressure Reducing Valve

A Pressure Regulating Valve (PRV) must be installed on the SCR to maintain a preset pressure. The PRV senses the SCR pressure and injects steam (above the water level) from the header in the event of a reduction in the tank pressure. The PRV should be set at 1–2 psi below the normal operating pressure. The PRV design flow must be equal to 25 percent of the maximum steam production rate. If low pressure steam is to be drawn from the receiver for other uses, this capacity must be considered when sizing the PRV. A check-valve must be installed between the PRV and the receiver to prevent backflow in the event of a flooded condition in the receiver.

NOTE

The PRV and BPR are not options. They must be installed to ensure the effective and efficient operation of the Clayton Semi-closed Receiver System.

1.1.11 Make-up Tank

A make-up tank is required to collect low pressure condensate and fresh softened make-up water. Steam is introduced to the make-up tank through a temperature control valve. The make-up tank temperature should be maintained between 190°–200° F. The make-up tank must be sized for the total boiler horsepower rating of the system. The make-up tank must also have sufficient elevation to provide the required NPSH of the make-up.

1.1.12 SCR Transfer Pump

An SCR transfer pump is required to transfer water from the make-up tank to the SCR (regenerative turbine type preferred). This pump must have a capacity that is at least equal to the total boiler feedwater pump capacity. The make-up pump must have a discharge head not less than 25 percent higher than the maximum receiver operating pressure. The discharge from this pump must enter the SCR below the minimum water level.

NOTE

A check-valve must be installed in the make up pump discharge line as close to the SCR as possible. This will prevent exposing the pump seal to excessive fluid temperatures.

1.1.13 Chemical Treatment

Feedwater Chemical Treatment is injected into the SCR below the water level. Feedwater treatment Chemicals are also be injected into the make-up tank to help protect the make up against corrosion. Both of these chemical injection lines must have a check-valve installed to prevent back feeding into the chemical pumps. Chemical pump output pressure must be greater than SCR pressure.

1.1.14 Hook-up

The feedwater line between the SCR and the generator feedwater water pump must have an inside diameter of 2 times that of the SCR discharge connection and the feedwater pump inlet connection. The pipe run to Clayton's positive displacement (PD) feedwater pump must be as short as possible (absolute minimum), and the elbows and restrictions must be kept at a minimum. A flex section (2 feet minimum) must be installed on the feedwater pump inlet. A port for a thermometer and a feedwater sampling port must be as close to the feedwater pump inlet as possible.

The pipe run from the SCR to Clayton's PD feedwater pump must be held as level as possible. No u-shaped pipe sections (either up or down) are allowed. This pipe run must be a continuous 2°–3° rise from Clayton's PD feedwater pump back up to the SCR discharge connection. All reducers must be eccentric with the flat side up.

1.1.15 System Steam Traps

The steam traps in the system must be rated for the system pressure, and sized for the difference between the steam system and the receiver. This usually requires the traps be one size larger than on an open system. The steam traps in the system must be properly maintained for the system to function normally. If there are traps "blowing by," the SCR will be pressurized above the BPR set point and steam will be needlessly vented to atmosphere.

1.1.16 A General Statement

Because of the uniqueness of an SCR system, the requirements put forth here must be closely followed to ensure trouble free operation. If properly installed and maintained the Clayton Semi-closed Receiver System will operate with a high degree of reliability and economic benefits.

SUPPLEMENT II - HEAVY OIL

2.1 HEAVY FUEL OIL (MODELS E-154 TO E-504)

2.1.1 General Statement

All Clayton heavy oil steam generators/fluid heaters require starting and stopping on light oil; therefore, an ample supply of light oil must always be available during startup and shutdown of the machine. In addition, the light oil supply is needed for flushing all heavy oil from the machine's fuel system and from the heavy oil heater unit during shutdown procedure.

Special handling, storage, maintenance, and proper operation are required when burning heavy fuel oil (other than #2). This supplement is intended as a general guide to aid the installer in the proper preparation of a site that will be using heavy oil. Careful consideration must be given to local codes and requirements when dealing with heavy fuel oil. The installer should observe the standards as established by the National Fire Protection Agency (NFPA), National Electric Code (NEC) and the Environmental Protection Agency (EPA).

Heavy fuel oil is typically a blend of distillates and residuals or even crudes. To keep the oils from separating in the storage it must be heated to 50° F above the pour point. If the blended oils are permitted to cool they can separate and form a sludge on the tank bottom. (Refer to chart R-8571 for viscosity and temperatures.)

2.1.2 Storage Tanks

In order to maintain the temperature in the fuel oil storage tank, the tank has to be heated to a minimum of 100°–130° F. Tank heaters may operate on hot water, steam, or electricity. If steam or hot water is available for a cold start, they are the more economical method of heating the tank. Normally, the heating coils are placed 6 inches above the lowest level in the tank. It is not necessary to have uniform heating throughout the tank if the oil return is at the opposite end from the pump suction since this provides a positive circulation throughout the tank. Additional heating must be provided with a heater bell at the pump suction point. If steam from the generator system is to be used for tank heating it must be piped to waste.

NOTE

All fuel oil storage tanks must be constructed in accordance with local and EPA codes. If an above ground tank is used, it must be insulated with a waterproof insulation.

2.1.3 Transfer Pump

Fuel oil is pumped from the storage tank to the Clayton fuel pump through an oil transfer pump, owner supplied. This pump should be a positive displacement pump (gear type or similar) and have a capacity of twice the total burner volume. Future steam generation capacity should be considered when sizing this pump. The pump should have the ability to turn over the tanks volume in a week. A suitable fuel strainer must be installed on the suction side of the transfer pump. This strainer will remove foreign particles that could damage the transfer and generator fuel pumps. The strainer should have a mesh not larger than 0.015 inch. The inlet pressure to the Clayton pump must not exceed 25 psi. A higher inlet pressure will damage the pump seals.

NOTE

The transfer pump must be equipped with a foot valve to avoid draining fuel back into the storage tank.

Both the transfer and Clayton fuel pumps should run continuously, circulating oil under pressure through the heaters to the burner. Excess oil flows through the Fuel Pressure Regulator to the inlet of the fuel pump. In a burner off cycle, the Oil Recirculating Valve opens and bypasses the fuel to the inlet of the fuel pump. This oil is at a higher temperature than the oil in the transfer loop. With this system, all the high temperature oil is confined to the burner loop. Oil heated in the transfer loop should be limited to 20° F below flash point (this temperature depends on oil viscosity).

2.1.4 Supply and Return Lines

Install fuel supply and return lines to the fuel pump from the storage tank, using appropriately sized piping for the required flow. The fuel supply system will depend on the burner design, storage tank, grade of oil, the number of generators, and local codes.

NOTE

Heavy oil supply and return lines must be heat traced (steam or electric) and insulated. Do not use galvanized pipes.

2.1.5 Oil Preheating Equipment (See Heavy Oil System Flow Diagram)

The Clayton heavy oil-fired unit uses an air atomizing burner. For proper combustion the oil viscosity must be a minimum of 55 Saybolt Seconds Universal (SSU). For oil that has a higher viscosity, controlled heating must be applied. The heated fuel temperature requirement varies with the initial viscosity of the oil. (see chart R-8571). A steam heater is provided to accomplish the required rise in temperature.

2.1.6 Electric Immersion Heater Option

An Electric Immersion Heater option can be provided with the generator. It is controlled by a Magnetic Controller Switch which is controlled by the Oil Heater Thermostat Switch. This switch is set to a slightly lower cut out point (10°–15° F) than the steam heater operating temperature. This permits the steam heater to do most of the heating. The electric heater is used primarily during start-up when sufficient steam is not available.

2.1.7 Steam Coil Heater

When sufficient steam becomes available the steam heater raises the fuel temperature to the proper value. A Temperature Control Valve is used to respond to the temperature of the incoming oil. This valve is set to maintain the fuel oil at the predetermined value (see chart R-8571). Steam that condenses inside the coil is discharged through a steam trap and must be piped to waste to avoid contamination

NOTE

All heavy oil fired units must be started and stopped using light Fuel Oil, #2 diesel.

2.1.8 Exhaust Stack

The heavy oil-fired, steam generator exhaust stack should be free standing, with a side inlet and an ash collector. The first stack section attached to the machine must be removable. It should also have an access door for water washing and a port for a thermometer. Any stack section that is inside the building should be insulated to reduce radiant heat loss and noise from vibration. The stack should be constructed of stainless steel for longevity. A vertical stack height over thirty feet may require a barometric damper.

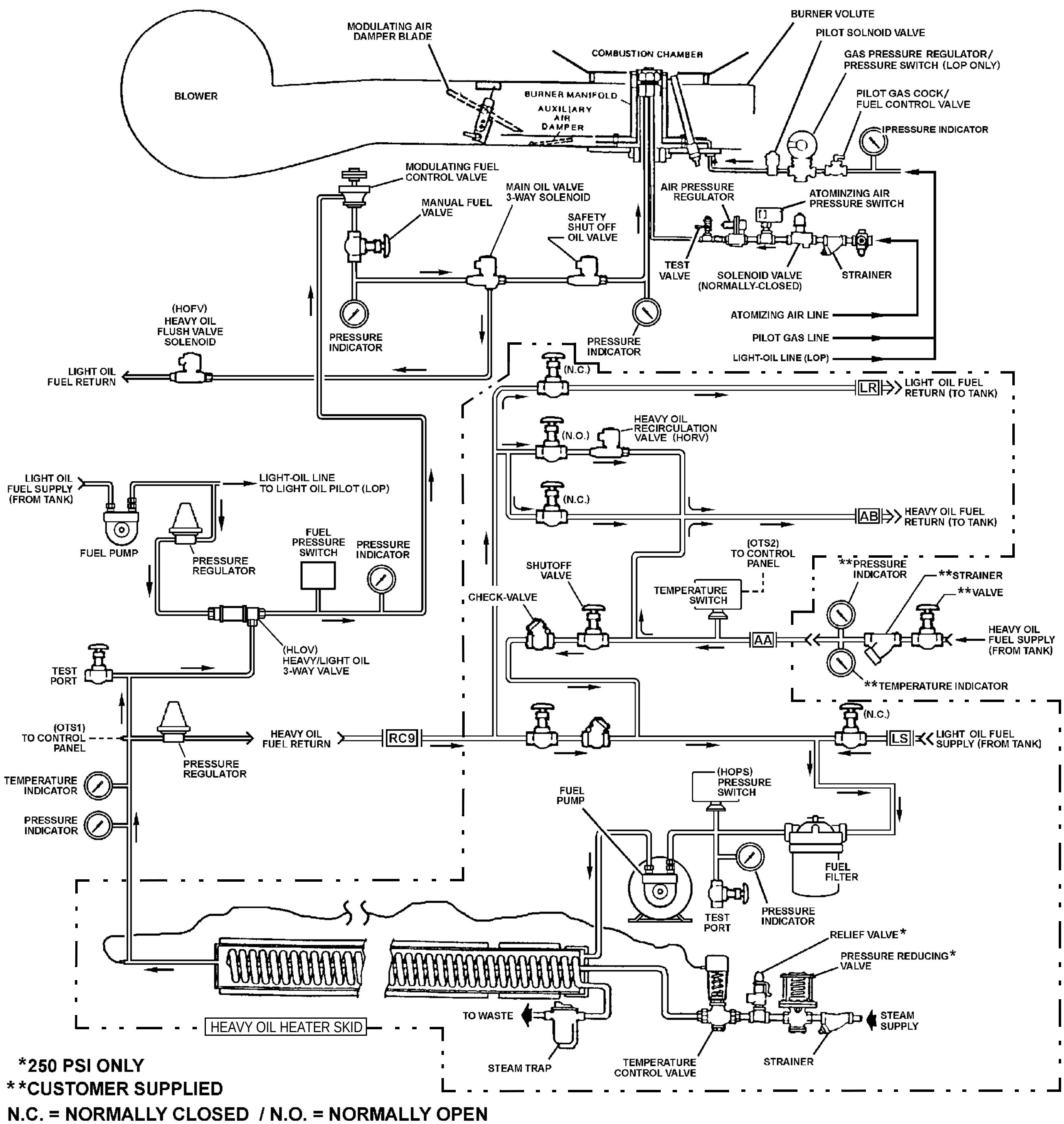
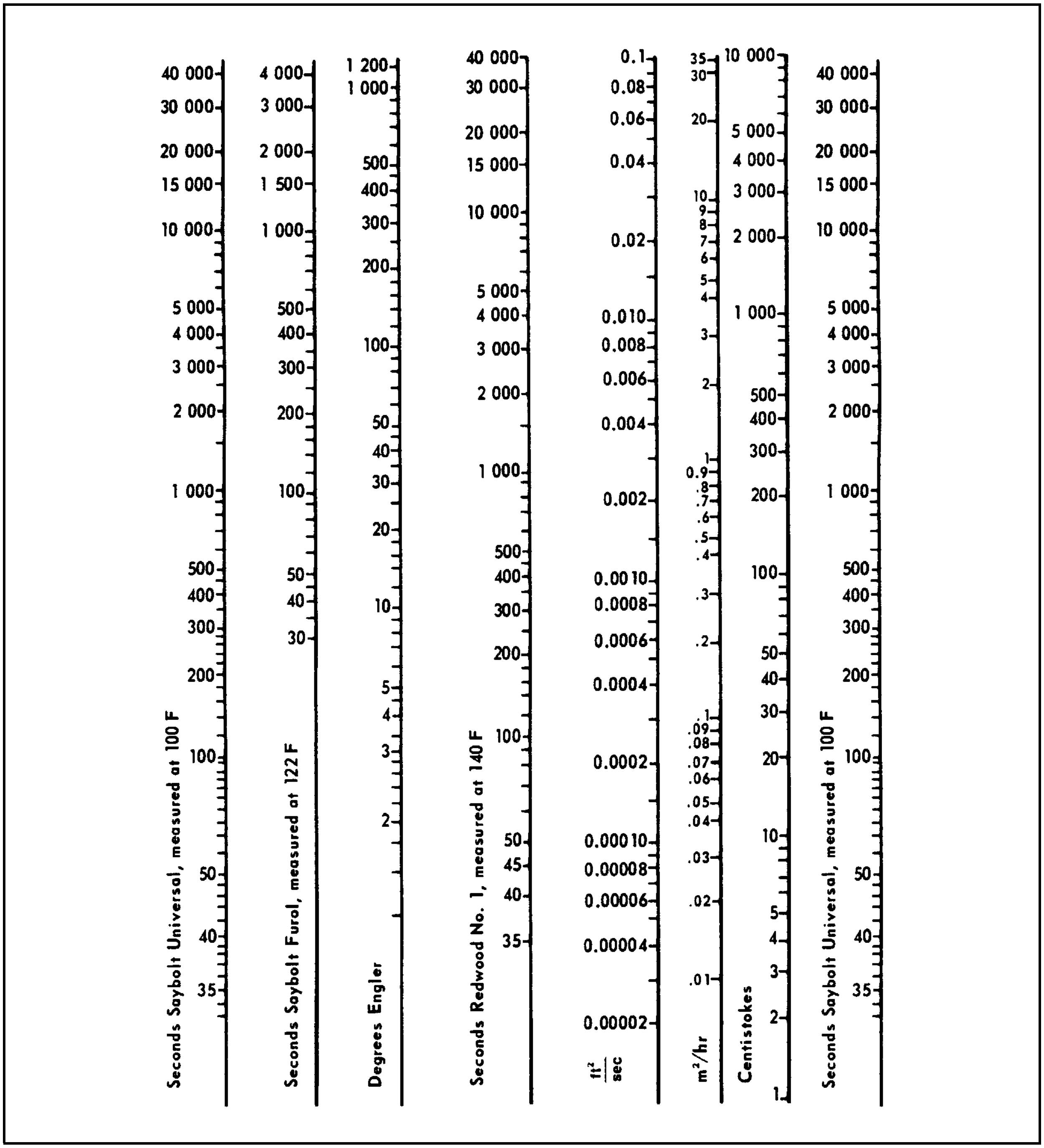


Figure 2-1 Flow Diagram - Heavy Oil System

2.2 FUELS

The conversion chart below should always be used in conjunction with enclosed Temperature-Viscosity Charts and is **not** intended to be used as a direct viscosity conversion. Use the chart below only when desired scale is not on Temperature-Viscosity Chart. (Measured at temperatures are for reference only).

Alignment Chart for comparing viscosity scales - Use a straightedge to read horizontal scales–far left and far right scales are identical.



2.3 CLAYTON STEAM GENERATORS EQUIPPED WITH HEAVY OIL FUEL SYSTEM

Heavy Oil Fuel Specifications

Clayton Burners require Heater adjustment to suit a specified viscosity. All fuel oil deliveries must have a uniform viscosity. Limit viscosity variation to plus 10% to minus 50% for Air Atomizing Burners.

The following specification covers the range of Fuel Grade Nos. 4, 5 and light No. 6 fuel oil in accordance with Commercial Standard CS-12-48 issued by the U.S. Department of Commerce and ASTM Specification D-396-64T. ***Local legal limits may supersede these regulations.***

Description of Supply Oil Required	Preferred	Limit
Gravity, Degrees API at 15 ^{o}C (60 ^{o}F)	14-26	10 min.
Gravity, Specific, at 15 ^{o}C (60 ^{o}F)	0.90-0.97	1 max.
Flash-Point, Pensky-Martens, (^{o}F)	150-230	150 min.
Viscosity, Saybolt Seconds Furol at 122 ^{o}F (50 ^{o}C) (SSF)	45 max.	175 max.
Sulfur, percent, Subject to Local Regulations	0.5 max.	2.0 max.
Sediment and Water, percent by volume	0.5 max.	1.0 max.
Carbon Residue, (on 10% residuum) percent	5-10	15 max.
Ash, percent by weight	0.05 max.	0.10 max.
Vanadium, parts per million	50 max.	100 max.

(Approximate)	High Heat Value	Low Heat Value
Btu per gallon	150,000	142,000
k cal/l	9,960	9,370

Light Fuel Oil Specifications

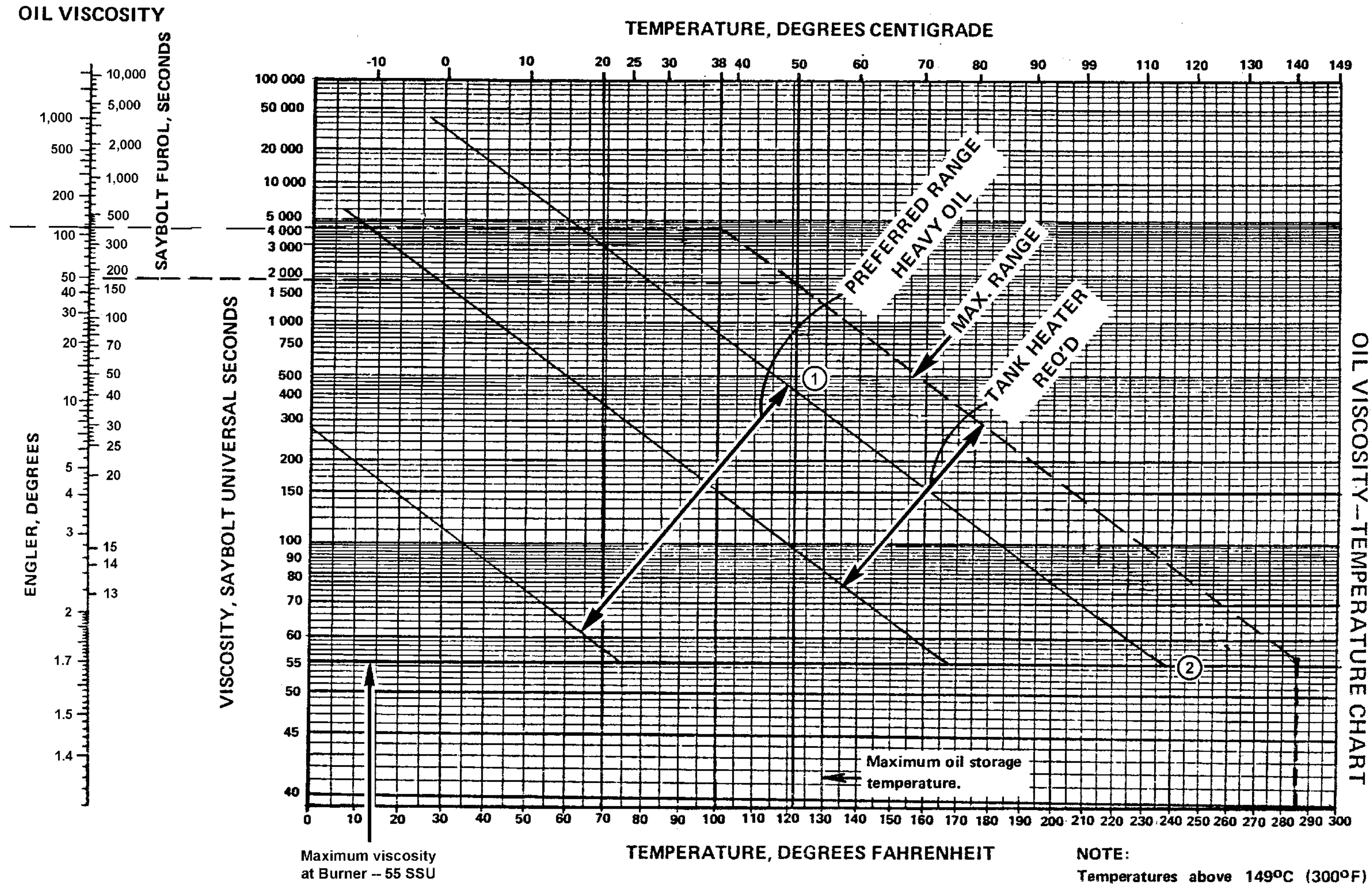
Fuel oil conforming to U.S. Commercial Standard No. 2 or Pacific Standard No. 200 furnace oil or diesel fuel.

Description of Supply Oil Required	Preferred	Limit
Gravity, Degrees API at 60 ^{o}F (15 ^{o}C	30-38	26 min.
Gravity, Specific at 60 ^{o}F (15 ^{o}C)	0.84-0.87	0.80-0.90
Flash Point. Pensky-Martens, ^{o}F	160-180	130 min.-230 max.
Viscosity, Saybolt Seconds Universal at 100 ^{o}F (SSU)	35-45	45 max.
Kinematic Viscosity at 68 ^{o}F (20 ^{o}C) (Centistokes)	4-9.5 max.	9.5 max.
Pour Point, ^{o}F	0 max.	15 max.
Sediment and Water, Percent by volume	none	0.10 max.
Sulfur, Percent	0.5 max.	0.8 max.
Carbon Residue (on 10% residuum) Percent	0.02 max.	0.25 max.

ASTM Distillation Range

Initial Boiling Point, °F	350-375	400 max.
Initial Boiling Point, °C	177-190.5	204 max.
90% Recovery, °F	600-625	675 max.
90% Recovery, °C	316-329	357 max.
End Point, °F	675-725	735 max.
End Point, °C	357-385	390.5 Max.

(Approximate)	High Heat Value	Low Heat Value
Btu per gallon	142,600	135,000
k cal/l	9,509	9,006



NOTE:
Temperatures above 149°C (300°F) will form carbon on heating surfaces at an excessive rate.

EXAMPLE

To find the temperature required at the burner nozzle for an oil with a viscosity of 45 Saybolt Furol Seconds at 50°C (122°F):

I. Find 45 Saybolt Furol Seconds on vertical scale. Extend a line horizontally to the vertical 50°C (122°F) line at ①

II. Travel diagonally on the line parallel to the temperature-viscosity line to point ② on the "maximum viscosity at burner" line -- 55 Saybolt universal seconds.

III. From ②, travel down to Fahrenheit temperature scale (240° F) or up to Celsius temperature scale (116° C). This is the minimum temperature for this oil.

OIL VISCOSITY — TEMPERATURE CHART — AIR ATOMIZING BURNER

SUPPLEMENT III - FLUID HEATER

3.1 FLUID HEATERS

The Clayton Fluid Heater is provided with an off frame mounted steam separator. This type of unit carries a “DZ” model designation. A stand pipe with ASME safety valve remains on the main frame of the Fluid Heater. This type of equipment layout requires remote mounting of the fluid separator with interconnecting piping between the main shut off valve, mounted on the stand pipe, and the inlet of the separator. The piping between the stand pipe mounted main steam shut off valve, and the inlet to the Fluid Heater should be run full size with a minimum of elbows.

The remote mounted separator is available without legs, for mounting in the steam header, or with legs/skirt for floor mounting close to the Fluid Heater.

(This page intentionally left blank.)

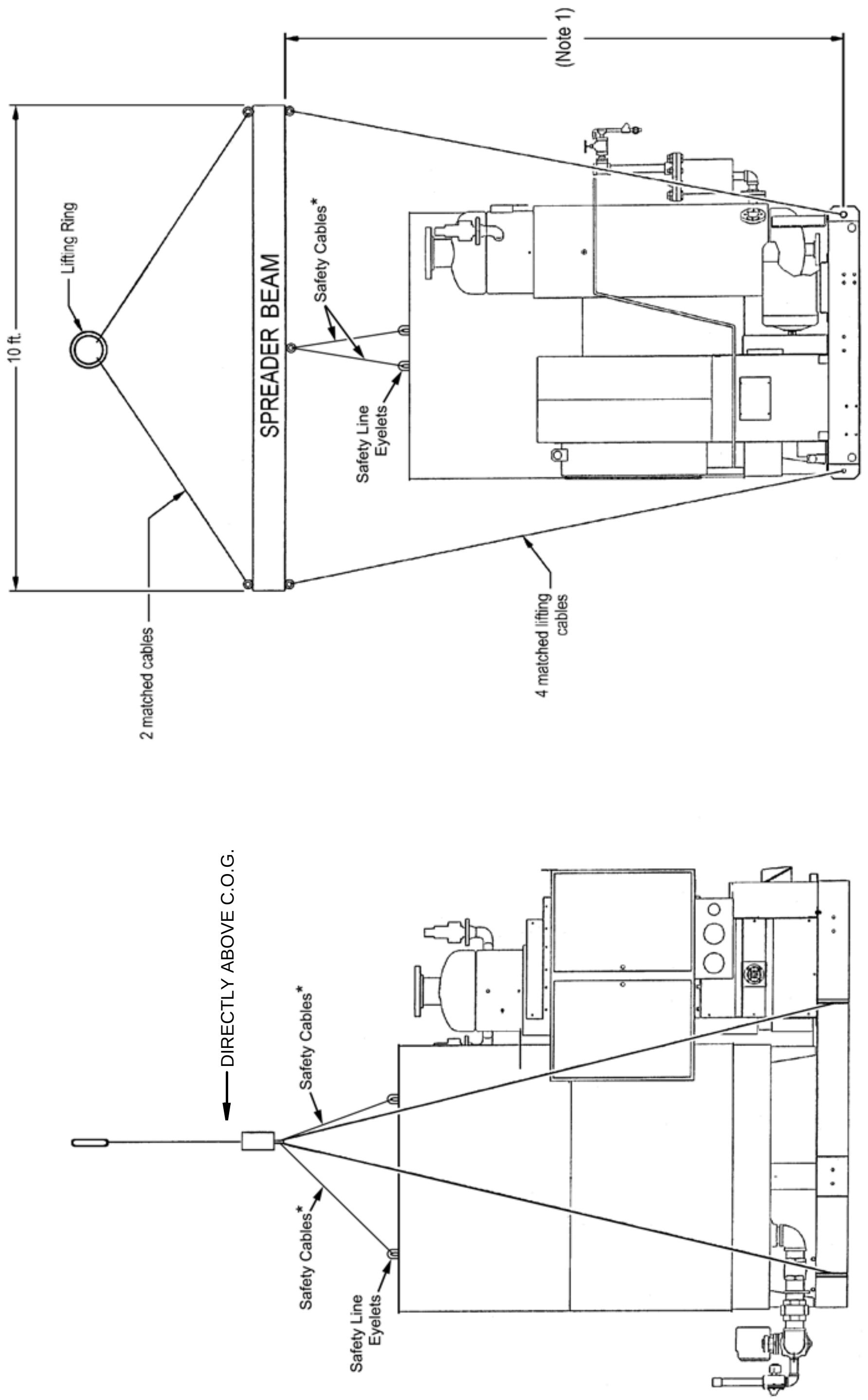
Appendix A

Steam Generator

Lifting Instructions

* Due to high center of gravity, safety cables must be used at ALL TIMES. DO NOT use safety cables for lifting.

* * Clayton rigging instructions are typical. **IT IS THE RESPOSIBILITY OF THE INSTALLER/CONTRACTOR TO HAVE PERSONNEL ON-SITE, WHO ARE TRAINED/CERTIFIED IN HOISTING AND RIGGING, VERIFY UNIT IS PROPERLY, SECURELY, AND SAFELY RIGGED BEFORE LIFTING.**



Note 1: Minimum height for E154-354=16 ft., E404-604=18 ft.

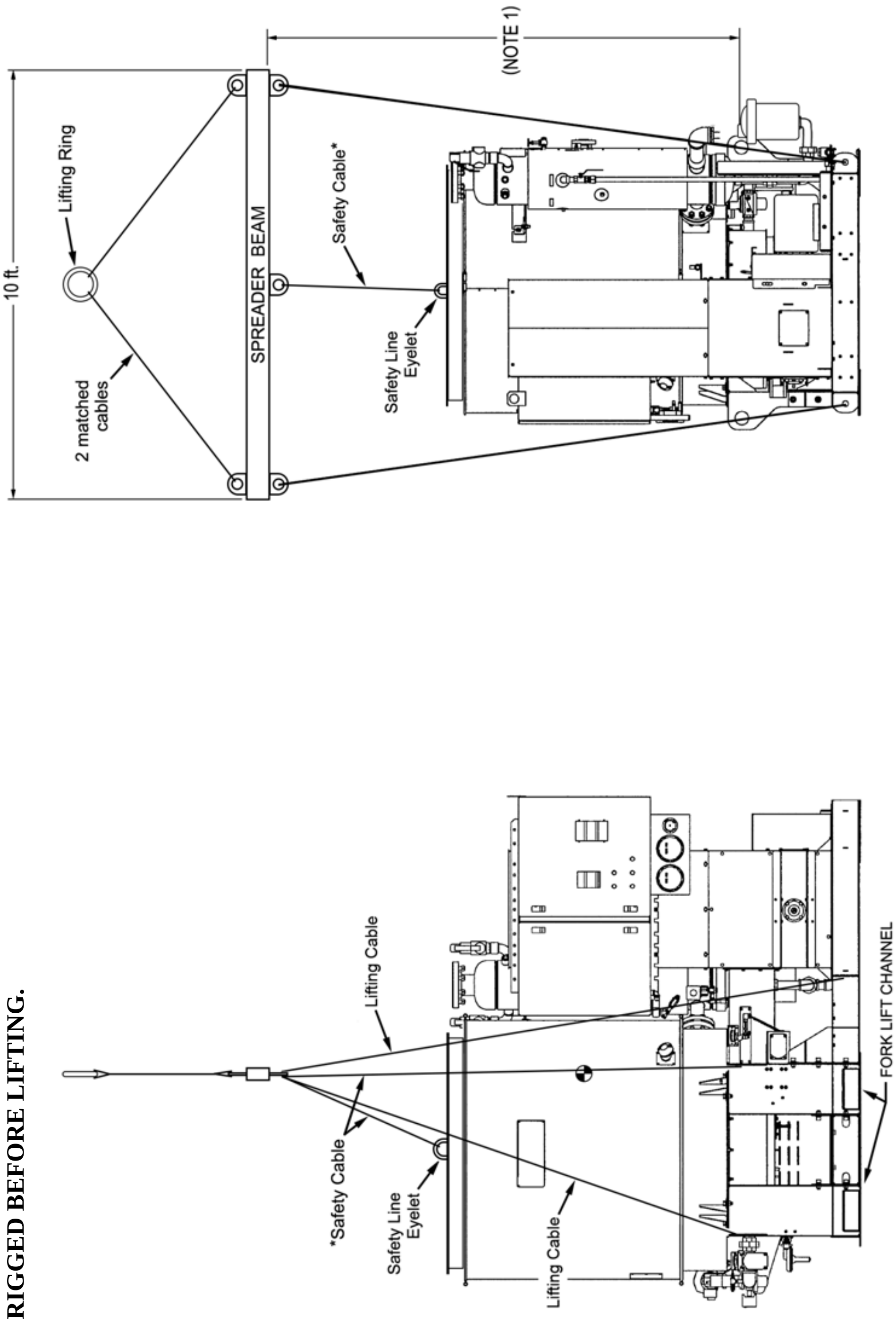
Note 2: E154-354 maximum lifting weight is 9,800 lb.
E404-604 maximum lifting weight is 17,130 lb.

Note 3: DO NOT lift from plumbing.

Typical rigging for steam/fluid generators with skid frames requiring stationary legs (illustration rotated 90° counterclockwise)

* Due to high center of gravity, safety cables must be used at ALL TIMES. DO NOT use safety cables for lifting.

* * Clayton rigging instructions are typical. **IT IS THE RESPOSIBILITY OF THE INSTALLER/CONTRACTOR TO HAVE PERSONNEL ON-SITE, WHO ARE TRAINED/CERTIFIED IN HOISTING AND RIGGING, VERIFY UNIT IS PROPERLY, SECURELY, AND SAFELY RIGGED BEFORE LIFTING.**



Note 1: Minimum height for E154FF-354FF=14 ft.

Note 2: E154FF-354FF maximum lifting weight is 9,800 lb.
Refer to applicable plan installation drawing for center-of-gravity (COG ◐) points.

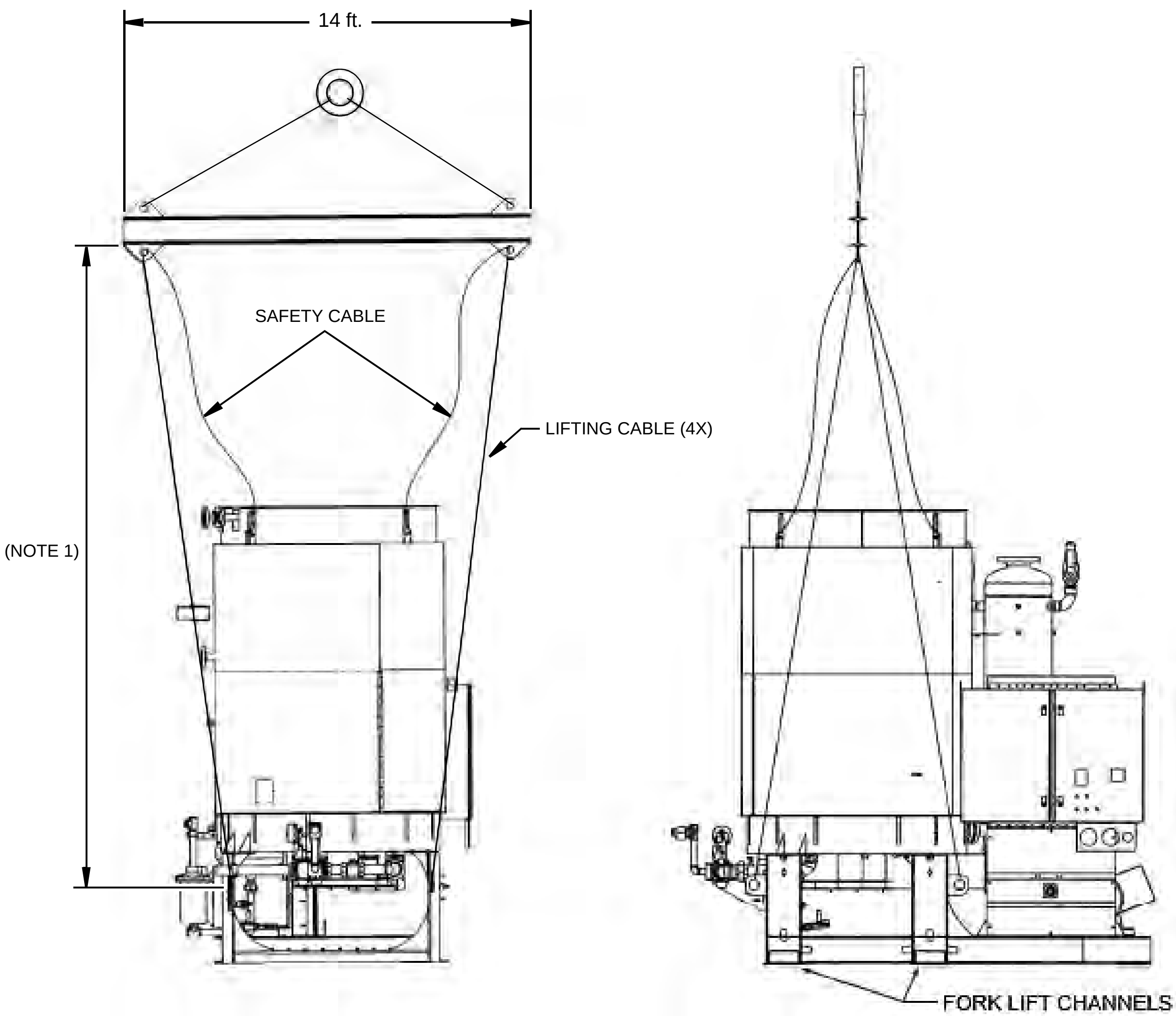
Note 3: DO NOT lift from plumbing.

Note 4–Fork Lift Option: Properly-sized fork lifts can be used with frame fork lift channels.

Typical rigging for steam/fluid generators with flush-floor skid frames (illustration rotated 90° counterclockwise)

*Due to high center of gravity, safety cable must be used at ALL TIMES.
DO NOT use safety cable for lifting.

* * Clayton rigging instructions are typical. IT IS THE RESPOSIBILITY OF THE INSTALLER/CONTRACTOR TO USE THEIR EXPERIENCE AND BEST JUDGEMENT TO VERIFY UNIT IS PROPERLY, SECURELY, AND SAFELY RIGGED BEFORE LIFTING.



NOTES:
1. Minimum height for E704 and E1004 is 25 feet.
2. Maximum lifting weight is 17,130 lb. for E704 and 29,000 lb. for E1004.
   Refer to applicable plan installation drawing for center-of-gravity (COG) points.
3. DO NOT use plumbing for lifting.
   Fork Lift Option: Properly-sized fork lifts can be used with frame fork lift channels.

Typical rigging for E704 and E1004 Steam Generators

Appendix B

Saturated Steam
Pressure-Temperature Table

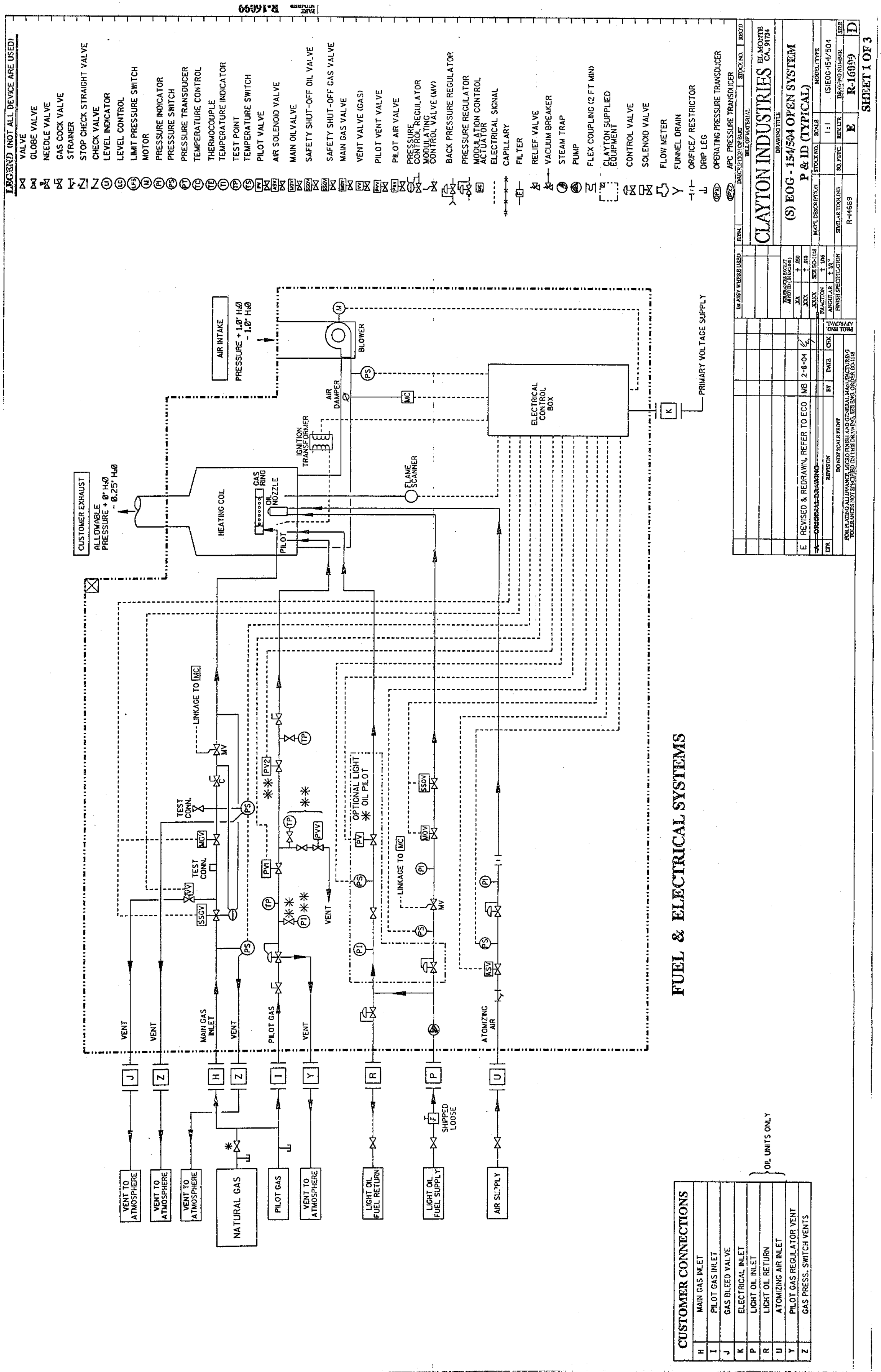
GAUGE PRESSURE PSIG	TEMP F	GAUGE PRESSURE kPa	TEMP C	GAUGE PRESSURE PSIG	TEMP F	GAUGE PRESSURE kPa	TEMP C	GAUGE PRESSURE PSIG	TEMP F	GAUGE PRESSURE kPa	TEMP C
60	308	413.6	153	270	413	1,861.5	211	600	489	4,136.8	254
70	316	482.6	158	280	416	1,930.5	213	650	497	4,481.6	259
80	324	551.5	162	290	419	1,999.4	215	725	509	4,998.7	265
90	331	620.5	166	300	422	2,068.4	217	750	513	5,171.1	267
100	338	689.4	170	310	425	2,137.3	218	775	517	5,343.4	269
110	344	758.4	173	320	428	2,206.3	220	800	520	5,515.8	271
120	350	827.3	177	330	431	2,275.2	222	825	524	5,688.2	273
130	356	896.3	180	340	433	2,344.2	223	850	527	5,860.5	275
140	361	965.2	183	350	436	2,413.2	224	875	531	6,032.9	277
150	366	1,034.2	186	360	438	2,482.1	226	900	534	6,205.3	279
160	370	1,103.2	188	370	441	2,551.1	227	925	537	6,377.7	281
170	375	1,172.1	191	380	443	2,620.0	229	950	540	6,550.0	282
180	380	1,241.0	193	390	445	2,689.0	230	975	543	6,722.4	284
190	384	1,310.0	196	400	448	2,757.9	231	1000	546	6,894.8	286
200	388	1,378.9	198	410	450	2,826.9	233	1050	552	7,239.5	289
210	392	1,447.9	200	420	453	2,895.7	234	1100	558	7,584.2	292
220	396	1,516.8	202	440	457	3,033.6	236	1150	564	7,929.0	295
230	399	1,585.7	204	460	462	3,171.5	239	1200	569	8,273.7	298
240	403	1,654.7	206	480	466	3,309.4	241	1250	574	8,618.4	301
250	406	1,723.6	208	500	470	3,447.3	243	1300	579	8,963.2	304
260	409	1,792.6	210	550	480	3,792.1	249	1350	584	9,307.9	307

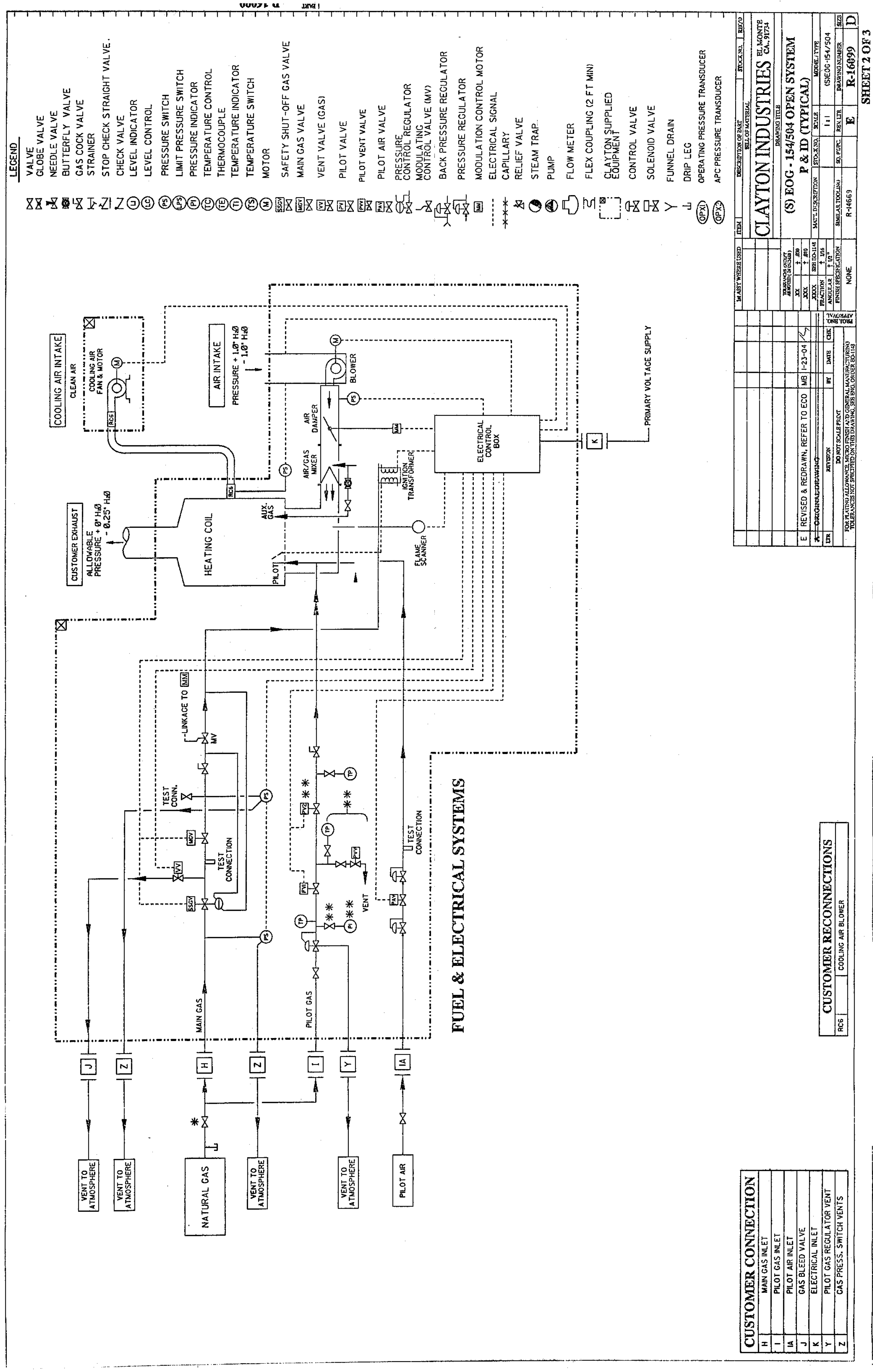
(This page intentionally left blank.)

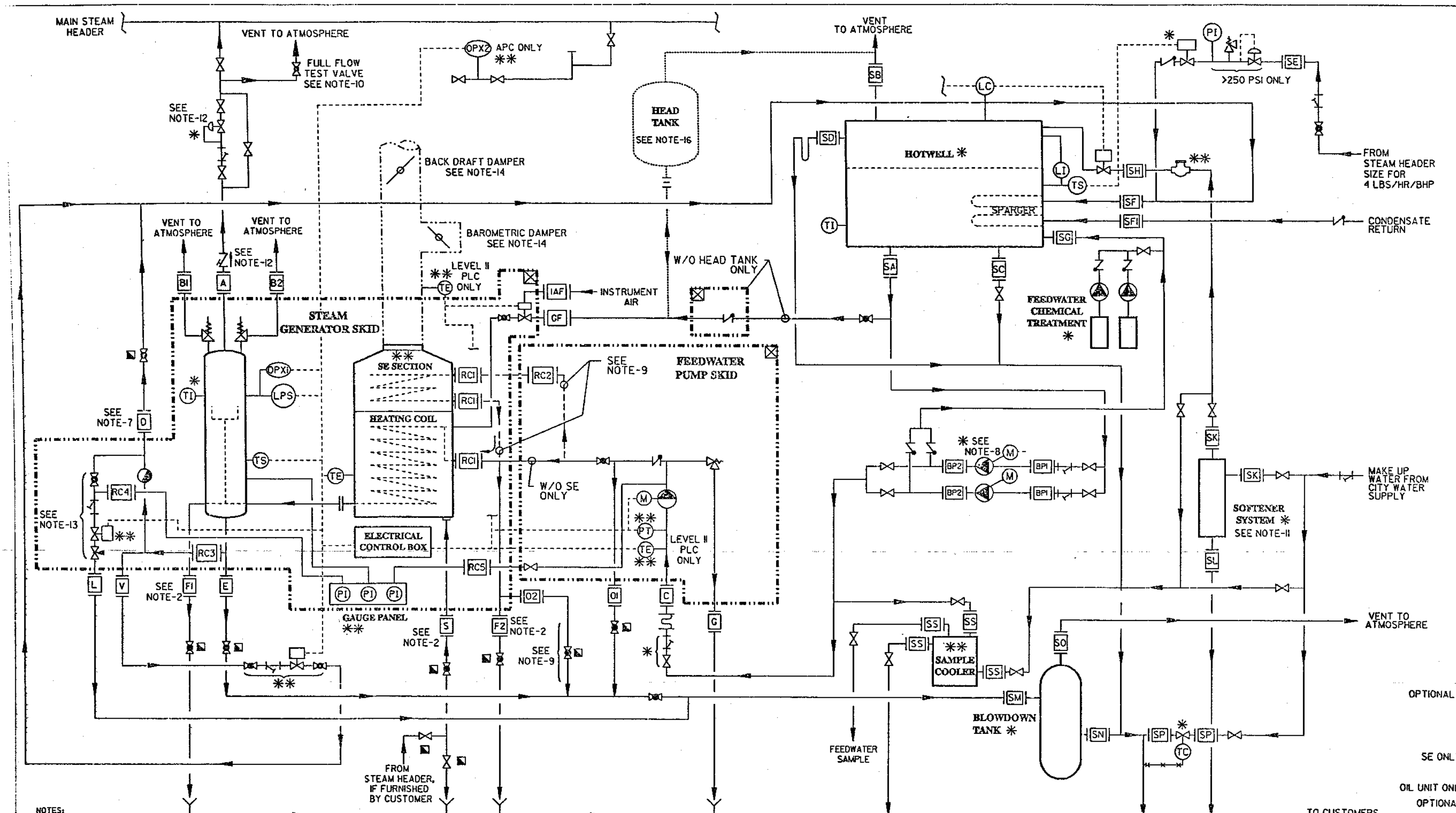
Appendix C

Piping and Instrumentation
Diagrams
(P & I D)

Contents


FUEL & ELECTRICAL SYSTEMS
LEGEND (NOT ALL DEVICE ARE USED)
VALVE
GLOBE VALVE
NEEDLE VALVE
GAS COCK VALVE
STRAINER
STOP CHECK STRAIGHT VALVE
CHECK VALVE
LEVEL INDICATOR
LEVEL CONTROL
LIMIT PRESSURE SWITCH
MOTOR
PRESSURE INDICATOR
PRESSURE SWITCH
PRESSURE TRANSDUCER
TEMPERATURE CONTROL
THERMOCOUPLE
TEMPERATURE INDICATOR
TEST POINT
TEMPERATURE SWITCH
PILOT VALVE
AIR SOLENOID VALVE
MAIN OIL VALVE
SAFETY SHUT-OFF OIL VALVE
SAFETY SHUT-OFF GAS VALVE
MAIN GAS VALVE
VENT VALVE (GAS)
PILOT VENT VALVE
PILOT AIR VALVE
PRESSURE CONTROL REGULATOR
MODULATING CONTROL VALVE (MV)
BACK PRESSURE REGULATOR
PRESSURE REGULATOR
MODULATION CONTROL ACTUATOR
ELECTRICAL SIGNAL
CAPILLARY
FILTER
RELIEF VALVE
VACUUM BREAKER
STEAM TRAP
PUMP
FLEX COUPLING (2 FT MIN)
CLAYTON SUPPLIED EQUIPMENT
CONTROL VALVE
SOLENOID VALVE
FLOW METER
FUNNEL DRAIN
ORIFICE / RESTRICTOR
DRIP LEG
OPERATING PRESSURE TRANSDUCER
APC PRESSURE TRANSDUCER
AIR INTAKE
PRESSURE + 1.0" H₂O - 1.0" H₂O
BLOWER
AIR DAMPER
ELECTRICAL CONTROL BOX
PRIMARY VOLTAGE SUPPLY
IGNITION TRANSFORMER
CUSTOMER EXHAUST
ALLOWABLE PRESSURE + 0" H₂O - 0.25" H₂O
HEATING COIL
GAS RING
OIL NOZZLE
PILOT
FLAME SCANNER
LINKAGE TO MC
TEST CONN.
OPTIONAL LIGHT OIL PILOT
VENT
MAIN GAS INLET
PILOT GAS
ATOMIZING AIR
SHIPPED LOOSE
VENT TO ATMOSPHERE
NATURAL GAS
LIGHT OIL FUEL RETURN
LIGHT OIL FUEL SUPPLY
AIR SUPPLY
OIL UNITS ONLY
CUSTOMER CONNECTIONS
H MAIN GAS INLET
I PILOT GAS INLET
J GAS BLEED VALVE
K ELECTRICAL INLET
P LIGHT OIL INLET
R LIGHT OIL RETURN
U ATOMIZING AIR INLET
Y PILOT GAS REGULATOR VENT
Z GAS PRESS. SWITCH VENTS
E REVISED & REDRAWN, REFER TO ECO MB 2-6-04
ORIGINAL DRAWING
CLAYTON INDUSTRIES EL MONTE CA. 91734
(S) EOG - 154/504 OPEN SYSTEM
P & ID (TYPICAL)
(S)EOG-154/504
R-16099
SHEET 1 OF 3
R-14669


FUEL & ELECTRICAL SYSTEMS
LEGEND
VALVE
GLOBE VALVE
NEEDLE VALVE
BUTTERFLY VALVE
GAS COCK VALVE
STRAINER
STOP CHECK STRAIGHT VALVE
CHECK VALVE
LEVEL INDICATOR
LEVEL CONTROL
PRESSURE SWITCH
LIMIT PRESSURE SWITCH
PRESSURE INDICATOR
TEMPERATURE CONTROL
THERMOCOUPLE
TEMPERATURE INDICATOR
TEMPERATURE SWITCH
MOTOR
SAFETY SHUT-OFF GAS VALVE
MAIN GAS VALVE
VENT VALVE (GAS)
PILOT VALVE
PILOT VENT VALVE
PILOT AIR VALVE
PRESSURE CONTROL REGULATOR
MODULATING CONTROL VALVE (MV)
BACK PRESSURE REGULATOR
PRESSURE REGULATOR
MODULATION CONTROL MOTOR
ELECTRICAL SIGNAL
CAPILLARY
RELIEF VALVE
STEAM TRAP
PUMP
FLOW METER
FLEX COUPLING (2 FT MIN)
CLAYTON SUPPLIED EQUIPMENT
CONTROL VALVE
SOLENOID VALVE
FUNNEL DRAIN
DRIP LEG
OPERATING PRESSURE TRANSDUCER
APC PRESSURE TRANSDUCER
COOLING AIR INTAKE
CLEAN AIR
COOLING AIR FAN & MOTOR
AIR INTAKE
PRESSURE + 1.0" H2O - 1.0" H2O
BLOWER
AIR DAMPER
AIR/GAS MIXER
CUSTOMER EXHAUST
ALLOWABLE PRESSURE + 0" H2O - 0.25" H2O
HEATING COIL
AUX. GAS
PILOT
IGNITION TRANSFORMER
FLAME SCANNER
ELECTRICAL CONTROL BOX
PRIMARY VOLTAGE SUPPLY
LINKAGE TO MM
MV
TEST CONN.
TEST CONNECTION
MAIN GAS
PILOT GAS
VENT
NATURAL GAS
PILOT AIR
VENT TO ATMOSPHERE
CUSTOMER RECONNECTIONS
RC6 COOLING AIR BLOWER
CUSTOMER CONNECTION
H MAIN GAS INLET
I PILOT GAS INLET
IA PILOT AIR INLET
J GAS BLEED VALVE
K ELECTRICAL INLET
Y PILOT GAS REGULATOR VENT
Z GAS PRESS. SWITCH VENTS
E REVISED & REDRAWN, REFER TO ECO MB 1-23-04
CLAYTON INDUSTRIES EL MONTE CA. 91734
(S) EOG - 154/504 OPEN SYSTEM
P & ID (TYPICAL)
R-14669
R-16099
E
D
SHEET 2 OF 3



CUSTOMER CONNECTIONS

SA	HOTWELL FEEDWATER OUTLET
SB	HOTWELL VENT
SC	HOTWELL DRAIN
SD	HOTWELL OVERFLOW
SE	HOTWELL STEAM SUPPLY
SF	TRAP RETURN
SFI	CONDENSATE RETURN
SG	CHEMICAL INJECTION/BP RECIRC.
SH	MAKEUP WATER INLET
SK	SOFTENER INLET/OUTLET
SL	SOFTENER DRAIN
SM	BLOWDOWN TANK INLET
SN	BLOWDOWN TANK DISCHARGE
SO	BLOWDOWN TANK VENT
SP	BLOWDOWN COOLING WATER
SS	SAMPLE COOLER CONNECTIONS
BPI	BOOSTER PUMP INLET
BP2	BOOSTER PUMP OUTLET

CUSTOMER CONNECTIONS

A	SEPARATOR OUTLET
BI	SAFETY VALVE OUTLET
B2	SAFETY VALVE OUTLET
C	FEEDWATER INLET
D	STEAM TRAP OUTLET
E	SEPARATOR /BLOWDOWN DRAIN
FI	COIL DRAIN
F2	UPPER WATERWALL DRAIN
G	PUMP RELIEF VALVE
GF	GRAVITY FILL
L	CONTINUOUS BLOWDOWN VALVE
IAF	INSTRUMENT AIR
OI	COIL BLOWDOWN
O2	COIL BLOWDOWN
S	SOOT BLOWER CONNECT.
V	AUTO DUMP VALVE

CUSTOMER RECONNECTIONS

RCI	COIL FEED
RC2	FEEDWATER PUMP
RC3	STEAM TRAP
RC4	TRAP PI
RC5	FEEDWATER PI

WATER/STEAM SYSTEMS

NOTES:

1. ALL INTERCONNECT PIPING SHALL BE SIZED TO ALLOW PROPER FLOW. NO INTERCONNECT PIPING SHALL BE REDUCED BELOW LARGEST CONNECTION SIZE OF EQUIPMENT SUPPLIED BY CLAYTON INDUSTRIES. MANIFOLDING OF COMMON CONNECTIONS MUST INCLUDE HEADER PIPE SIZE DERATING TO PROPERLY HANDLE TOTAL FLOW.
2. CUSTOMER DRAIN CONNECTIONS [FI], [F2], [G] AND [S] MUST BE PIPED TO OPEN DRAIN TO PROVIDE A VISIBLE MEANS OF DETECTING WATER CONTAMINATION IN THE HEATING COIL AND LEAKAGE OF THE RELIEF VALVE.
3. ALL PIPE SIZES SHOWN ARE CONNECTION SIZES ONLY. IT IS THE INSTALLERS RESPONSIBILITY TO INCREASE PIPE SIZES AS NECESSARY TO ACHIEVE SPECIFIED FLOW VALUES. CLAYTON INSTALLATION INSTRUCTIONS MUST BE FOLLOWED AT ALL TIMES.
4. ✳ DENOTES REQUIRED EQUIPMENT AVAILABLE FOR PURCHASE FROM CLAYTON. EQUIPMENT IS SHIPPED LOOSE AND MUST BE INSTALLED BY CUSTOMER.
5. ✳✳ DENOTES OPTIONAL EQUIPMENT AVAILABLE FOR PURCHASE FROM CLAYTON. ITEMS SHOWN WITHIN CLAYTON SUPPLIED BOUNDARY ARE INSTALLED BY CLAYTON WHEN PURCHASED. IF EXTERNAL TO BOUNDARY, ITEMS ARE SHIPPED LOOSE WHEN PURCHASED AND INSTALLED BY CUSTOMER.
6. ◪ DENOTES REQUIRED EQUIPMENT AVAILABLE FOR PURCHASE FROM CLAYTON. EQUIPMENT IS INSTALLED BY CLAYTON WHEN PURCHASED FROM CLAYTON.
7. INCREASE ONE FULL PIPE SIZE AFTER FIRST ELBOW.
8. BOOSTER PUMPS REQUIRED IF HOTWELL ELEVATION CAN NOT PROVIDE SUFFICIENT NPSH TO FEEDWATER PUMP.
9. RELEVANT ONLY TO SE OPTION.
10. A FULL FLOW ATMOSPHERIC TEST VALVE IS REQUIRED AND MUST BE READILY ACCESSIBLE. INSTALL A CHAIN OPERATOR ON STOP AND TEST VALVES.
11. WATER SOFTENER REQUIRED IF DEMINERALIZED WATER /RO SYSTEM IS NOT AVAILABLE.
12. A BACK PRESSURE REGULATOR VALVE IS RECOMMENDED ON ALL INSTALLATIONS. A BACK PRESSURE REGULATOR VALVE AND A STOP CHECK VALVE ARE REQUIRED ON APC, AUTO START/STOP, MASTER LEAD LAG, MULTIPLE UNIT INSTALLATIONS AND/ OR DESIGN STEAMING PRESSURES OF BELOW 65 PSIG.
13. CUSTOMER MUST INSTALL CLAYTON AVAILABLE CONTINUOUS BLEED VALVE KIT, OR AUTO TDS CONTROLLER KIT, OR PROVIDE OTHER MEANS TO CONTROL THE TDS LEVEL IN THE SYSTEM.
14. BAROMETRIC DAMPER MAY BE REQUIRED TO MAINTAIN REQUIRED STACK DRAFT OF 0.00-0.25 WCI. BACK DRAFT DAMPER REQUIRED IN COLD WEATHER INSTALLATIONS TO PROTECT COIL FROM FREEZING.
15. REFER TO INSTALLATION MANUAL R-16600 FOR GENERAL INSTALLATION GUIDELINES AND RECOMMENDATIONS. IT IS THE CUSTOMER'S RESPONSIBILITY TO MEET ALL APPLICABLE CODES AND STANDARDS.
16. A HEAD TANK ELEVATED 2 FEET ABOVE TOP OF COIL MUST BE PROVIDED WHEN BOTTOM OF HOTWELL CAN NOT BE ELEVATED ABOVE TOP OF COIL.

LTR	REVISION	BY	DATE	CHK
E	REVISED & REDRAWN, REFER TO ECO	MB	1-26-04	
A	~~ORIGINAL DRAWING~~			

DO NOT SCALE PRINT

FOR PLATING ALLOWANCE, MICRO FINISH AND GENERAL MANUFACTURING TOLERANCES NOT SPECIFIED ON THIS DRAWING, SEE ENG. ORDER EO-1148

CLAYTON INDUSTRIES EL MONTE CA., 91734

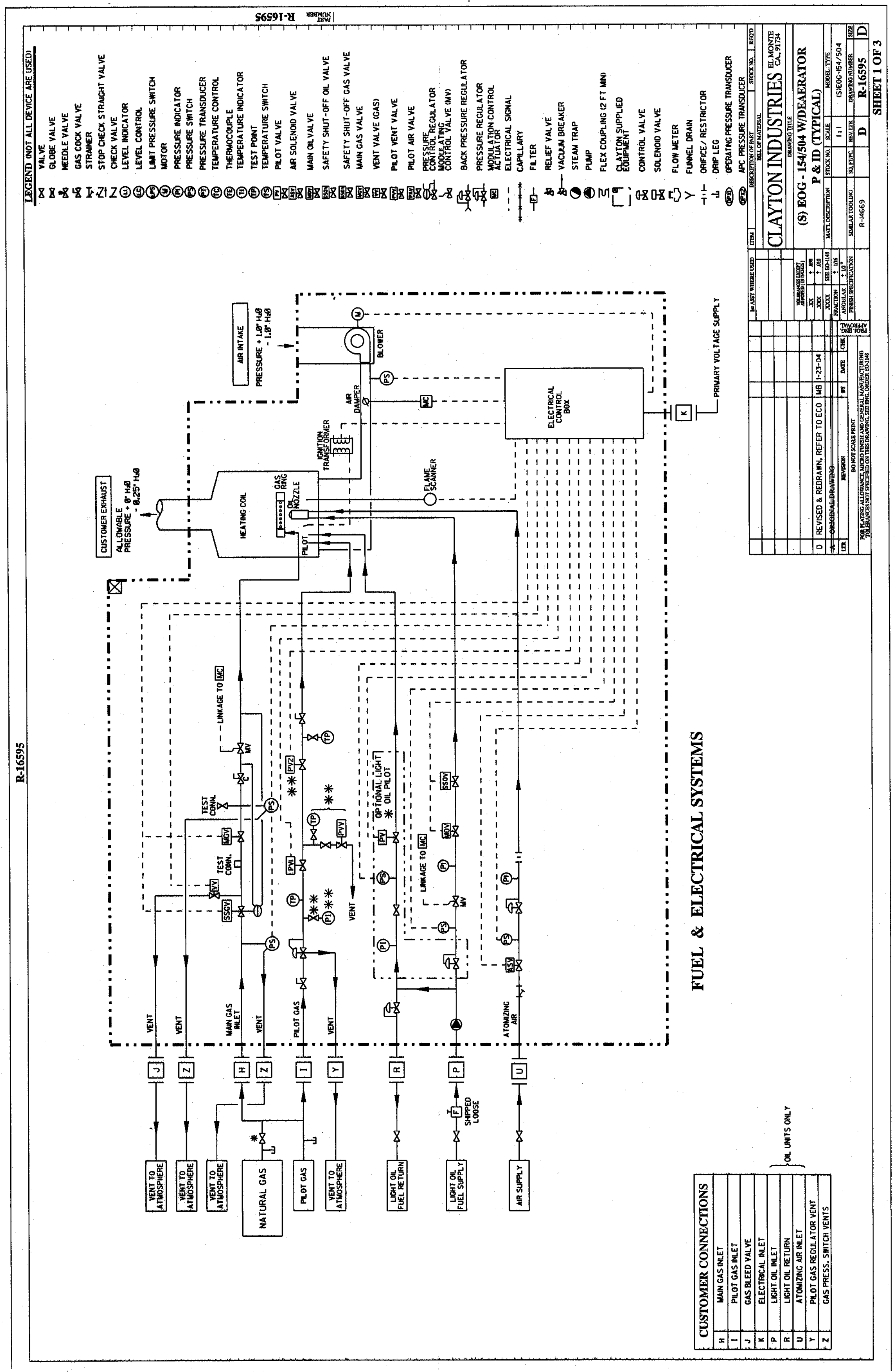
DRAWING TITLE: (S) EOG - 154/504 OPEN SYSTEM P & ID (TYPICAL)

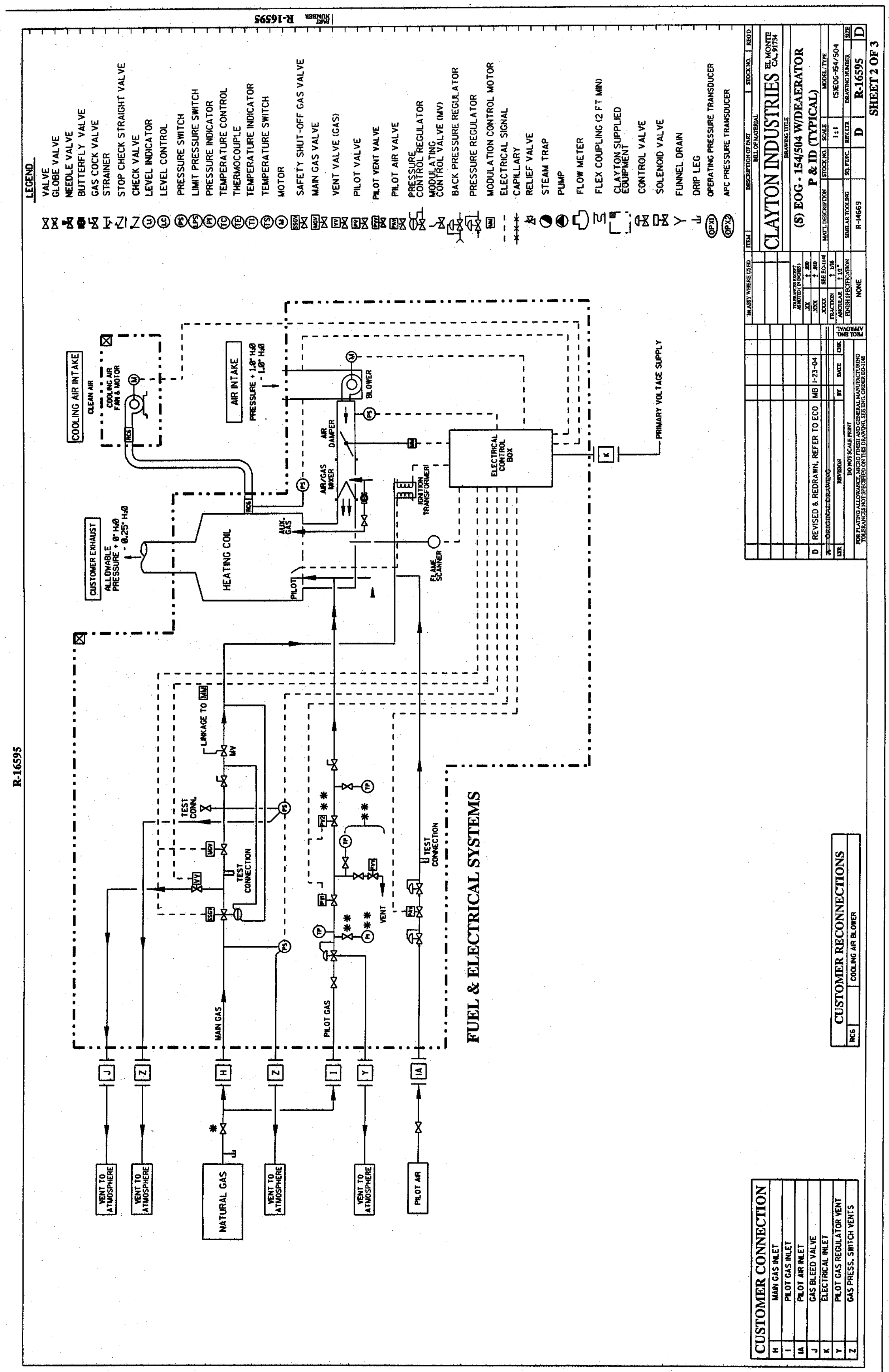
SCALE	MODEL/TYPE	SIMILAR TOOLING	REV. LTR	DRAWING NUMBER	SIZE
1:1	(S) EOG-154/504	R-14669	E	R-16099	D

FINISH SPECIFICATION: NONE

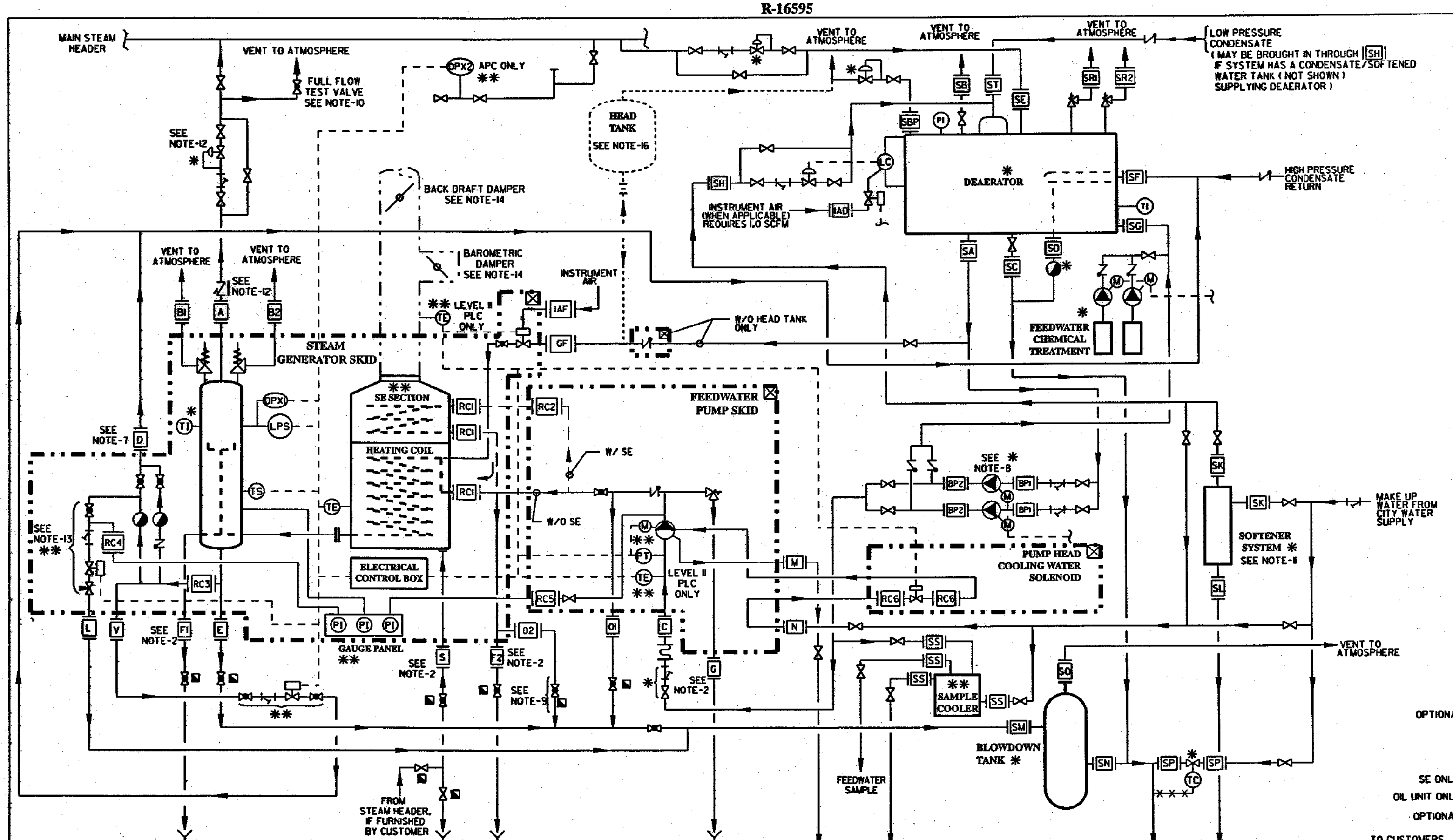
SHEET 3 OF 3

R-16099


R-16595
FUEL & ELECTRICAL SYSTEMS
LEGEND (NOT ALL DEVICE ARE USED)
VALVE
GLOBE VALVE
NEEDLE VALVE
GAS COCK VALVE
STRAINER
STOP CHECK STRAIGHT VALVE
CHECK VALVE
LEVEL INDICATOR
LEVEL CONTROL
LIMIT PRESSURE SWITCH
MOTOR
PRESSURE INDICATOR
PRESSURE SWITCH
PRESSURE TRANSDUCER
TEMPERATURE CONTROL
THERMOCOUPLE
TEMPERATURE INDICATOR
TEST POINT
TEMPERATURE SWITCH
PILOT VALVE
AIR SOLENOID VALVE
MAIN OIL VALVE
SAFETY SHUT-OFF OIL VALVE
SAFETY SHUT-OFF GAS VALVE
MAIN GAS VALVE
VENT VALVE (GAS)
PILOT VENT VALVE
PILOT AIR VALVE
PRESSURE CONTROL REGULATOR
MODULATING CONTROL VALVE (MV)
BACK PRESSURE REGULATOR
PRESSURE REGULATOR
MODULATION CONTROL ACTUATOR
ELECTRICAL SIGNAL
CAPILLARY
FILTER
RELIEF VALVE
VACUUM BREAKER
STEAM TRAP
PUMP
FLEX COUPLING (2 FT MIN)
CLAYTON SUPPLIED EQUIPMENT
CONTROL VALVE
SOLENOID VALVE
FLOW METER
FUNNEL DRAIN
ORIFICE / RESTRICTOR
DRIP LEG
OPERATING PRESSURE TRANSDUCER
APC PRESSURE TRANSDUCER
AIR INTAKE
PRESSURE + 1.0" H₂O - 1.0" H₂O
BLOWER
AIR DAMPER
ELECTRICAL CONTROL BOX
PRIMARY VOLTAGE SUPPLY
IGNITION TRANSFORMER
FLAME SCANNER
CUSTOMER EXHAUST
ALLOWABLE PRESSURE + 0" H₂O - 0.25" H₂O
HEATING COIL
GAS RING
OIL NOZZLE
PILOT
LINKAGE TO MC
TEST CONN.
OPTIONAL LIGHT OIL PILOT
VENT
MAIN GAS INLET
PILOT GAS
ATOMIZING AIR
SHIPPED LOOSE
VENT TO ATMOSPHERE
NATURAL GAS
LIGHT OIL FUEL RETURN
LIGHT OIL FUEL SUPPLY
AIR SUPPLY
OIL UNITS ONLY
CUSTOMER CONNECTIONS
H MAIN GAS INLET
I PILOT GAS INLET
J GAS BLEED VALVE
K ELECTRICAL INLET
P LIGHT OIL INLET
R LIGHT OIL RETURN
U ATOMIZING AIR INLET
Y PILOT GAS REGULATOR VENT
Z GAS PRESS. SWITCH VENTS
D REVISED & REDRAWN, REFER TO ECO MB 1-23-04
ORIGINAL DRAWING
CLAYTON INDUSTRIES EL MONTE CA. 91734
(S) EOG - 154/504 W/DEAERATOR
P & ID (TYPICAL)
(S)EOG-154/504
R-14669
R-16595
SHEET 1 OF 3
DO NOT SCALE PRINT


R-16595
LEGEND
VALVE
GLOBE VALVE
NEEDLE VALVE
BUTTERFLY VALVE
GAS COCK VALVE
STRAINER
STOP CHECK STRAIGHT VALVE
CHECK VALVE
LEVEL INDICATOR
LEVEL CONTROL
PRESSURE SWITCH
LIMIT PRESSURE SWITCH
PRESSURE INDICATOR
TEMPERATURE CONTROL
THERMOCOUPLE
TEMPERATURE INDICATOR
TEMPERATURE SWITCH
MOTOR
SAFETY SHUT-OFF GAS VALVE
MAIN GAS VALVE
VENT VALVE (GAS)
PILOT VALVE
PILOT VENT VALVE
PILOT AIR VALVE
PRESSURE CONTROL REGULATOR
MODULATING CONTROL VALVE (MV)
BACK PRESSURE REGULATOR
PRESSURE REGULATOR
MODULATION CONTROL MOTOR
ELECTRICAL SIGNAL
CAPILLARY
RELIEF VALVE
STEAM TRAP
PUMP
FLOW METER
FLEX COUPLING (2 FT MIN)
CLAYTON SUPPLIED EQUIPMENT
CONTROL VALVE
SOLENOID VALVE
FUNNEL DRAIN
DRIP LEG
OPERATING PRESSURE TRANSDUCER
APC PRESSURE TRANSDUCER
COOLING AIR INTAKE
CLEAN AIR
COOLING AIR FAN & MOTOR
AIR INTAKE
PRESSURE + 1.0" H₂O - 1.0" H₂O
BLOWER
AIR DAMPER
AIR/GAS MIXER
IGNITION TRANSFORMER
ELECTRICAL CONTROL BOX
PRIMARY VOLTAGE SUPPLY
CUSTOMER EXHAUST
ALLOWABLE PRESSURE + 0" H₂O - 0.25" H₂O
HEATING COIL
AUX. GAS
PILOT
FLAME SCANNER
LINKAGE TO MM
TEST CONN.
TEST CONNECTION
MAIN GAS
PILOT GAS
VENT
FUEL & ELECTRICAL SYSTEMS
VENT TO ATMOSPHERE
NATURAL GAS
PILOT AIR
CUSTOMER RECONNECTIONS
RC6 COOLING AIR BLOWER
CUSTOMER CONNECTION
H MAIN GAS INLET
I PILOT GAS INLET
IA PILOT AIR INLET
J GAS BLEED VALVE
K ELECTRICAL INLET
Y PILOT GAS REGULATOR VENT
Z GAS PRESS. SWITCH VENTS
D REVISED & REDRAWN, REFER TO ECO MB 1-23-04
CLAYTON INDUSTRIES EL MONTE CA. 91734
(S) EOG - 154/504 W/DEAERATOR
P & ID (TYPICAL)
R-14669
D
R-16595
SHEET 2 OF 3

R-16595



CUSTOMER CONNECTIONS

SA	DEAERATOR FEEDWATER OUTLET
SB	DEAERATOR VENT
SBP	BACK PRESSURE REGULATOR
SC	DEAERATOR DRAIN
SD	DEAERATOR OVERFLOW
SE	STEAM NOZZLE
SF	HP CONDENSATE/ TRAP RETURN
SG	CHEMICAL INJECTION/BP RECIRC.
SH	MAKEUP WATER INLET
SK	SOFTENER INLET/OUTLET
SL	SOFTENER DRAIN
SM	BLOWDOWN TANK INLET
SN	BLOWDOWN TANK DISCHARGE
SO	BLOWDOWN TANK VENT
SP	BLOWDOWN COOLING WATER
SR1	SENTINAL RELIEF VALVE
SR2	SAFETY RELIEF VALVE
SS	SAMPLE COOLER CONNECTIONS
ST	LP CONDENSATE RETURNS
BP1	BOOSTER PUMP INLET
BP2	BOOSTER PUMP OUTLET
IAD	INSTRUMENT AIR, LEVEL CONTROL

	A	SEPARATOR OUTLET
	BI	SAFETY VALVE OUTLET
	B2	SAFETY VALVE OUTLET
	C	FEEDWATER INLET
	D	STEAM TRAP OUTLET
	E	SEPARATOR DRAIN
	FI	COIL DRAIN
	F2	UPPER WATERWALL DRAIN
	G	PUMP RELIEF VALVE
	GF	GRAVITY FILL
	IAF	INSTRUMENT AIR, GRAVITY FILL
OPTIONAL	L	CONTINUOUS BLOWDOWN VALVE
	M	PUMP HEAD COOLING OUTLET
	N	PUMP HEAD COOLING INLET
	OI	COIL BLOWDOWN
SE ONLY	O2	COIL BLOWDOWN
OIL UNIT ONLY	S	SOOT BLOWER CONNECT.
OPTIONAL	V	AUTO DUMP VALVE

CUSTOMER RECONNECTIONS

RC1	COIL FEED
RC2	FEEDWATER PUMP
RC3	STEAM TRAP
RC4	TRAP PI
RC5	FEEDWATER PI
RC6	PUMP HEAD COOLING WATER SOLENOID

NOTES:

1. ALL INTERCONNECT PIPING SHALL BE SIZED TO ALLOW PROPER FLOW. NO INTERCONNECT PIPING SHALL BE REDUCED BELOW LARGEST CONNECTION SIZE OF EQUIPMENT SUPPLIED BY CLAYTON INDUSTRIES. MANIFOLDING OF COMMON CONNECTIONS MUST INCLUDE HEADER PIPE SIZE DERATING TO PROPERLY HANDLE TOTAL FLOW.
2. CUSTOMER DRAIN CONNECTIONS [F1], [O1], [O2] AND [S] MUST BE PIPED TO OPEN DRAIN TO PROVIDE A VISIBLE MEANS OF DETECTING WATER CONTAMINATION IN THE HEATING COIL AND LEAKAGE OF THE RELIEF VALVE.
3. ALL PIPE SIZES SHOWN ARE CONNECTION SIZES ONLY. IT IS THE INSTALLERS RESPONSIBILITY TO INCREASE PIPE SIZES AS NECESSARY TO ACHIEVE SPECIFIED FLOW VALUES. CLAYTON INSTALLATION INSTRUCTIONS MUST BE FOLLOWED AT ALL TIMES.
4. * DENOTES REQUIRED EQUIPMENT AVAILABLE FOR PURCHASE FROM CLAYTON. EQUIPMENT IS SHIPPED LOOSE AND MUST BE INSTALLED BY CUSTOMER.
5. ** DENOTES OPTIONAL EQUIPMENT AVAILABLE FOR PURCHASE FROM CLAYTON. ITEMS SHOWN WITHIN CLAYTON SUPPLIED BOUNDARY ARE INSTALLED BY CLAYTON WHEN PURCHASED. IF EXTERNAL TO BOUNDARY, ITEMS ARE SHIPPED LOOSE WHEN PURCHASED AND INSTALLED BY CUSTOMER.
6. ▣ DENOTES REQUIRED EQUIPMENT AVAILABLE FOR PURCHASE FROM CLAYTON. EQUIPMENT IS INSTALLED BY CLAYTON WHEN PURCHASED FROM CLAYTON.
7. INCREASE ONE FULL PIPE SIZE AFTER FIRST ELBOW.
8. BOOSTER PUMPS REQUIRED IF HOTWELL ELEVATION CAN NOT PROVIDE SUFFICIENT NPSH TO FEEDWATER PUMP.
9. RELEVANT ONLY TO SE APPLICATION.
10. A FULL FLOW ATMOSPHERIC TEST VALVE IS REQUIRED AND MUST BE READILY ACCESSIBLE. INSTALL A CHAIN OPERATOR IF NECESSARY.
11. WATER SOFTENER REQUIRED IF DEMINERALIZED WATER /RO SYSTEM IS NOT AVAILABLE.
12. A BACK PRESSURE REGULATOR VALVE IS RECOMMENDED ON ALL INSTALLATIONS. A BACK PRESSURE REGULATOR VALVE AND A STOP CHECK VALVE ARE REQUIRED ON APC, AUTO START/STOP, MASTER LEAD LAG, AND MULTIPLE UNIT INSTALLATIONS.
13. CUSTOMER MUST INSTALL CLAYTON AVAILABLE CONTINUOUS BLEED VALVE KIT, OR AUTO TDS CONTROLLER KIT, OR PROVIDE OTHER MEANS TO CONTROL THE TDS LEVEL IN THE SYSTEM.
14. BAROMETRIC DAMPER MAY BE REQUIRED TO MAINTAIN REQUIRED STACK DRAFT OF 0.00-0.25 WCI. BACK DRAFT DAMPER REQUIRED IN COLD WEATHER INSTALLATIONS TO PROTECT COIL FROM FREEZING.
15. REFER TO INSTALLATION MANUAL R-16600 FOR GENERAL INSTALLATION GUIDELINES AND RECOMMENDATIONS. IT IS THE CUSTOMER'S RESPONSIBILITY TO MEET ALL APPLICABLE CODES AND STANDARDS.
16. A HEAD TANK ELEVATED 2 FEET ABOVE TOP OF COIL MUST BE PROVIDED WHEN BOTTOM OF DEAERATOR CAN NOT BE ELEVATED ABOVE OF COIL.

LTR	REVISION	BY	DATE	CHK
D	REVISED & REDRAWN, REFER TO ECO	MB	1-26-04	
~~A~~	~~ORIGINAL DRAWING~~			

DO NOT SCALE PRINT

FOR PLATING ALLOWANCE, MICRO FINISH AND GENERAL MANUFACTURING TOLERANCES NOT SPECIFIED ON THIS DRAWING, SEE ENG. ORDER EO-1148

TOLERANCES EXCEPT AS NOTED (IN INCHES): .XX ± .030; .XXX ± .010; .XXXX SEE EO-1148; FRACTION ± 1/16; ANGULAR ± 1/2°

FINISH SPECIFICATION: NONE

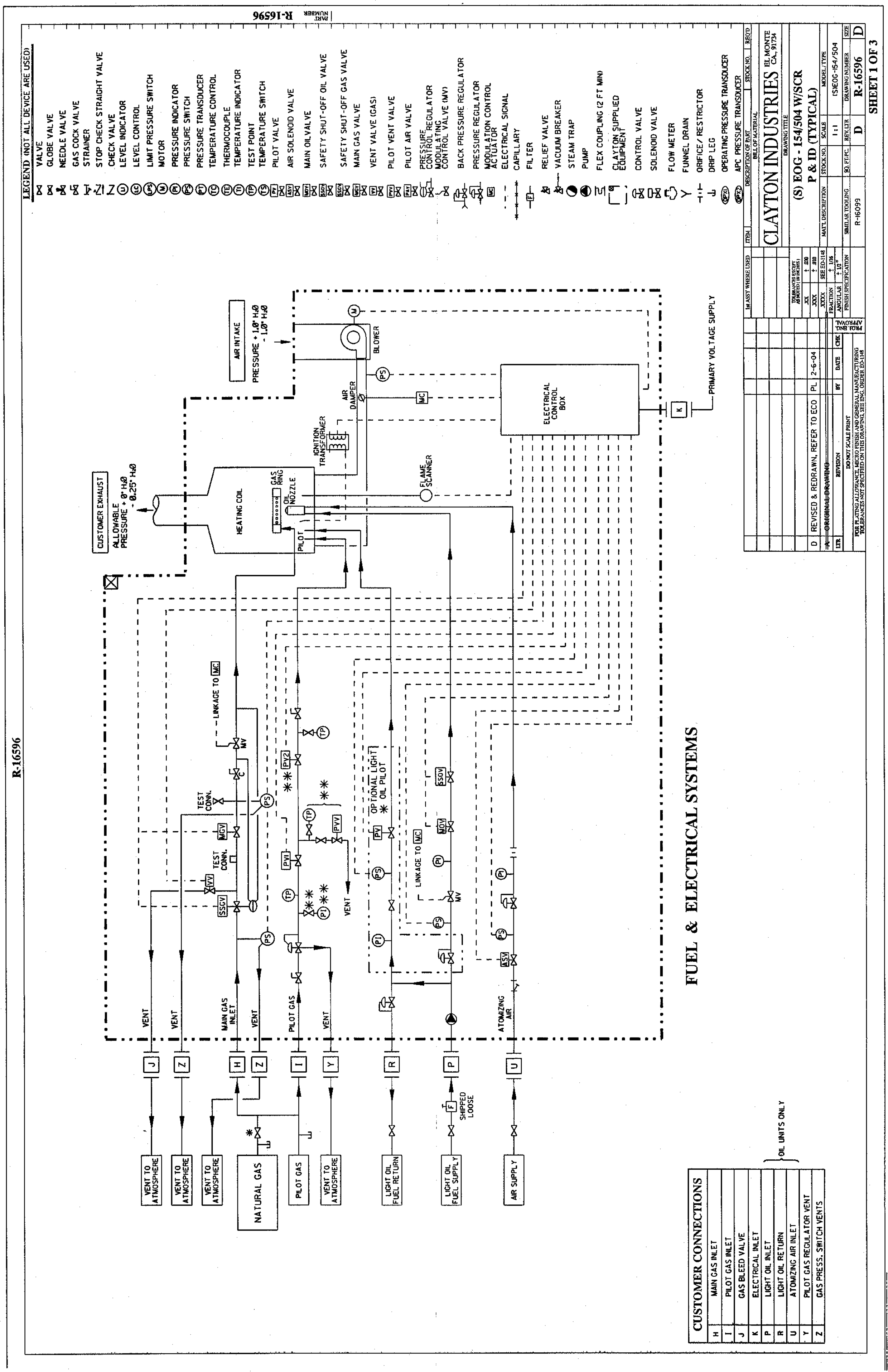
CLAYTON INDUSTRIES EL MONTE CA., 91734

DRAWING TITLE: (S) EOG-154/504 W/DEARERATOR P & ID (TYPICAL)

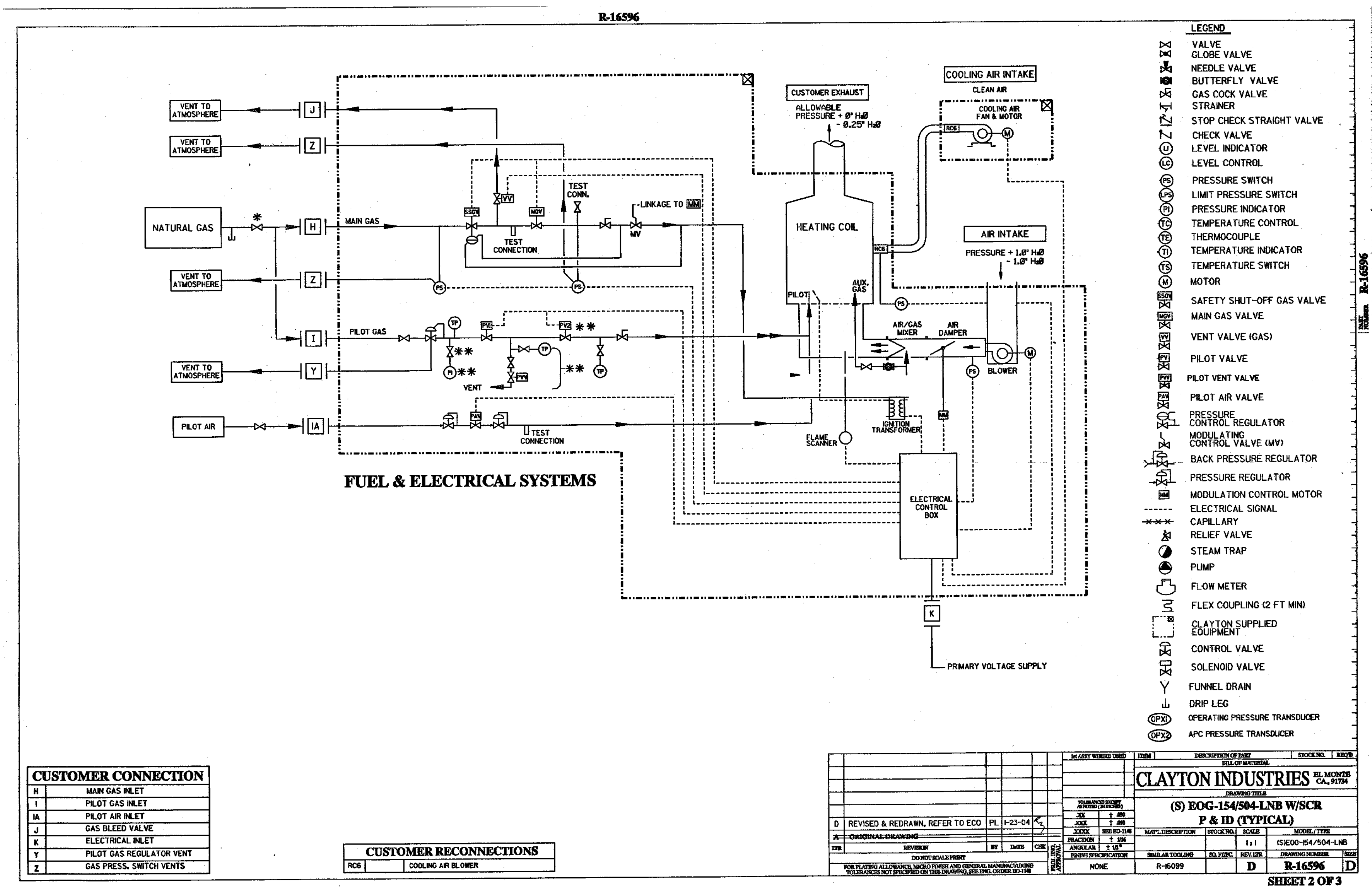
MAT'L DESCRIPTION	STOCK NO.	SCALE	MODEL/TYPE
		1:1	(S) EOG-154/504

SIMILAR TOOLING	SQ. FT/PC.	REV. LTR	DRAWING NUMBER	SIZE
R-14669		D	R-16595	D

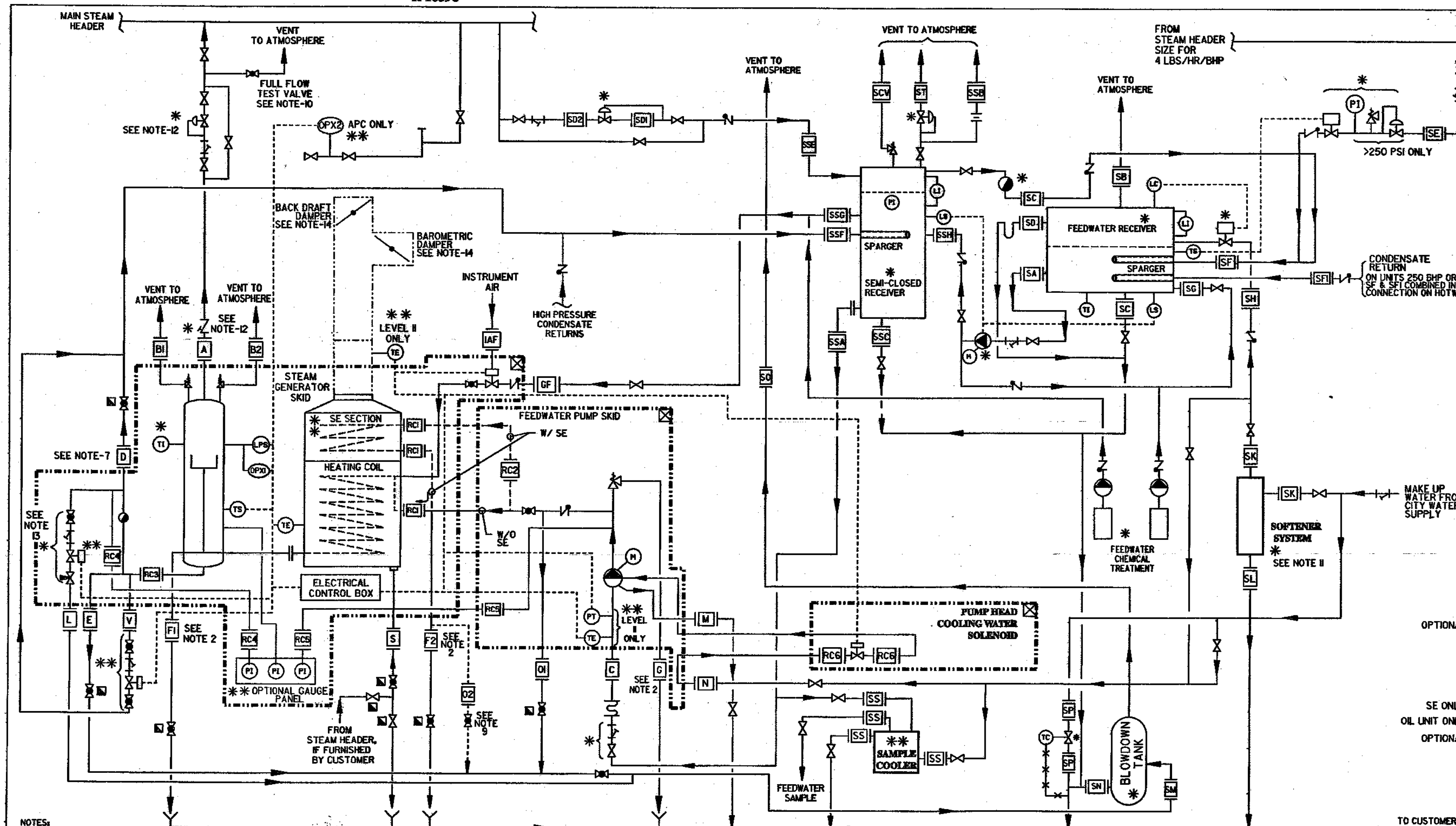
SHEET 3 OF 3



R-16596
FUEL & ELECTRICAL SYSTEMS
LEGEND (NOT ALL DEVICE ARE USED)
VALVE
GLOBE VALVE
NEEDLE VALVE
GAS COCK VALVE
STRAINER
STOP CHECK STRAIGHT VALVE
CHECK VALVE
LEVEL INDICATOR
LEVEL CONTROL
LIMIT PRESSURE SWITCH
MOTOR
PRESSURE INDICATOR
PRESSURE SWITCH
PRESSURE TRANSDUCER
TEMPERATURE CONTROL
THERMOCOUPLE
TEMPERATURE INDICATOR
TEST POINT
TEMPERATURE SWITCH
PILOT VALVE
AIR SOLENOID VALVE
MAIN OIL VALVE
SAFETY SHUT-OFF OIL VALVE
SAFETY SHUT-OFF GAS VALVE
MAIN GAS VALVE
VENT VALVE (GAS)
PILOT VENT VALVE
PILOT AIR VALVE
PRESSURE CONTROL REGULATOR
MODULATING CONTROL VALVE (MV)
BACK PRESSURE REGULATOR
PRESSURE REGULATOR
MODULATION CONTROL ACTUATOR
ELECTRICAL SIGNAL
CAPILLARY
FILTER
RELIEF VALVE
VACUUM BREAKER
STEAM TRAP
PUMP
FLEX COUPLING (2 FT MIN)
CLAYTON SUPPLIED EQUIPMENT
CONTROL VALVE
SOLENOID VALVE
FLOW METER
FUNNEL DRAIN
ORIFICE / RESTRICTOR
DRIP LEG
OPERATING PRESSURE TRANSDUCER
APC PRESSURE TRANSDUCER
CUSTOMER EXHAUST
ALLOWABLE PRESSURE + 0" H₂O - 0.25" H₂O
AIR INTAKE
PRESSURE + 1.0" H₂O - 1.0" H₂O
BLOWER
AIR DAMPER
IGNITION TRANSFORMER
HEATING COIL
GAS RING
OIL NOZZLE
PILOT
FLAME SCANNER
ELECTRICAL CONTROL BOX
PRIMARY VOLTAGE SUPPLY
LINKAGE TO MC
TEST CONN.
OPTIONAL LIGHT OIL PILOT
VENT
MAIN GAS INLET
PILOT GAS
ATOMIZING AIR
SHIPPED LOOSE
VENT TO ATMOSPHERE
NATURAL GAS
PILOT GAS
LIGHT OIL FUEL RETURN
LIGHT OIL FUEL SUPPLY
AIR SUPPLY
OIL UNITS ONLY
CUSTOMER CONNECTIONS
H MAIN GAS INLET
I PILOT GAS INLET
J GAS BLEED VALVE
K ELECTRICAL INLET
P LIGHT OIL INLET
R LIGHT OIL RETURN
U ATOMIZING AIR INLET
Y PILOT GAS REGULATOR VENT
Z GAS PRESS. SWITCH VENTS
CLAYTON INDUSTRIES EL MONTE CA., 91734
(S) EOG - 154/504 W/SCR
P & ID (TYPICAL)
D REVISED & REDRAWN, REFER TO ECO PL 2-6-04
DO NOT SCALE PRINT
R-16099
(S)EOG-154/504
R-16596
SHEET 1 OF 3
PART NUMBER R-16596


R-16596
FUEL & ELECTRICAL SYSTEMS
VENT TO ATMOSPHERE
NATURAL GAS
PILOT AIR
MAIN GAS
PILOT GAS
TEST CONN.
TEST CONNECTION
LINKAGE TO MM
VENT
CUSTOMER EXHAUST
ALLOWABLE PRESSURE + 0" H2O - 0.25" H2O
HEATING COIL
PILOT
AUX. GAS
COOLING AIR INTAKE
CLEAN AIR
COOLING AIR FAN & MOTOR
AIR INTAKE
PRESSURE + 1.0" H2O - 1.0" H2O
AIR/GAS MIXER
AIR DAMPER
BLOWER
FLAME SCANNER
IGNITION TRANSFORMER
ELECTRICAL CONTROL BOX
PRIMARY VOLTAGE SUPPLY
LEGEND
VALVE
GLOBE VALVE
NEEDLE VALVE
BUTTERFLY VALVE
GAS COCK VALVE
STRAINER
STOP CHECK STRAIGHT VALVE
CHECK VALVE
LEVEL INDICATOR
LEVEL CONTROL
PRESSURE SWITCH
LIMIT PRESSURE SWITCH
PRESSURE INDICATOR
TEMPERATURE CONTROL
THERMOCOUPLE
TEMPERATURE INDICATOR
TEMPERATURE SWITCH
MOTOR
SAFETY SHUT-OFF GAS VALVE
MAIN GAS VALVE
VENT VALVE (GAS)
PILOT VALVE
PILOT VENT VALVE
PILOT AIR VALVE
PRESSURE CONTROL REGULATOR
MODULATING CONTROL VALVE (MV)
BACK PRESSURE REGULATOR
PRESSURE REGULATOR
MODULATION CONTROL MOTOR
ELECTRICAL SIGNAL
CAPILLARY
RELIEF VALVE
STEAM TRAP
PUMP
FLOW METER
FLEX COUPLING (2 FT MIN)
CLAYTON SUPPLIED EQUIPMENT
CONTROL VALVE
SOLENOID VALVE
FUNNEL DRAIN
DRIP LEG
OPERATING PRESSURE TRANSDUCER
APC PRESSURE TRANSDUCER
CUSTOMER CONNECTION
H MAIN GAS INLET
I PILOT GAS INLET
IA PILOT AIR INLET
J GAS BLEED VALVE
K ELECTRICAL INLET
Y PILOT GAS REGULATOR VENT
Z GAS PRESS. SWITCH VENTS
CUSTOMER RECONNECTIONS
RC6 COOLING AIR BLOWER
D REVISED & REDRAWN, REFER TO ECO PL 1-23-04
A ORIGINAL DRAWING
DO NOT SCALE PRINT
CLAYTON INDUSTRIES EL MONTE CA., 91734
(S) EOG-154/504-LNB W/SCR
P & ID (TYPICAL)
SCALE 1:1
MODEL/TYPE (S)EOG-154/504-LNB
SIMILAR TOOLING R-16099
FINISH SPECIFICATION NONE
REV. LTR. D
DRAWING NUMBER R-16596
SIZE D
SHEET 2 OF 3

R-16596



CUSTOMER CONNECTIONS

SA	MAKEUP OUTLET
SSA	FEEDWATER OUTLET
SB	FEEDWATER RECEIVER VENT
SSB	SCR VENT (1/8" ORIFICE)
SC	FEEDWATER RECEIVER DRAIN
SSC	SCR DRAIN
SD	FEEDWATER RECEIVER OVERFLOW
SDI	STEAM SUPPLY (TO SCR)
SD2	STEAM SUPPLY (TO PRV)
SE	STEAM SUPPLY (HOTWELL)
SSE	STEAM SUPPLY (SCR)
SF	LOW PRESSURE CONDENSATE RETURN
SSF	TRAP / HIGH PRESSURE CONDENSATE RETURN
SG	CHEMICAL INJECTION (BP RECIRC.)
SSG	CHEMICAL INJECTION (SCR)
SH	MAKEUP WATER INLET (HOTWELL)
SSH	MAKEUP WATER INLET (SCR)
SK	SOFTENER INLET/OUTLET
SL	SOFTENER DRAIN
SM	BLOWDOWN TANK INLET
SN	BLOWDOWN TANK DISCHARGE
SO	BLOWDOWN TANK VENT
ST	BPR OUTLET (SCR)
SCV	SAFETY VALVE OUTLET (SCR)
SS	SAMPLE COOLER CONNECTIONS

CUSTOMER CONNECTIONS

	A	SEPARATOR OUTLET
	BI	SAFETY VALVE OUTLET
	B2	SAFETY VALVE OUTLET
	C	FEEDWATER INLET
	D	STEAM TRAP OUTLET
	E	SEPARATOR DRAIN
	FI	COIL DRAIN
	F2	UPPER WATERWALL DRAIN
	G	PUMP RELIEF VALVE
	GF	GRAVITY FILL
OPTIONAL	L	CONTINUOUS BLOWDOWN VALVE
	IAF	INSTRUMENT AIR
	M	PUMP HEAD COOLING WATER OUTLET
	N	PUMP HEAD COOLING WATER INLET
	OI	COIL BLOWDOWN
SE ONLY	O2	COIL BLOWDOWN
OIL UNIT ONLY	S	SOOT BLOWER CONN.
OPTIONAL	V	AUTO DUMP VALVE

CUSTOMER RECONNECTIONS

RC1	COIL FEED
RC2	FEEDWATER PUMP (SE ONLY)
RC3	STEAM TRAP
RC4	TRAP PI
RC5	FEEDWATER PI

WATER/STEAM SYSTEMS

NOTES:

1. ALL INTERCONNECT PIPING SHALL BE SIZED TO ALLOW PROPER FLOW. NO INTERCONNECT PIPING SHALL BE REDUCED BELOW LARGEST CONNECTION SIZE OF EQUIPMENT SUPPLIED BY CLAYTON INDUSTRIES. MANIFOLDING OF COMMON CONNECTIONS MUST INCLUDE HEADER PIPE SIZE DERATING TO PROPERLY HANDLE TOTAL FLOW.
2. CUSTOMER DRAIN CONNECTIONS [F1], [F2], [G] AND [S] MUST BE PIPED TO OPEN DRAIN TO PROVIDE A VISIBLE MEANS OF DETECTING WATER CONTAMINATION IN THE HEATING COIL AND LEAKAGE OF THE RELIEF VALVE.
3. ALL PIPE SIZES SHOWN ARE CONNECTION SIZES ONLY. IT IS THE INSTALLERS RESPONSIBILITY TO INCREASE PIPE SIZES AS NECESSARY TO ACHIEVE SPECIFIED FLOW VALUES. CLAYTON INSTALLATION INSTRUCTIONS MUST BE FOLLOWED AT ALL TIMES.
4. ✳ DENOTES REQUIRED EQUIPMENT AVAILABLE FOR PURCHASE FROM CLAYTON. EQUIPMENT IS SHIPPED LOOSE AND MUST BE INSTALLED BY CUSTOMER.
5. ✳✳ DENOTES OPTIONAL EQUIPMENT AVAILABLE FOR PURCHASE FROM CLAYTON. ITEMS SHOWN WITHIN CLAYTON SUPPLIED BOUNDARY ARE INSTALLED BY CLAYTON WHEN PURCHASED. IF EXTERNAL TO BOUNDARY, ITEMS ARE SHIPPED LOOSE WHEN PURCHASED AND INSTALLED BY CUSTOMER.
6. ◪ DENOTES REQUIRED EQUIPMENT AVAILABLE FOR PURCHASE FROM CLAYTON. EQUIPMENT IS INSTALLED BY CLAYTON WHEN PURCHASED FROM CLAYTON.
7. INCREASE ONE FULL PIPE SIZE AFTER FIRST ELBOW.
8. NOT USED.
9. RELEVANT ONLY TO SE APPLICATION.
10. A FULL FLOW ATMOSPHERIC TEST VALVE IS REQUIRED AND MUST BE READILY ACCESSIBLE. INSTALL A CHAIN OPERATOR ON STOP AND TEST VALVES.
11. WATER SOFTENER REQUIRED IF DEMINERALIZED WATER /RO SYSTEM IS NOT AVAILABLE.
12. A BACK PRESSURE REGULATOR VALVE IS RECOMMENDED ON ALL INSTALLATIONS. A BACK PRESSURE REGULATOR VALVE AND A STOP CHECK VALVE ARE REQUIRED ON APC, AUTO START/STOP, MASTER LEAD LAG, AND MULTIPLE UNIT INSTALLATIONS AND/ OR DESIGN STEAMING PRESSURES OF BELOW 65 PSIG.
13. CUSTOMER MUST INSTALL CLAYTON AVAILABLE CONTINUOUS BLEED VALVE KIT, OR AUTO TDS CONTROLLER KIT, OR PROVIDE OTHER MEANS TO CONTROL THE TDS LEVEL IN THE SYSTEM.
14. BAROMETRIC DAMPER MAY BE REQUIRED TO MAINTAIN REQUIRED STACK DRAFT OF 0.00-0.25 WCI. BACK DRAFT DAMPER REQUIRED IN COLD WEATHER INSTALLATIONS TO PROTECT COIL FROM FREEZING.
15. REFER TO INSTALLATION MANUAL R-16600 FOR GENERAL INSTALLATION GUIDELINES AND RECOMMENDATIONS. IT IS THE CUSTOMER'S RESPONSIBILITY TO MEET ALL APPLICABLE CODES AND STANDARDS.
16. NOT USED

LTR	REVISION	BY	DATE	CHK
D	REVISED & REDRAWN, REFER TO ECO	PL	1-26-04	
C	REVISED & REDRAWN, REFER TO ECO	MB	7-31-02	RY
B	REVISED & REDRAWN, REFER TO ECO.	RY	12-1-98	RY
A	~~ORIGINAL DRAWING~~			

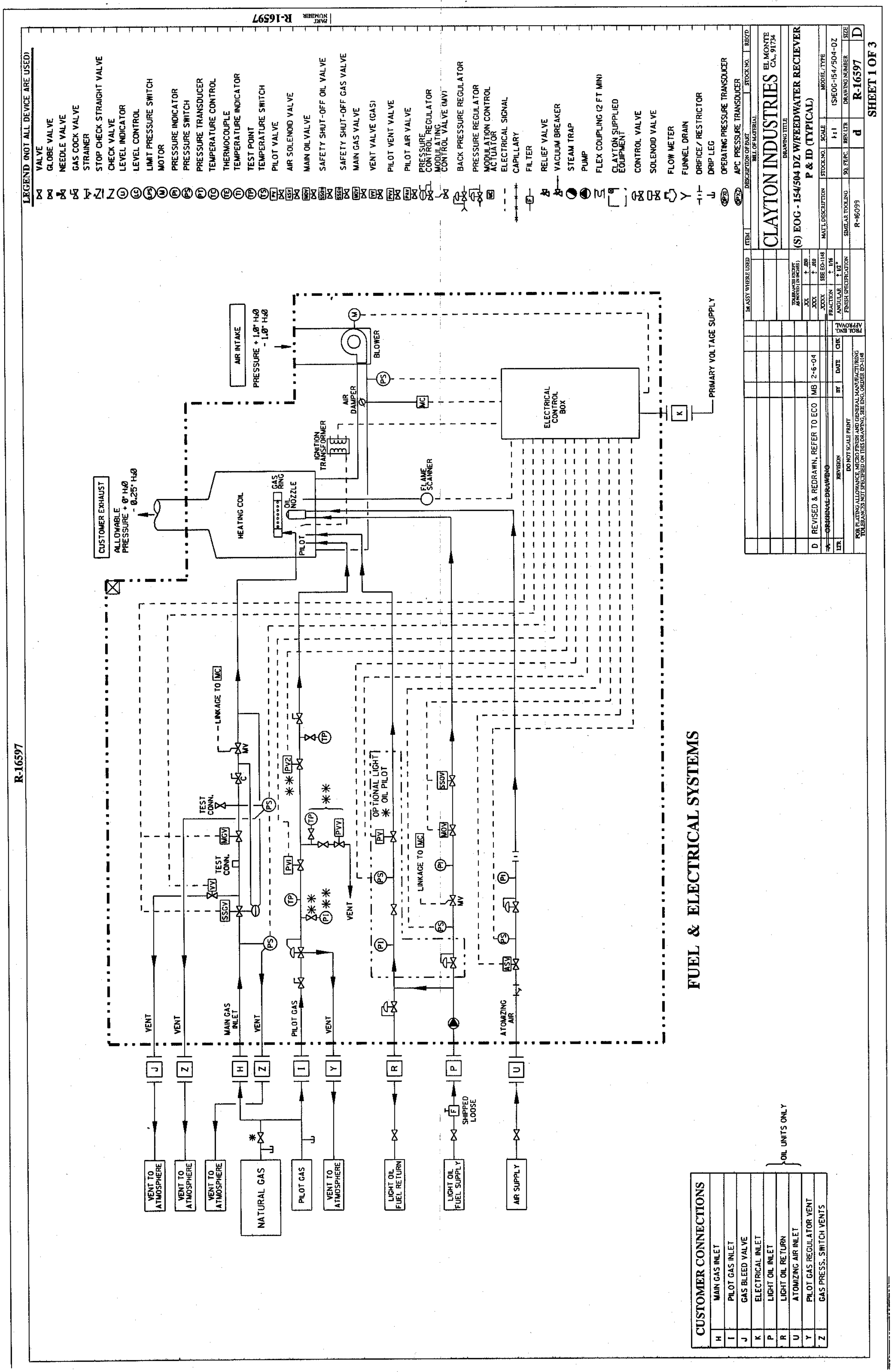
DO NOT SCALE PRINT

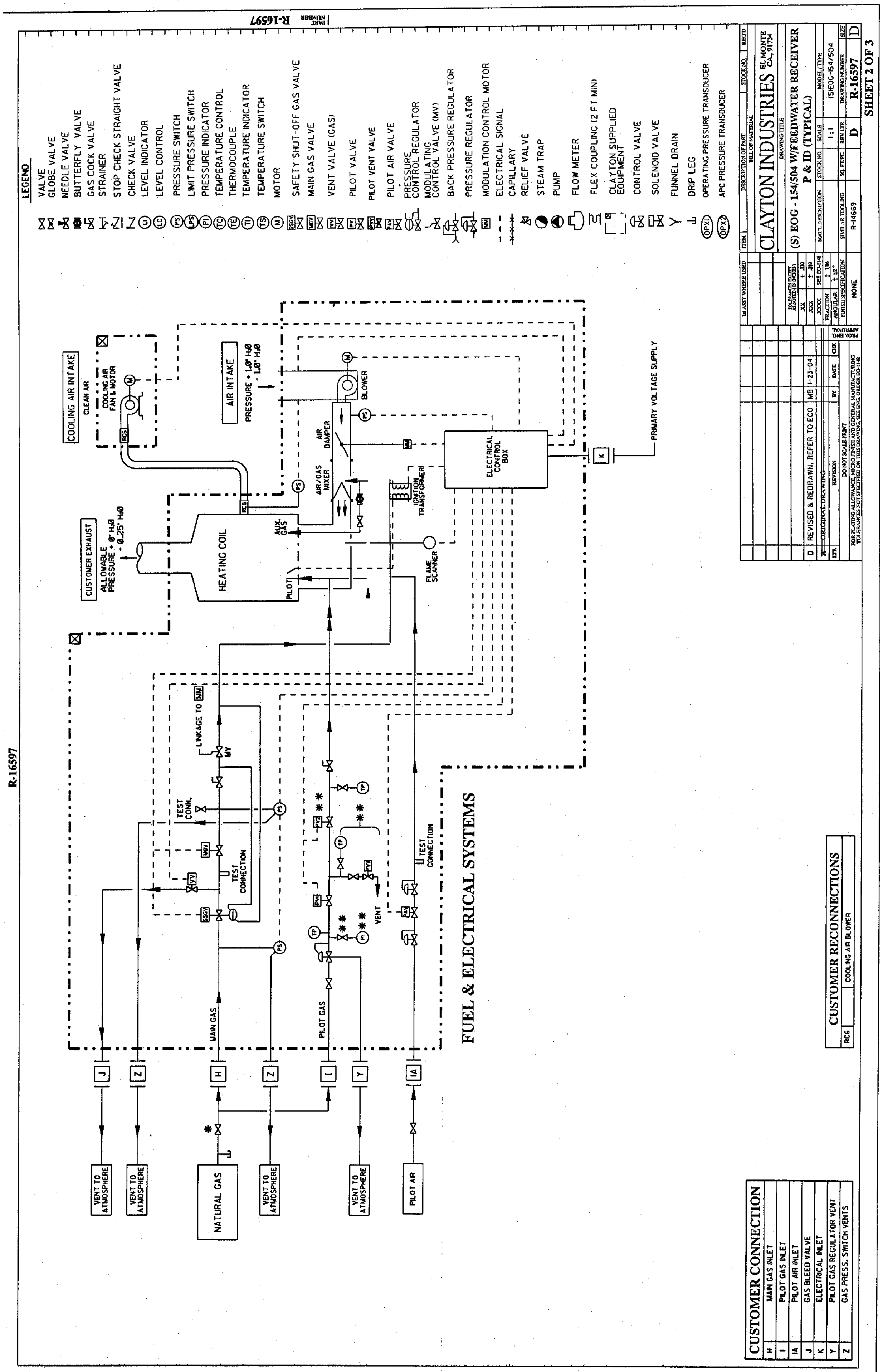
CLAYTON INDUSTRIES EL MONTE CA., 91734

DRAWING TITLE: (S)EOG 154-504 w/ SCR P& ID (TYPICAL)

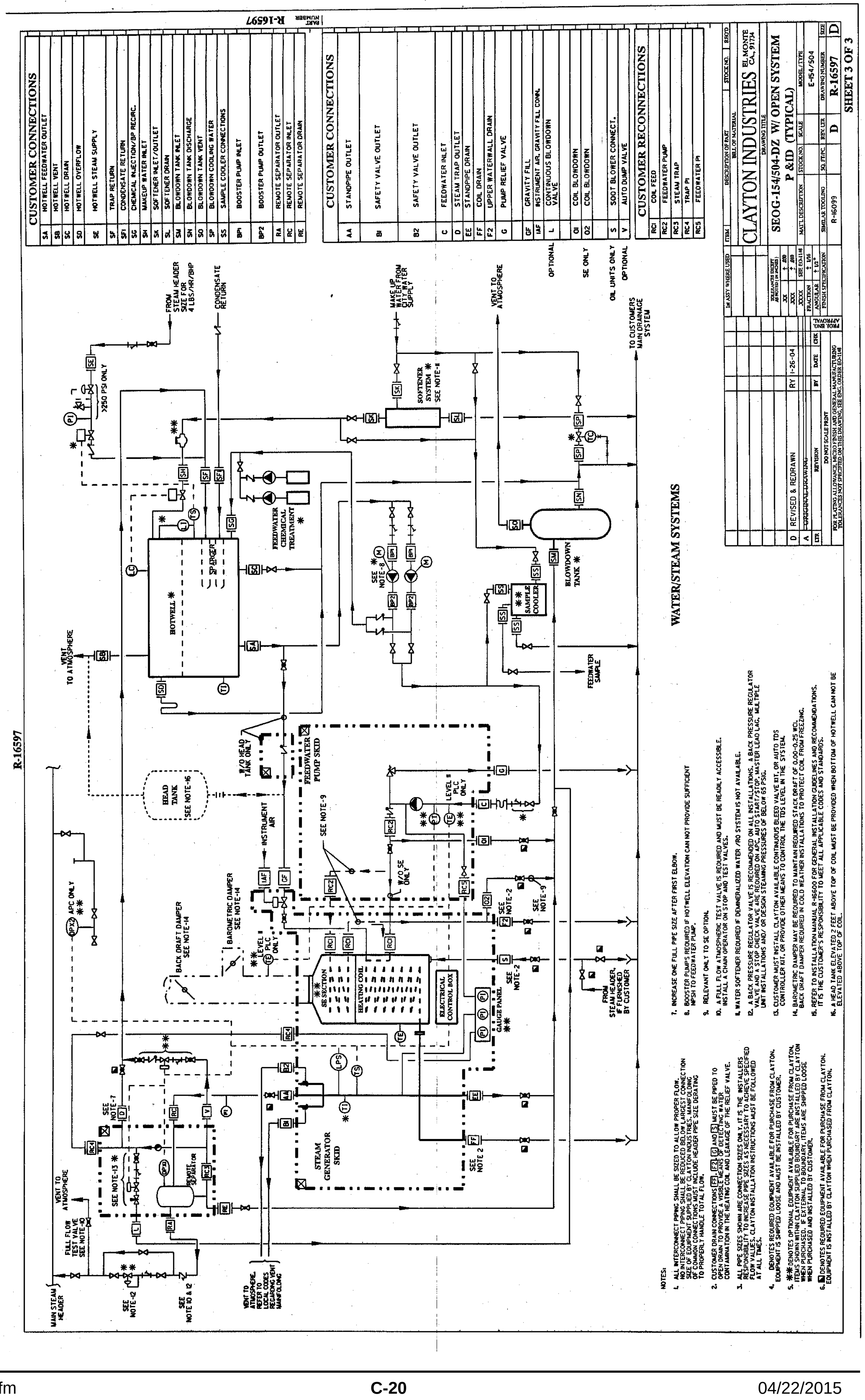
SCALE: NONE — MODEL/TYPE: (S)EOG 154-504 — FINISH SPECIFICATION: NONE — SIMILAR TOOLING: R-15973 — REV. LTR: D — DRAWING NUMBER: R - 16596 — SIZE: D

SHEET 3 OF 3


R-16597
PART NUMBER R-16597
LEGEND (NOT ALL DEVICE ARE USED)
VALVE
GLOBE VALVE
NEEDLE VALVE
GAS COCK VALVE
STRAINER
STOP CHECK STRAIGHT VALVE
CHECK VALVE
LEVEL INDICATOR
LEVEL CONTROL
LIMIT PRESSURE SWITCH
MOTOR
PRESSURE INDICATOR
PRESSURE SWITCH
PRESSURE TRANSDUCER
TEMPERATURE CONTROL
THERMOCOUPLE
TEMPERATURE INDICATOR
TEST POINT
TEMPERATURE SWITCH
PILOT VALVE
AIR SOLENOID VALVE
MAIN OIL VALVE
SAFETY SHUT-OFF OIL VALVE
SAFETY SHUT-OFF GAS VALVE
MAIN GAS VALVE
VENT VALVE (GAS)
PILOT VENT VALVE
PILOT AIR VALVE
PRESSURE CONTROL REGULATOR
MODULATING CONTROL VALVE (MV)
BACK PRESSURE REGULATOR
PRESSURE REGULATOR
MODULATION CONTROL ACTUATOR
ELECTRICAL SIGNAL
CAPILLARY
FILTER
RELIEF VALVE
VACUUM BREAKER
STEAM TRAP
PUMP
FLEX COUPLING (2 FT MIN)
CLAYTON SUPPLIED EQUIPMENT
CONTROL VALVE
SOLENOID VALVE
FLOW METER
FUNNEL DRAIN
ORIFICE / RESTRICTOR
DRIP LEG
OPERATING PRESSURE TRANSDUCER
APC PRESSURE TRANSDUCER
AIR INTAKE
PRESSURE + 1.0" H₂O - 1.0" H₂O
BLOWER
AIR DAMPER
IGNITION TRANSFORMER
ELECTRICAL CONTROL BOX
PRIMARY VOLTAGE SUPPLY
CUSTOMER EXHAUST
ALLOWABLE PRESSURE + 0" H₂O - 0.25" H₂O
HEATING COIL
GAS RING
OIL NOZZLE
PILOT
FLAME SCANNER
LINKAGE TO MC
TEST CONN.
OPTIONAL LIGHT OIL PILOT
VENT
MAIN GAS INLET
PILOT GAS
ATOMIZING AIR
SHIPPED LOOSE
VENT TO ATMOSPHERE
NATURAL GAS
LIGHT OIL FUEL RETURN
LIGHT OIL FUEL SUPPLY
AIR SUPPLY
OIL UNITS ONLY
FUEL & ELECTRICAL SYSTEMS
CUSTOMER CONNECTIONS
H MAIN GAS INLET
I PILOT GAS INLET
J GAS BLEED VALVE
K ELECTRICAL INLET
P LIGHT OIL INLET
R LIGHT OIL RETURN
U ATOMIZING AIR INLET
Y PILOT GAS REGULATOR VENT
Z GAS PRESS. SWITCH VENTS
D REVISED & REDRAWN, REFER TO ECO MB 2-6-04
ORIGINAL DRAWING
CLAYTON INDUSTRIES EL MONTE CA., 91734
(S) EOG - 154/504 DZ W/FEEDWATER RECIEVER P & ID (TYPICAL)
(S)EOG-154/504-DZ
R-16099
R-16597
SHEET 1 OF 3



R-16597
LEGEND
VALVE
GLOBE VALVE
NEEDLE VALVE
BUTTERFLY VALVE
GAS COCK VALVE
STRAINER
STOP CHECK STRAIGHT VALVE
CHECK VALVE
LEVEL INDICATOR
LEVEL CONTROL
PRESSURE SWITCH
LIMIT PRESSURE SWITCH
PRESSURE INDICATOR
TEMPERATURE CONTROL
THERMOCOUPLE
TEMPERATURE INDICATOR
TEMPERATURE SWITCH
MOTOR
SAFETY SHUT-OFF GAS VALVE
MAIN GAS VALVE
VENT VALVE (GAS)
PILOT VALVE
PILOT VENT VALVE
PILOT AIR VALVE
PRESSURE CONTROL REGULATOR
MODULATING CONTROL VALVE (MV)
BACK PRESSURE REGULATOR
PRESSURE REGULATOR
MODULATION CONTROL MOTOR
ELECTRICAL SIGNAL
CAPILLARY
RELIEF VALVE
STEAM TRAP
PUMP
FLOW METER
FLEX COUPLING (2 FT MIN)
CLAYTON SUPPLIED EQUIPMENT
CONTROL VALVE
SOLENOID VALVE
FUNNEL DRAIN
DRIP LEG
OPERATING PRESSURE TRANSDUCER
APC PRESSURE TRANSDUCER
COOLING AIR INTAKE
CLEAN AIR
COOLING AIR FAN & MOTOR
AIR INTAKE
PRESSURE + 1.0" H₂O - 1.0" H₂O
BLOWER
AIR DAMPER
AIR/GAS MIXER
IGNITION TRANSFORMER
ELECTRICAL CONTROL BOX
PRIMARY VOLTAGE SUPPLY
CUSTOMER EXHAUST
ALLOWABLE PRESSURE + 0" H₂O - 0.25" H₂O
HEATING COIL
AUX. GAS
PILOT
FLAME SCANNER
LINKAGE TO MM
MV
TEST CONN.
TEST CONNECTION
MAIN GAS
PILOT GAS
VENT
FUEL & ELECTRICAL SYSTEMS
VENT TO ATMOSPHERE
NATURAL GAS
PILOT AIR
CUSTOMER RECONNECTIONS
RC6 COOLING AIR BLOWER
CUSTOMER CONNECTION
H MAIN GAS INLET
I PILOT GAS INLET
IA PILOT AIR INLET
J GAS BLEED VALVE
K ELECTRICAL INLET
Y PILOT GAS REGULATOR VENT
Z GAS PRESS. SWITCH VENTS
D REVISED & REDRAWN, REFER TO ECO MB 1-23-04
CLAYTON INDUSTRIES EL MONTE CA. 91734
(S) EOG - 154/504 W/FEEDWATER RECEIVER P & ID (TYPICAL)
R-14669
(S)EOG-154/504
R-16597
D
SHEET 2 OF 3


R-16597
CUSTOMER CONNECTIONS
SA HOTWELL FEEDWATER OUTLET
SB HOTWELL VENT
SC HOTWELL DRAIN
SD HOTWELL OVERFLOW
SE HOTWELL STEAM SUPPLY
SF TRAP RETURN
SF1 CONDENSATE RETURN
SG CHEMICAL INJECTION/BP RECIRC.
SH MAKEUP WATER INLET
SK SOFTENER INLET/OUTLET
SL SOFTENER DRAIN
SM BLOWDOWN TANK INLET
SN BLOWDOWN TANK DISCHARGE
SO BLOWDOWN TANK VENT
SP BLOWDOWN COOLING WATER
SS SAMPLE COOLER CONNECTIONS
BP1 BOOSTER PUMP INLET
BP2 BOOSTER PUMP OUTLET
RA REMOTE SEPARATOR OUTLET
RC REMOTE SEPARATOR OUTLET
RE REMOTE SEPARATOR DRAIN
CUSTOMER CONNECTIONS
AA STANDPIPE OUTLET
B1 SAFETY VALVE OUTLET
B2 SAFETY VALVE OUTLET
C FEEDWATER INLET
D STEAM TRAP OUTLET
EE STANDPIPE DRAIN
FF COIL DRAIN
F2 UPPER WATERWALL DRAIN
G PUMP RELIEF VALVE
GF GRAVITY FILL
IAF INSTRUMENT AIR, GRAVITY FILL CONN.
L CONTINUOUS BLOWDOWN VALVE
O1 COIL BLOWDOWN
O2 COIL BLOWDOWN
S SOOT BLOWER CONNECT.
V AUTO DUMP VALVE
CUSTOMER RECONNECTIONS
RC1 COIL FEED
RC2 FEEDWATER PUMP
RC3 STEAM TRAP
RC4 TRAP PI
RC5 FEEDWATER PI
CLAYTON INDUSTRIES EL MONTE CA. 91734
SEOG-154/504-DZ W/ OPEN SYSTEM
P &ID (TYPICAL)
E-154/504
R-16597
SHEET 3 OF 3
D REVISED & REDRAWN RY 1-26-04
WATER/STEAM SYSTEMS
HOTWELL
BLOWDOWN TANK
SAMPLE COOLER
SOFTENER SYSTEM SEE NOTE-11
FEEDWATER CHEMICAL TREATMENT
FEEDWATER PUMP SKID
STEAM GENERATOR SKID
HEAD TANK SEE NOTE-16
ELECTRICAL CONTROL BOX
GAUGE PANEL
MAIN STEAM HEADER
VENT TO ATMOSPHERE
NOTES:
7. INCREASE ONE FULL PIPE SIZE AFTER FIRST ELBOW.
8. BOOSTER PUMPS REQUIRED IF HOTWELL ELEVATION CAN NOT PROVIDE SUFFICIENT NPSH TO FEEDWATER PUMP.
9. RELEVANT ONLY TO SE OPTION.
11. WATER SOFTENER REQUIRED IF DEMINERALIZED WATER /RO SYSTEM IS NOT AVAILABLE.

Appendix D

Installing SE

(Super Economizer)

Option

(This page intentionally left blank.)

INTRODUCTION

A Clayton SE (Super Economizer) Coil provides added efficiency to your existing Clayton steam generator/fluid heater. The SE coil allows feedwater supply to be preheated prior to entering the main heating section. This preheated fluid helps to reduce the energy consumption of the machine without compromising its output capacity.

An SE coil is offered as a kit. This kit includes the coil assembly, outer shell extensions, band clamps, piping, and necessary hardware.

IMPORTANT

Before ordering an SE Kit, verify there is ample overhead clearance above the machine. An SE section adds twenty-four to forty-eight inches of height to the machine. Additional clearance must also be available for lifting SE coil onto the main coil. See Section 6.7 for height requirements.

WARNING

An SE coil assembly weighs several hundred pounds. Make sure all safety measures are observed throughout the SE Kit installation process. Make sure the lifting apparatus that will be used to hoist the SE coil assembly is designed for lifting such weights.

NOTE

It is always recommended that these procedures be reviewed completely before beginning the SE Kit installation.

INSTALLATION

Execute a dry shutdown of the machine. See Section IV in the Steam Generator/Fluid Heater Instruction Manual for procedure. Allow the machine to cool.

WARNING

Secure the machine to prevent accidental start up during SE Kit installation.

Remove Heater Covers

a. Disconnect and remove the flue exhaust duct from the heater cover.

b. Disconnect and remove the existing feedwater supply and discharge piping from the machine.

c. Remove the outer heater cover clamp bands and outer heater cover (See Figure 1.)

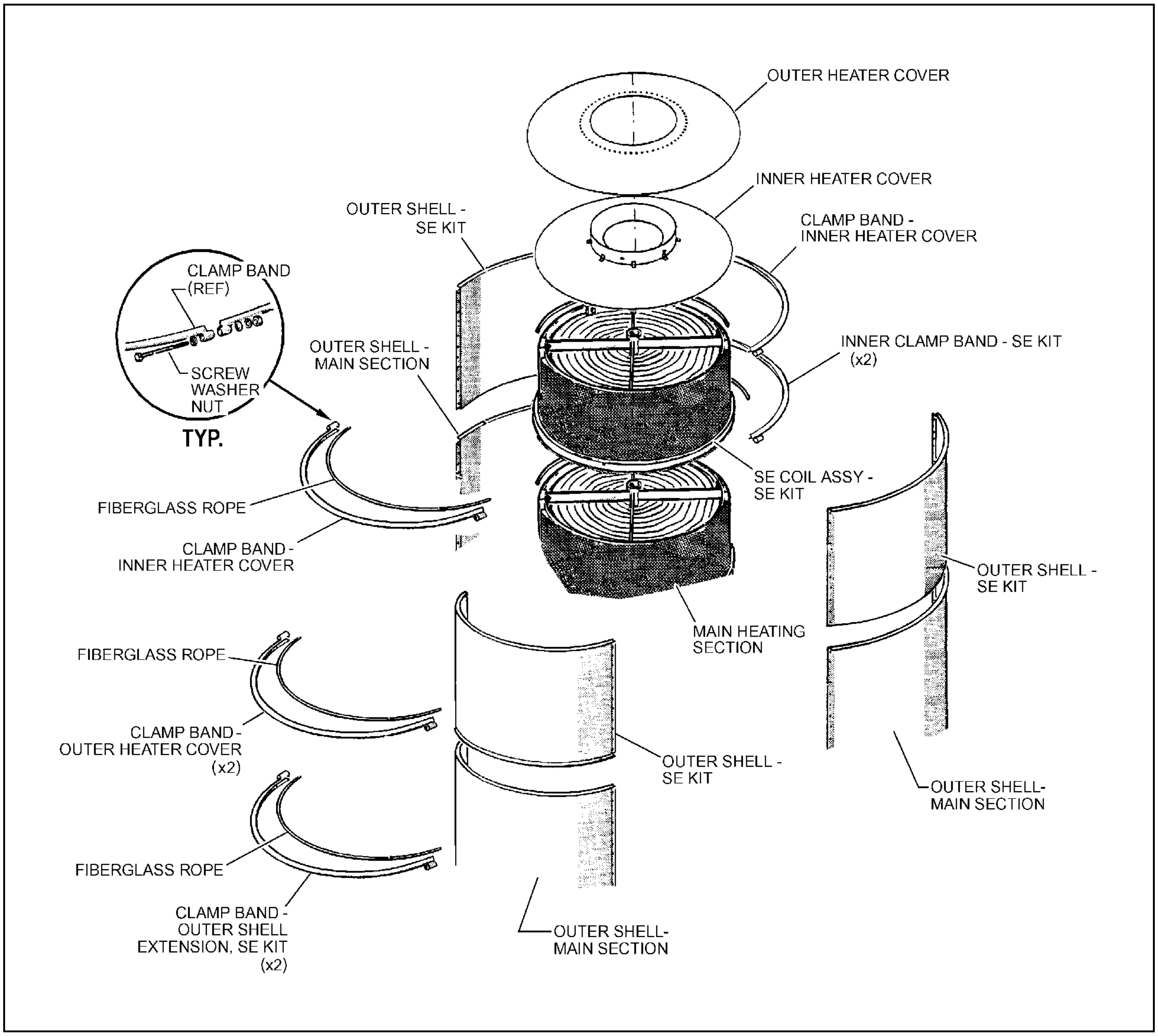


Figure 1 SE Coil Kit installation diagram (typical)

d. If applicable, remove the outer shell extension clamp bands and outer shell extension.

e. Remove the inner heater cover clamp bands and inner heater cover.

Remove Outer Shells and Top Coil (E704 Steam Generator/Fluid Heater Only)

a. Remove the patch-plates around the feedwater supply and the feedwater discharge openings.

b. Remove the top outer shell clamp bands.

c. Remove the assembly screws for the outer shells and remove the outer shells.

d. Secure the top coil assembly by attaching the lifting apparatus to the lifting hook installed on the top coil assembly.

e. Remove the coil clamp bands that secures the top coil assembly to the lower coil assembly.

f. Carefully, lift and remove the top coil assembly off the lower coils.

Install SE Coil Assembly

(See Figure 1.)

a. Prepare the main heating section flange ring surface with a layer of G. S. Teflon Thread Sealing Compound. This will aid in adjusting the SE coil assembly into alignment with the main heating section.

b. Lift the SE coil assembly up onto the main heating section.

NOTE

If desired, the inner heater cover may be installed on the SE coil assembly prior to lifting it onto the main heating section.

c. Align the SE coil assembly's bottom flange ring with the main coil section flange ring.

d. Rotate the SE coil assembly, as needed, to align the feedwater inlet(s), as shown in Figure 2 and 3.

e. Install the inner clamp bands around the main heating section flange ring and the SE coil assembly's bottom flange ring. Secure the clamp bands with their attaching hardware.

f. Place and align the inner heater cover on SE coil assembly.

g. Install the inner heater cover clamp bands around the heater cover and the SE coil assembly's top flange ring. Secure the clamp bands with their attaching hardware.

Install Outer Shells

a. **Two-piece Outer Shells-** Lift the rear outer shell piece (the shell piece with the cut-outs) up around the rear-side of the SE coil assembly and the feedwater inlet/discharge, allowing it to rest on the main outer shell below. Using a set of self-locking clamps, Vise-Grip® pliers for example, clamp the SE outer shell to the main outer shell.

   Three-piece Outer Shells- Pre-assemble the front outer shell piece and the left outer shell piece while on the ground. The left outer shell piece consist of two cut-outs in the lower half. Screw the two shell ends opposite the cut-outs together. Lift these assembled outer shells up around the front and left side of the SE coil assembly and the feedwater inlet, allowing it to rest on the main outer shell below. Using a set of self-locking clamps, Vise-Grip® pliers for example, clamp the SE outer shells to the main outer shell.

b. Lift the remaining outer shell piece into place. Screw the two shell ends together. Align the assembled SE outer shells with the main outer shells below.

c. Install the outer clamp bands around the main outer shell flange and the SE outer shell flange. Secure the clamp bands with their attaching hardware.

d. Install the outer heater cover in the same manner as the inner heater cover was installed. Refer to steps f and g in the previous section.

e. Install the patch plates around the feedwater inlet piping and the feedwater discharge piping.

Install Piping

a. Pre-assemble the SE Kit feedwater supply and feedwater discharge piping and flanges.

b. Install the pre-assembled SE piping to the feedwater supply side and the feedwater discharge side of the machine, as shown in Figures 2 and 3.

IMPORTANT

Before starting the steam generator/fluid heater, verify all piping connections, outer shell assemblies, and clamp bands are secure.

Check Completed SE Kit Installation

a. Start and fill the heating unit without burner operation. See the filling procedure in Section IV of the Steam Generator/Fluid Heater Instruction Manual.

b. Check for leakage around connections of the newly installed SE Kit piping.

c. Boil out SE coil using soft water. See the “Conditioning of New Installations” procedure in Section III of the Steam Generator/Fluid Heater Instruction Manual.

The machine should be ready to be placed into regular operation at this point.

NOTE

Some parameters of the control system may require adjustment with the added SE Kit. Consult your Clayton Service Representative for further details.

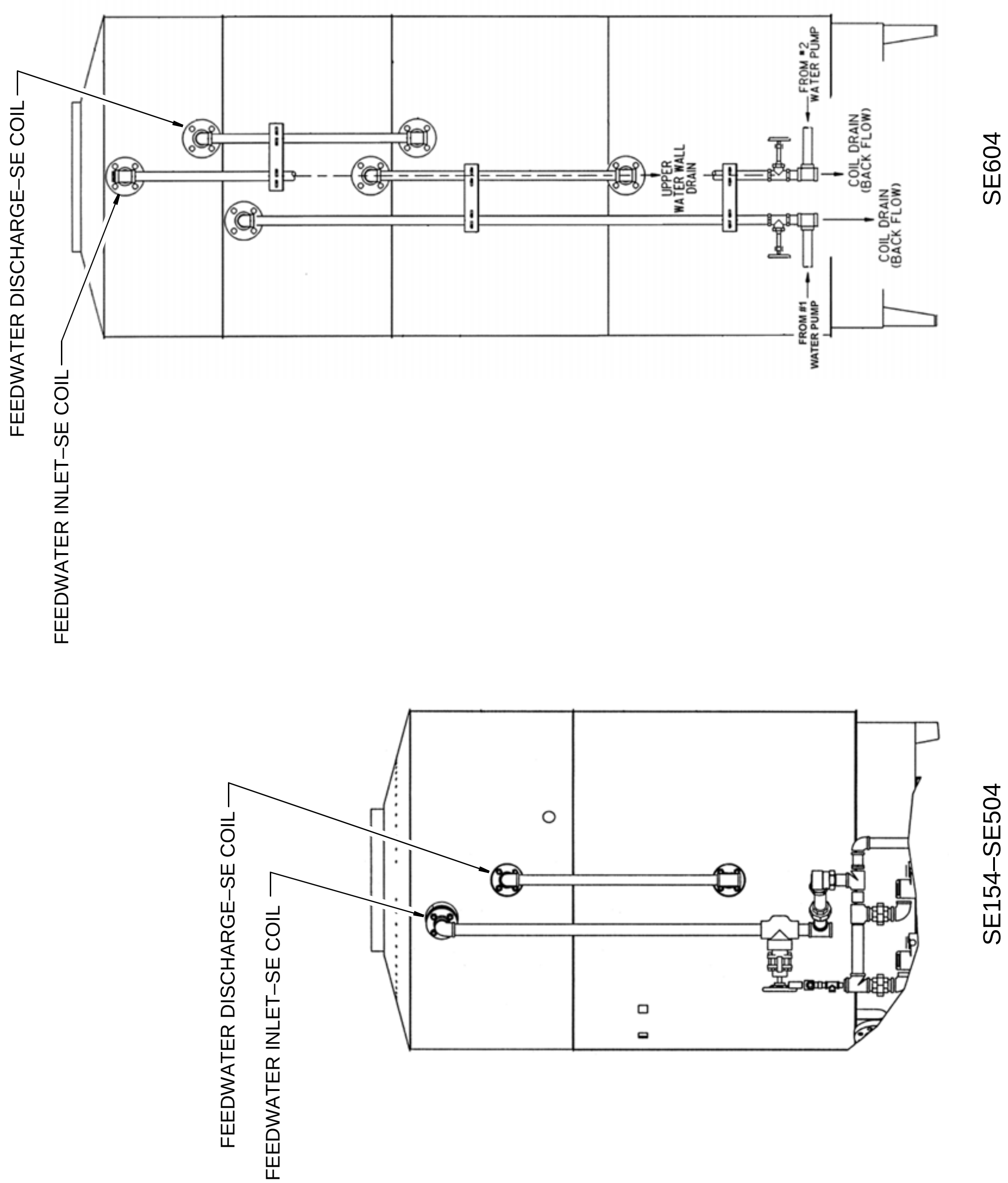


Figure 2 SE Kit completed hookup (rotated 90^{o} counterclockwise)

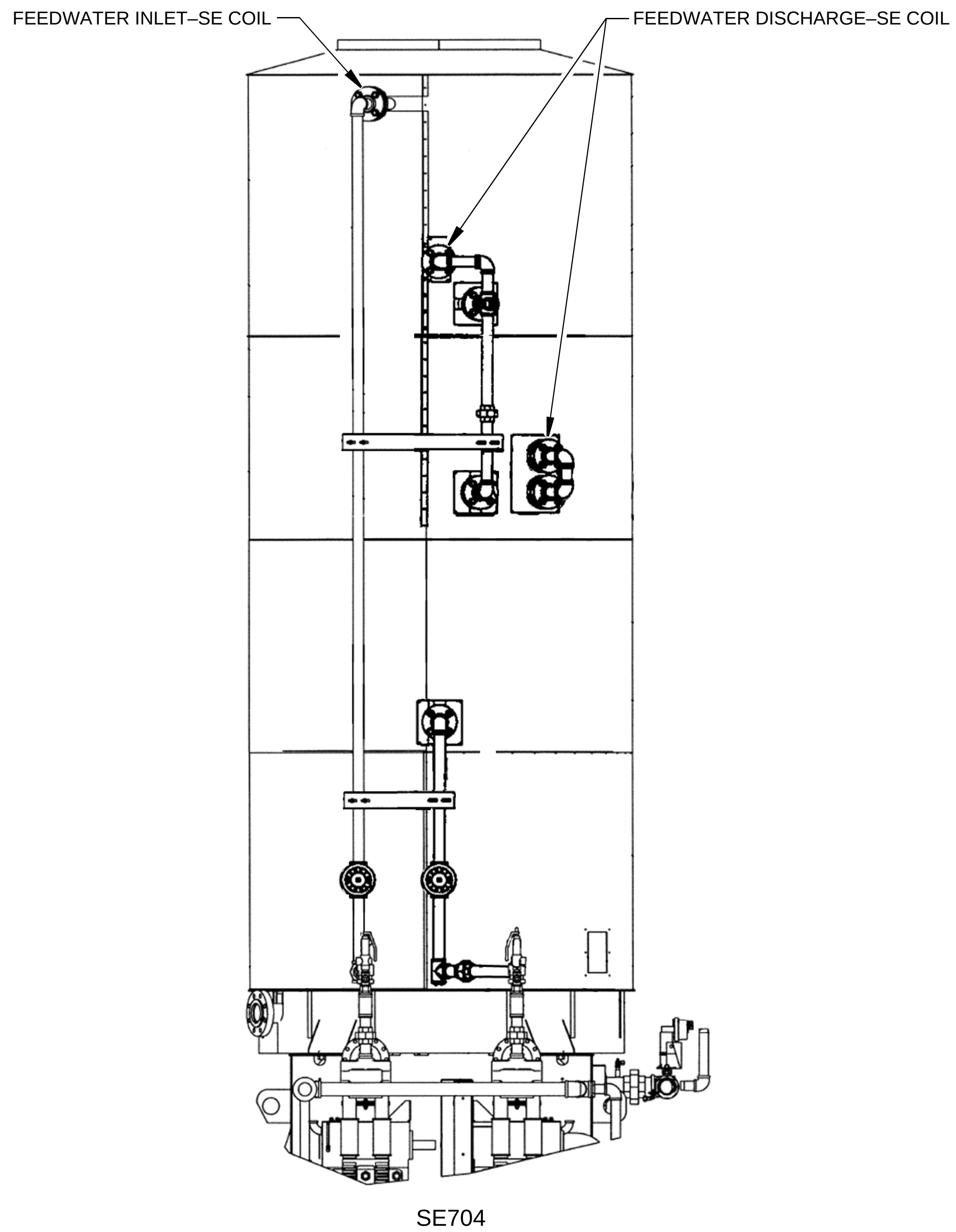


Figure 3 SE Kit completed hookup, E704

Clayton Industries

17477 Hurley Street, City of Industry, California 91744-5106, USA
Phone: +1 (626) 435-1200 Fax: +1 (626) 435-0180
Internet: www.claytonindustries.com
Email: sales@claytonindustries.com