



Economizers

CRE / CCE / C2X / C1X

Operation Manual



750-266
1/15

CLEAVER-BROOKS

Economizers

CRE - CCE - C2X - C1X

Operation Manual



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DO NOT OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS YOU FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.

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FAILURE TO FOLLOW ALL APPLICABLE WARNINGS AND INSTRUCTIONS MAY RESULT IN SEVERE PERSONAL INJURY OR DEATH.

TO: Owners, Operators and/or Maintenance Personnel

This operating manual presents information that will help to properly operate and care for the equipment. Study its contents carefully. The unit will provide good service and continued operation if proper operating and maintenance instructions are followed. No attempt should be made to operate the unit until the principles of operation and all of the components are thoroughly understood. Failure to follow all applicable instructions and warnings may result in severe personal injury or death.

It is the responsibility of the owner to train and advise not only his or her personnel, but the contractors' personnel who are servicing, repairing or operating the equipment, in all safety aspects.

Cleaver-Brooks equipment is designed and engineered to give long life and excellent service on the job. The electrical and mechanical devices supplied as part of the unit were chosen because of their known ability to perform; however, proper operating techniques and maintenance procedures must be followed at all times. Although these components afford a high degree of protection and safety, operation of equipment is not to be considered free from all dangers and hazards inherent in handling and firing of fuel.

Any "automatic" features included in the design do not relieve the attendant of any responsibility. Such features merely free him of certain repetitive chores and give him more time to devote to the proper upkeep of equipment.

It is solely the operator's responsibility to properly operate and maintain the equipment. No amount of written instructions can replace intelligent thinking and reasoning and this manual is not intended to relieve the operating personnel of the responsibility for proper operation. On the other hand, a thorough understanding of this manual is required before attempting to operate, maintain, service, or repair this equipment.

Because of state, local, or other applicable codes, there are a variety of electric controls and safety devices which vary considerably from one boiler to another. This manual contains information designed to show how a basic burner operates.

Operating controls will normally function for long periods of time and we have found that some operators become lax in their daily or monthly testing, assuming that normal operation will continue indefinitely. Malfunctions of controls lead to uneconomical operation and damage and, in most cases, these conditions can be traced directly to carelessness and deficiencies in testing and maintenance.

It is recommended that a boiler room log or record be maintained. Recording of daily, weekly, monthly and yearly maintenance activities and recording of any unusual operation will serve as a valuable guide to any necessary investigation. Most instances of major boiler damage are the result of operation with low water. We cannot emphasize too strongly the need for the operator to periodically check his low water controls and to follow good maintenance and testing practices. Cross-connecting piping to low water devices must be internally inspected periodically to guard against any stoppages which could obstruct the free flow of water to the low water devices. Float bowls of these controls must be inspected frequently to check for the presence of foreign substances that would impede float ball movement.

The waterside condition of the pressure vessel is of extreme importance. Waterside surfaces should be inspected frequently to check for the presence of any mud, sludge, scale or corrosion.

It is essential to obtain the services of a qualified water treating company or a water consultant to recommend the proper boiler water treating practices.

The operation of this equipment by the owner and his or her operating personnel must comply with all requirements or regulations of his insurance company and/or other authority having jurisdiction. In the event of any conflict or inconsistency between such requirements and the warnings or instructions contained herein, please contact Cleaver-Brooks before proceeding.

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Section 1 - Model CRE and CCE Economizers



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1.1-GENERAL

The Cleaver-Brooks economizer is essentially a static reactive type heat exchanger. The performance of this type of exchanger is ultimately dependent upon the dynamic conditions of temperature, pressure and mass or flow available on both the liquid and gas side.

The C-B economizer exchangers are virtually maintenance free because they have no moving parts except the movement of internal gas bypass assembly or the optional timed automatic soot blower.

Model CRE exchangers are equipped with a divertor plate and all exchangers include the C-B exclusive internal stainless steel by-pass damper to divert the waste heat through the fin tubing or bypass a portion up through the center or modulate (with optional equipment) according to performance requirements.

Computer performance estimates are calculated on the basis that the damper is adjusted in the fully closed position or perpendicular to the exhaust flow.

1.2-UNLOADING

Prior to manufacture all exchangers were represented with the issuance of an AutoCAD drawing to scale for customer approval. This drawing can be used to prepare for installation and provide for special equipment movement needs.

Cleaver Brooks inspects all equipment prior to shipment and cannot be held responsible for damage caused in transit. In addition, all electrical devices are also thoroughly tested to assure that they operate according to design specifications.

All exchangers are shipped via common carrier. Take care to inspect the heat exchanger when you receive it and make any claims for damages immediately to the carrier within the allowable time limit.

The CCE product line units are shipped in enclosed crates. To remove the economizer, first position the unit, while either still in the shipping container or on the skid, as close to the installation site as possible. Then attach a lifting hoist to all the lifting lugs located on the top lid or cone.

The CRE economizer is generally shipped in the position it is designed to be installed in. Depending on size, some exchangers are shipped on wooden pallets and/or mounted on structural steel skid for fork lift removal and/or installation. The very large exchangers if installed in the vertical position are shipped on the side. Use all lifting lugs when lifting. To remove a large exchanger from the flat bed, attach a lifting hoist to all the lifting lugs as required when lifting from horizontal to the vertical position. For the extremely large heat exchangers be sure to have an experienced crane operator(s) for removal from the flat bed and positioning. If there are any questions during the removal and installation of the exchanger please do not hesitate to contact your authorized Cleaver-Brooks representative for suggestions. Large exchangers include structural steel supports for mounting to the final support (supplied by others) as required by the installation.

NOTE: *Spare parts may be shipped within the crate or skid mounted unit. Spare parts shipped within the unit will be located beneath the damper bypass assembly in a separate shipping box.*

To avoid delays in moving the economizer into position, have a fork lift and scaffolding ready prior to receipt of the unit.

1.3-INSTALLATION

Consult submittal data for specific weights and dimensions to ensure a well designed and safe installation when either hanging or supporting the exchanger.

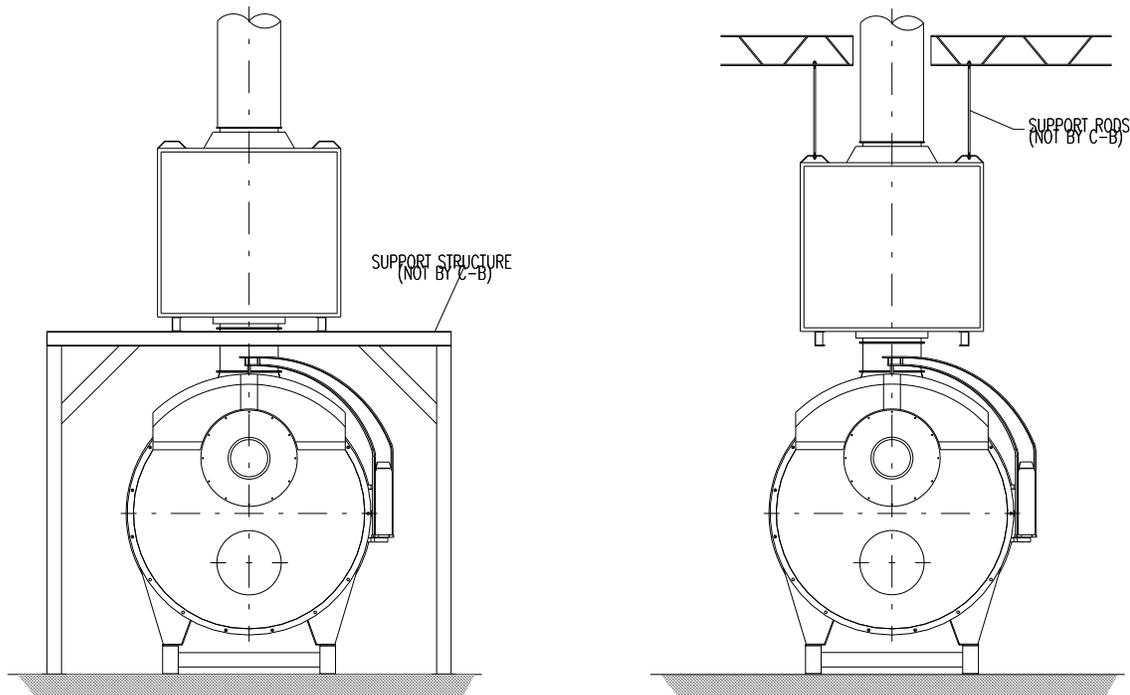
The exchanger is shipped ready to be mounted in the vertical or horizontal position as originally specified (consult the factory if a change in the gas flow direction is desired).

For existing retrofit installations, ensure that the combustion source has been turned off and has cooled.

For retrofit installations the economizer is installed in line with the existing exhaust stack or duct unless otherwise noted. Generally a section of the exhaust stack is cut and removed to accommodate the insertion of the economizer. The remaining portion of the exhaust stack above the cut should not exceed 500 lbs. and must be adequately supported. In some cases the economizer may be placed directly on top of the combustion source, in effect forming the first section of the exhaust duct, with the existing exhaust stack lifted or cut to accommodate the economizer.

For vertical flow units where the plan is to set the economizer on the existing stack, verify that the supporting stack permits load. It is recommended, however, that other means of support be incorporated to reduce or remove bearing weight of the economizer on the source of waste heat. Position four (4) 5/8" tie rods through the lifting lugs which can be used to suspend the smaller units depending on upper suspension capabilities.

Figure 1.1 - Installation, vertical flow units



For horizontal flow units the economizer must be set in place on a structural support (designed by others) and/or suspended from the ceiling as permitted.

Figure 1.2 - Installation, horizontal flow unit w/floor support

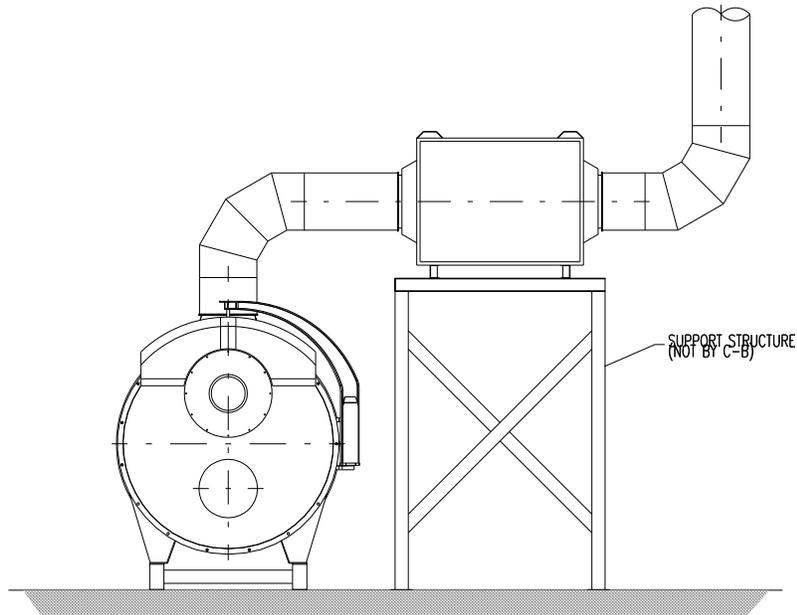
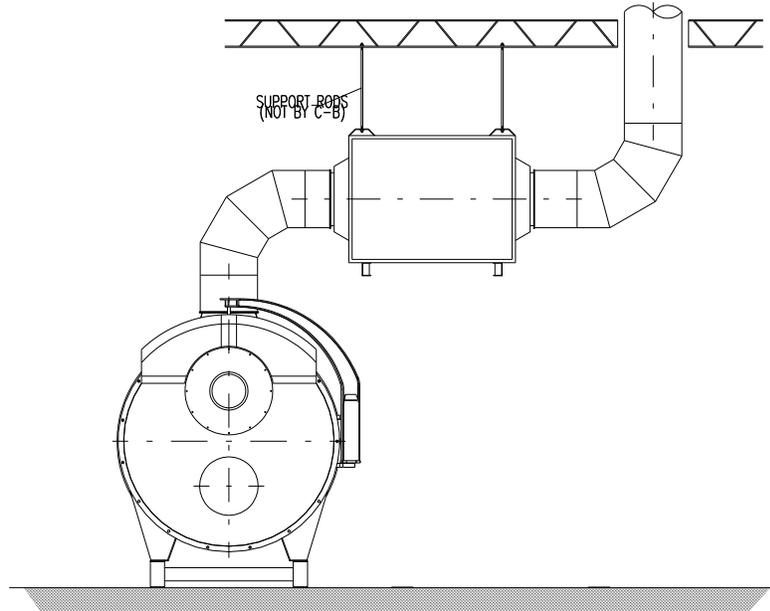


Figure 1.3 - Installation, horizontal flow unit w/ceiling support



Two (2) supported I-beams or channels can be used where larger economizers are being installed. The exchanger can then be set on the beams and slid to the lower stack and/or stack adapter for final securing. Position four (4) tie rods (as specified and supplied by others) which can be used to suspend units depending on upper support.

C-B economizers are designed to support a maximum of 500 lbs stack weight above the economizer. Structural integrity of the building should be verified (by others) prior to installing an economizer by suspending from the ceiling.

Apply expansion joints (supplied by others) as required by the installation to ensure that no outside forces from thermal expansion to either the exhaust gas connections or to the piping will be permitted.

Exhaust connections are generally mated with optional mating flanges and/or stack transitions. The mating flanges can be butt or slip fit welded to the stack breaching once aligned. Ensure that the economizer is level before final welding and/or bolting into position.

Liquid connections are connected either with NPT threaded fittings or flange connections. Liquid piping should include shut-off and bypass valve piping in the event the exchanger is required to be isolated.

NOTE: *The safety relief valve must be located between any isolation valves and the economizer and within close proximity of the exchanger. Liquid piping to and from the exchanger should allow the exchanger to be filled at all times especially when flow could stop.*

Deaerated water is recommended with any C-B economizer. Generally, schedule 80 steel pipe is used in the piping installation. In some applications other piping material may be needed. Consider the type of liquid, operating pressures and temperatures, and any corrosive elements in the liquid or in the atmosphere when determining the best piping material for your installation. The use of unions and/or flanges is recommended where isolation might be required. Stainless steel piping is recommended if using non-deaerated water.

If a circulating pump is part of the system being installed, a ball or flow control valve installed on the suction side of the pump and one on the discharge side of the pump will allow for easier pump removal and replacement.

Drain piping should include valves of dependable manufacture in order to further reduce the possibility of an undetected leak.

Safety relief valves, as required, should be located at the exchanger and piped separately and safely to the drain.

The installation of a vent valve at the highest point in the piping system is recommended in order to purge air out especially during initial start up.

1.3.1- Special Installation Considerations

The C-B economizer may be installed inside or outside with appropriate drain piping installed for shutdown periods. If there is a remote chance the temperatures outside might fall below freezing it is recommended that care be taken to avoid freezing the heat transfer core. Coil type exchangers (CCE) installed in the horizontal position will require 80 psig minimum air pressure to blow the liquid out of the coil.

A drain connection and catch basin are provided in the bottom for all economizers.

For natural gas applications where the economizer is installed horizontally, a drain connection is provided by C-B at the bottom point of the side. Please note the submittal drawing or consult C-B for exact installation position. Condensate drain piping can be piped to the floor drain. Condensate piping should include a water trap to prevent the escape of flue gas.

Freeze protection concerns: During a system shutdown where combustion halts for an extended period of time (other than normal cycling), cold air will travel back down the stack and exhaust breachings, through the exchanger and into the combustion source. If the cold air is below freezing, it could freeze the finned tubing and cause a rupture, ultimately destroying the exchanger. For potential freezing applications where the water flow might stop, a manual system shut down routine should be incorporated. It is not recommended to use solenoid type drain valves for auto draining in sub zero environments unless absolutely necessary.

Do not insulate the exchanger where factory insulation has already been applied or damage to the exchanger can occur. Insulate piping and exhaust ducting as required.

Ensure that no liquid connections interfere with the opening of access door panels.

For the CCE series exchangers it is recommended that the liquid flow connects into the top of the economizer and out the bottom for cross flow. Consult the circulating flow diagram (if applicable) for your application in regards to the piping layout and components. Exhaust and liquid inlet and outlet thermometers (optional) may be included in the installation.

Economizer relief valves shall not have set pressure ratings higher than the rated pressure of the economizer. Liquid storage tank relief valves shall not have discharge pressure ratings higher than the rated pressure of the storage tank. To avoid safety valve leakage, ensure that safety valve set pressure is sufficiently higher than dead head pressure of the feed pump.

It is recommended that the pipe and circulating tank (if included) be insulated to reduce heat loss.

If existing conditions may subject the fin tubing to internal scale build up, pressure gauges (furnished by others) should be installed on the liquid inlet and outlet sides of the economizer. This will enable monitoring of liquid flow restriction. Capped tees, one on the liquid inlet side and one on the liquid outlet side, incorporated into the piping installation may allow a descaling solution to be used with the economizer in place. Consult the factory for suitable descaling solutions.

Installations with a modulating feed valve are subject to pressure buildup in the economizer piping when the feed valve is closed. Frequent overpressure can lead to overuse of the safety valves with eventual valve failure. To avoid this condition, a bypass (recirculation) line should be installed as shown in **Figure 1.4**.

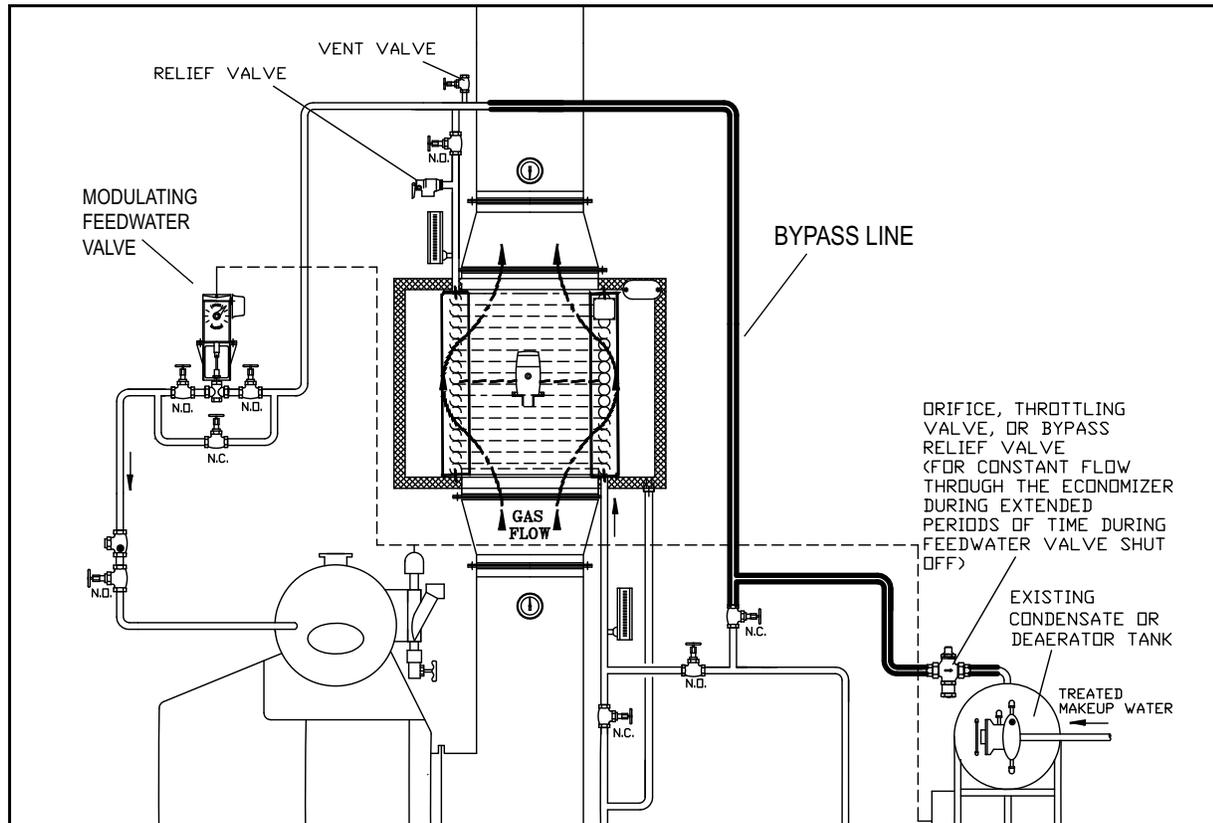


Figure 1.4 - Bypass line

1.4-STARTUP

During the initial startup and before combustion heat can be applied to the exchanger, ensure that liquid is flowing through the economizer.

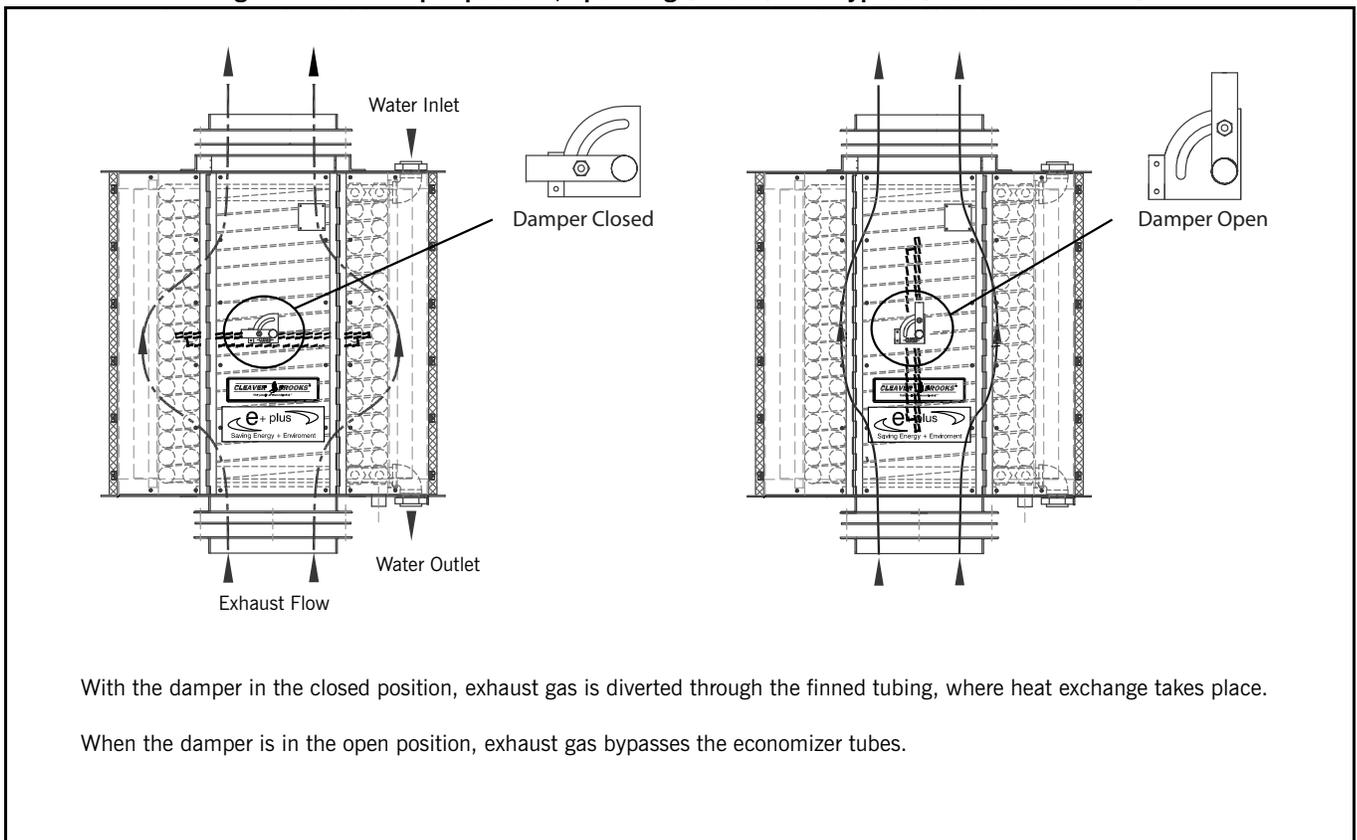
NOTE: C-B requires that liquid must be flowing through the economizer at all times to avoid damage to the exchanger from stack exhaust overheating. *Upon cold startup of a full boiler, provisions must be made to ensure water flow through the economizer.* Assure sufficient flow to prevent any unwarranted temperature and pressure buildup within the liquid side of the economizer. When the boiler reaches the operating steam pressure of the system and begins to take on feedwater, normal operation can resume.

Important

If liquid is introduced into a hot exchanger, severe damage can result and will void any warranty. Contact C-B for applications where the exchanger is requested to run dry.

If the final exhaust temperatures are too low, pressure drop across the economizer is too high, or if the desired water temperatures is not exceeded, adjust the gas bypass damper to attain the desired objective.

Figure 1.5 - Damper position, operating (closed) and bypass (Model CCE shown)





Bypass damper CRE



Bypass damper CCE



Manual Damper Adjustment

While the exchanger is in a clean, like-new condition, note and record the following:

- Liquid inlet and outlet temperatures
- Exhaust gas inlet and outlet temperatures
- Pressure gauge reading (if applicable)

This information will provide a point of reference in the event of a future fouling condition.

1.5-MONITORING PERFORMANCE

It is recommended to inspect the core or coil if the performance (liquid temperatures leaving and Btu/hr. recovery) begins to decrease. A good practice of maintenance is to keep a performance schedule starting when the economizer is installed to compare with any future changes.

A simple method of determining whether the heat exchanger is performing properly is to monitor the exit temperatures on the liquid and gas sides while in the new condition to establish a base of comparable data. If the stack temperature leaving the exchanger is higher than normal and the liquid exit temperature is lower than normal, then either the heat transfer surface is probably fouled or scaled on the inside of the tubing. This requires cleaning as soon as possible during a convenient shut down period.

In a circulating system containing a pump and BTU storage tank, if the economizer pressure relief valve discharges, it is likely that there is no or little liquid circulating through the economizer. Check the pump operation and repair or replace as necessary. **DO NOT ATTEMPT TO REMOVE OR REPLACE THE PUMP UNLESS THE PUMP, PIPES AND LIQUID HAVE BEEN ALLOWED TO COOL.** You may also need to check for flow restrictions in the piping and/or the economizer.

If the economizer liquid and outlet temperatures are approaching being equal, this may be a pump problem and/or a scale accumulation in the finned tubing. Remedy as indicated above. It is also possible that the fin coils are severely fouled. Refer to section 1.7 for cleaning.

1.6-MAINTENANCE

As stated in the General Description, the economizers are "mechanically maintenance free", but of course, when ancillary control equipment is added to an exchanger, such as timed automatic sootblowers, damper controls, etc., then those components will require periodic maintenance consistent with normal operation (Refer to appropriate control equipment detail and specific owners manual as applicable).

A routine physical inspection of the heat transfer core area will be dependent on the conditions of temperature and the quality of combustion within the flue gas stream. **NOTE:** Ensure that the

combustion source is off and is cool, and the economizer is cool before attempting to inspect or clean the fin coil(s).

On natural gas fired applications, with clean exhaust conditions, physical inspection will be minimal if proper combustion at the heat source is maintained.

Oil fired applications may require more frequent inspection of the heat transfer core area because of the greater potential for soot loading and particulate buildup on the finned tube surface.

C-B's exclusive Timed Automatic Sootblower assemblies are often recommended on oil fired or incineration applications where fouling is inevitable on a more regular basis. Keeping the heating surface clean at all times assures the maximum heat transfer. Soot buildup on the finned tubing from poor combustion acts as an insulator and will dramatically reduce the exchanger's efficiency. When the combustion source is a fuel oil grade, a good periodic maintenance schedule for inspecting the exchanger and keeping the combustion source tuned up will ensure many years of trouble free fuel savings from exhaust heat recovery.

Stainless steel inspection door panels shroud the coil(s) of all CCE Series exchangers. The door closure of each hinged panel has a set of quick-release tension latches (requiring no tools) that enable immediate and complete access to the heat exchanger area. Some units have bolted doors when static pressure exceeds 10.0" water column and will require a wrench to open.

The inspection and maintenance procedure can be performed without dismantling any of the piping or the stack connections. If the Btu/hr. recovery begins to show a consistent performance drop off from the original operating condition, the sootblower (if equipped as an option) should be initiated. If the economizer is not equipped with a timed automatic sootblower, the access door should be opened for inspection and cleaning. A large access door (optional hinged assembly available) for tube inspection, cleaning, or tube removal is provided for use as required (CRE only).

If it has been determined the fins are dirty and need cleaning (i.e. 1/16" thickness build up on the fins), the fouled finned tube area can be manually cleaned by blowing high pressure steam or air with a lance assembly across the fins. When manually cleaning with air or steam, first open the internal damper to the 'bypass position' (the damper arm should be placed in line or parallel to the exhaust gas stream).

The following is the procedure for opening and closing large doors on CRE units. **NOTE:** it may be necessary to provide a means of supporting the weight of the door.

1. Remove all nuts from the door flange studs, except one located opposite the hinges.
2. Loosen all hinge nuts.
3. Pull hinge side of door all the way out to where the hinge slots stop at the studs and retighten hinge nuts.
4. Remove the last nut opposite the hinge side.
5. *Pull door out until adjusting bolt hits stop. The door should be out past the bolts.
6. *Lower adjusting bolt until door hangs freely and adjusting bolt clears stop.
7. Door is ready to open.
8. Reverse steps to close.

*The adjusting bolt feature is not incorporated on the smaller hinged doors.

Once exposed, the fouled finned tube core area can be manually cleaned by blowing high pressure steam or air through a lance assembly across the fins. If high pressure air or steam is not available, an industrial vacuum cleaner may be substituted. Coil Bright (a commercial cleaner can also be used in conjunction with a steam or hot water cleaning device) also offers an excellent cleaning capability if high pressure air is not available.

NOTE: Often there is sufficient draft at the stack above the exchanger which can blow the soot off the fins and carry it out the stack.

1.7-OPTIONS

1.7.1 - Sootblower

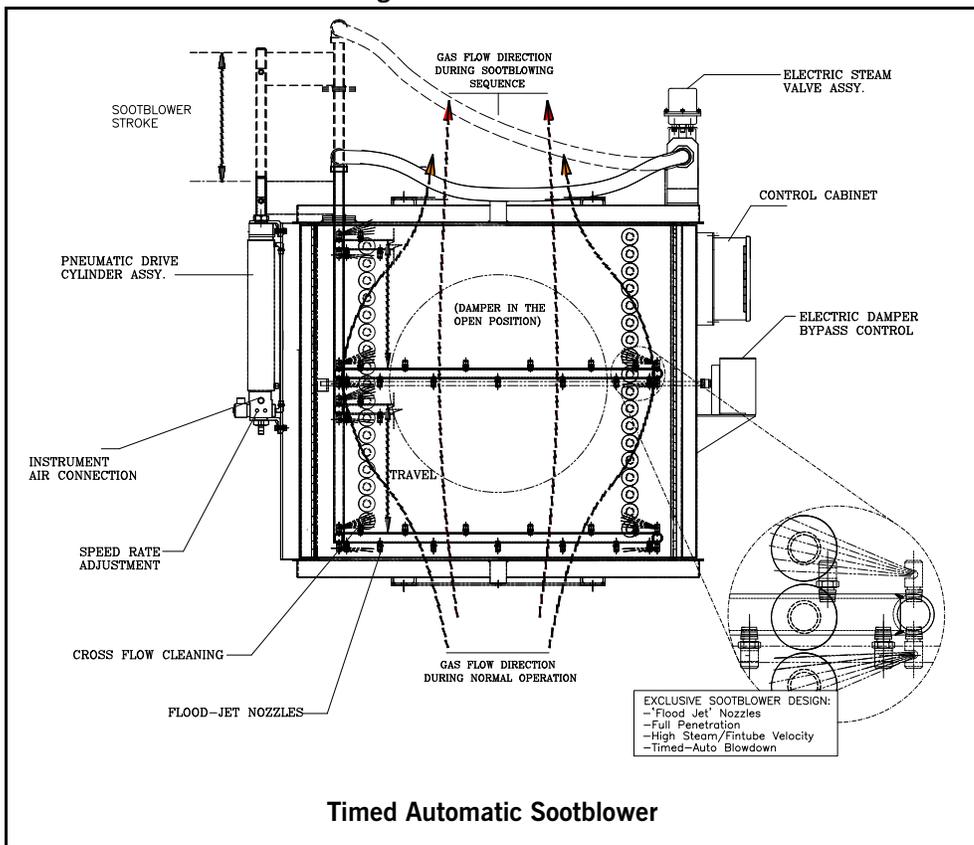
Sootblowers are applied where combustion can foul to the degree where it is not cost effective to manually open inspection doors and physically clean the exchanger by other means.

Typically diesel, No. 2 oil, and No. 6 oil having multiple coils with proper fin spacing can be used in conjunction with a sootblower assembly. A single row design or a maximum of three coils (square pitch design), in conjunction with the proper sootblower will ensure the best possible solution to achieve a nearly soot free exchanger.

The sootblower assembly surrounds the outside of the core or coil area. When operated, the particulate is blown off into the flue gas stream. The internal bypass damper must be in the open position during blowdown. A routine blowdown schedule should be established at time intervals consistent with the soot loading characteristics of the fuel being burned. For example, on a boiler burning No. 2 oil, a daily blowdown may be all that is required. If the primary fuel is No. 6, then the sootblower should be used at a time interval consistent with the normal boiler blowdown.

All Sootblowers are designed to utilize high pressure air or steam at 50 psig minimum -100 psig maximum rating. It should be noted that no Sootblower can provide 100% cleaning ability, but they can definitely minimize the need for manual cleaning. For heavy oil or incinerator-type atmospheres, periodic manual cleaning of the heat exchanger surface will be required to insure maximum efficiency capability.

Figure 1.6 - Sootblower



1.7.2 - Stack Corrosion Control

Stack Corrosion Control holds the stack temperature down in order to prevent condensation and corrosion. The damper will automatically modulate to maintain a predetermined temperature.

ELECTRICAL COMPONENTS

1. INDICATING CONTROL PANEL (combining Automatic Sootblower and Stack Corrosion Control) including:
 - Terminal Strip providing customer 120V power connection and a thermocouple connection.
 - “Power on/off” switch and “Indicating light” opens the circuit to operate the Stack Corrosion Control Assembly including the indicating controller modulating damper actuator, and thermocouple.
 - “Sootblower on/off” switch opens the circuit to operate the Timed Automatic Sootblower Assembly including the Electric Steam Valve Assembly, Pneumatic Drive Cylinder Assembly.
 - Duration Timer controls the length of time between sootblowing cycles (off/interval) and the length of time at the Pneumatic Drive Cylinder Assy. (on/duration). A control knob for each setting allows for specific times within the ranges.
 - Delay Timer controls the Electric Steam Valve Assembly and the Modulating Electric Valve Assembly during the sootblowing cycle causing the controller to put the Damper Actuator in an override position, driving the damper(s) to the bypass position. When the Pneumatic Cylinder Assembly returns to its original position, the delay timer causes the Steam Valve to close and returns the Thermocouple to its normal function concerning the Stack Corrosion Control.
2. PNEUMATIC DRIVE CYLINDER ASSY is controlled by a solenoid valve. The solenoid is energized at the beginning of the sootblowing cycle by the Delay Timer, allowing the ram to move outward to its furthest position. At the end of its stroke the timer de-energizes the solenoid valve, allowing the stroke to retract to its original position.
3. MODULATING ELECTRIC DAMPER ASSY receives a signal from the temperature controller and modulates the damper to bypass the flow of exhaust, to maintain the desired temperature. During the sootblowing cycle damper moves to the full bypass position. This allows the soot to be blown out through the center of the economizer until the end of the sootblowing cycle.
4. ELECTRIC STEAM VALVE ASSY is energized to open (5 seconds) during sootblowing operation allowing 50-100 PSIG steam to the sootblower assembly - and energized again to close after the sootblowing cycle is complete.
5. EXHAUST TEMPERATURE INDICATING CONTROLLER (for Stack Corrosion Control) receives a signal from the thermocouple sensing the exhaust temperature leaving the economizer and controls the Modulating Electric Damper Assembly.
6. THERMOCOUPLE (for Stack Corrosion Control) is remote mounted (by others) sensing the exhaust gas temperature leaving the economizer.

FUNCTION

Timed Automatic Sootblower design is a fully adjustable sootblower which avoids day-to-day operator attendance by running the sootblower in specific timed intervals. The actual blowing down of soot collecting on the fins utilizes special flood-jet type nozzles for achieving maximum velocity and a concentrated spray pattern specifically directed at the heat transfer surfaces. The Sootblower Assembly contains ring nozzle assembly(s) for inward blowing per standard economizer, with a varied

amount of nozzles depending on the economizer size. The ring nozzle assembly is attached to a manifold and powered up and down (vertical installation) or side to side (horizontal installation) by a Pneumatic Drive Cylinder.

During the sootblowing operation, the internal damper automatically is adjusted to the full bypass position and steam or air is also automatically controlled to enter the economizer. The flue gas then changes from the normal gas flow to bypass gas flow direction, enabling a unique 'cross flow cleaning' to take place. This type of cleaning occurs because the ring nozzle assembly encompasses the heat transfer surfaces and blows transverse to the fin tube row while the flue gases blow longitudinal to the row. Operating the combustion source at maximum output conditions, during blowdown cycle increases the velocity over the fin tubing, however it is not mandatory. The sootblowing sequence can operate at any load condition. The complete cleaning occurs as a result of an effective sootblower design having to penetrate only a maximum of three coils or rows.

The Pneumatic Drive Cylinder is mounted on the exterior of the economizer and is powered by 100PSI control air and actuated by a 120 volt solenoid for on/off air control. The Duration Timer adjusts the sequence of the sootblower intervals ranging from 6 - 24 hours and sootblower duration on time ranging from 6 - 42 seconds. The Pneumatic Drive Cylinder moves the ring nozzle assembly up when energized and down when de-energized (for vertical gas flow economizer installations). The speed rate of upward and downward travel are also individually adjustable, to allow closer control of the sootblowing cycle as required. A manual push button start located at the Pneumatic Drive Cylinder's solenoid allows for a manual override and is used to check test runs for speed at which the Pneumatic Drive Cylinder extends and retracts.

Mounted at the internal exhaust bypass damper shaft is a 120 volt Electric Damper Control (modulating for Stack Corrosion Control) for flue gas bypass control flow. When energized, the damper is moved to the closed position for normal economizer operation. When de-energized as the sootblowing cycle begins, the damper returns to the open or by-pass operation.

The Electric Control Valve allows 50 to 120 PSI air or steam (usually steam due to cost and greater effectiveness) to the ring nozzle assembly when energized. As soon as it opens the cleaning action immediately begins, and stops the flow of steam or air when de-energized at the end of the cycle.

SOOTBLOWING OPERATING SEQUENCE



Important

Sootblowing intervals are dependent on periodic inspections of the finned tubing and the efficiency of the combustion source. When used in conjunction with the Stack Corrosion Control, the blowdown cycle time interrupts the control signal for 30-45 seconds and upon completion, the Stack Corrosion Control returns to its normal operation.

1. Upon the start of the blowdown cycle, the Pneumatic Drive Cylinder is activated and begins to move by an adjustable Duration Timer.
2. Upon moving, both the Damper Control, and Control Valve are also activated.
3. Control Valve opens and allows steam to begin the cleaning action.
4. Damper control opens and bypasses flue gas through the center.
5. Pneumatic Drive Cylinder begins to move the ring nozzle assembly as the cleaning action takes place.
6. When the Pneumatic Drive Cylinder reaches its full stroke, its solenoid is de-energized by the Duration Timer and begins to retract to the original position.

7. The Delay Timer keeps the bypass and steam valve open until the cylinder returns to its original position.
8. The Damper control and Control Valve then return to the normal heat recovery operating position.
9. Upon completion of the sootblowing cycle, the Duration Timer resets for the next period.

1.7.3 - Circulating Recovery System

The Circulating Recovery System/Tank assembly is a separate system used as an alternate to converting on/off boilers to modulating boiler feed water systems for preheating boiler feed water. The CRS/Tank assembly is a more economical and safe alternate system to select, primarily because it does not affect the existing system or require major engineering considerations.

CRS Operation:

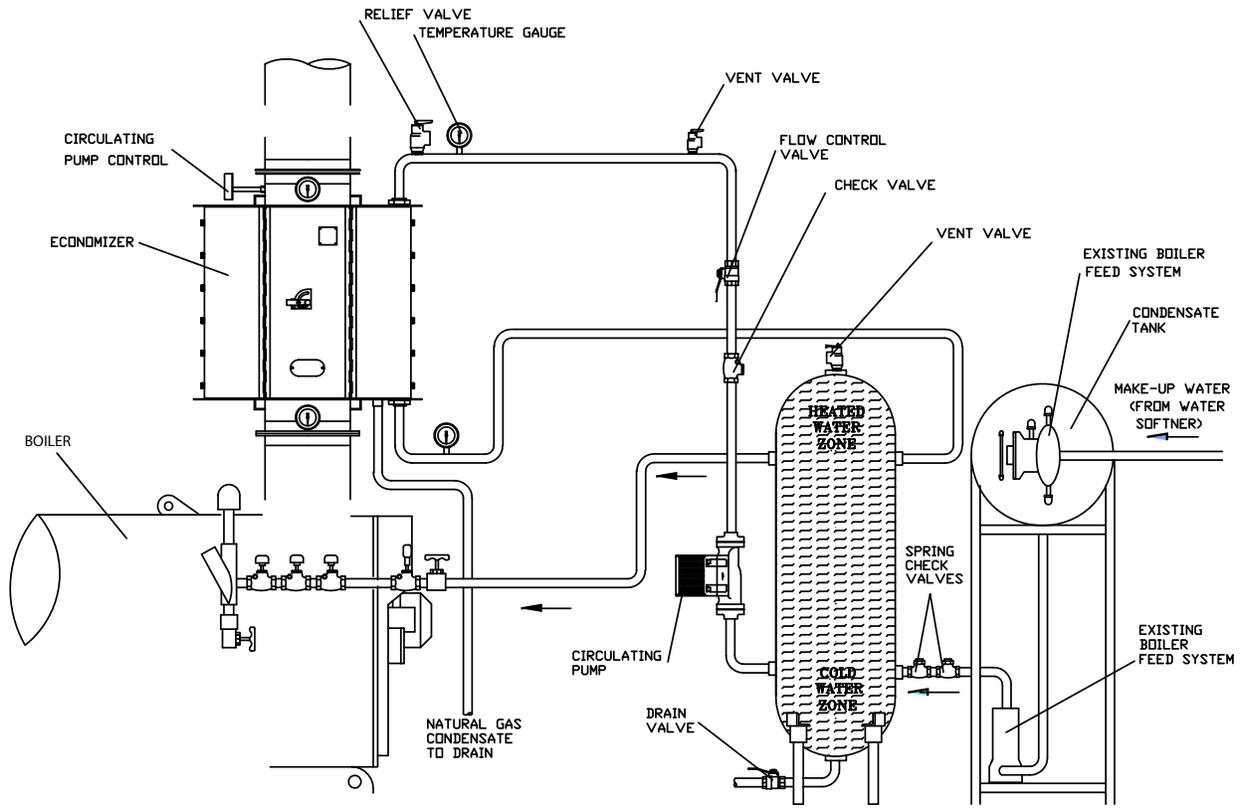
TUBE SIDE: Boiler feedwater normally entering the boiler instead enters the bottom of the vertical pressurized tank (ASME designed and stamped) or essentially a 'bulge in the feedwater flow line'. Two spring loaded check valves hold the water in the tank when the boiler feed pumps shut off. The circulating pump, located within the added closed loop circuit, circulates the colder water from the bottom of the tank through a flow control valve and a check valve to the economizer to be heated with recovered BTU's and then back to the top of the tank. When the boiler feed pumping system operates, the water enters the bottom of the tank and heated water leaves the top of the tank and enters the boiler.

SHELL SIDE: As the temperature at the exhaust outlet of the economizer begins to drop to a safe operating exit temperature, the flow control valve is adjusted to maintain the proper flow required to stabilize the minimum desired gas temperature. The differential pump controller can be installed at the outlet of the boiler economizer stack. It will shut the pump off if the stack temperature falls below the preset point (250 deg F on gas, 275 deg F on No. 2 Fuel Oil) and energize the pump at 300 deg F. This occurs during burner off cycles or low load conditions. The pump controller is also field adjustable and can be adjusted to a lower or higher point as required.

Certain applications with continuous water circulation may not require the installation of a differential pump controller. Consult the factory for suggestions as applicable.

PERFORMANCE: The fuel saving net result is that the boiler requires less Btu/hr to raise the now higher boiler feed temperature to the desired operating steam temperature. During all firing modes and on/off feed pump operations, all wasted exhaust heat above the 250°F entering the economizer will be recovered in the boiler feed water with the Circulating Recovery System/Tank Assembly and with no mechanical or increased temperature effect on the existing boiler feed system. The difference is the temperature of the boiler feedwater being elevated significantly with wasted BTU's normally exhausted out the boiler stack. The firing rate at the boiler is now lower and thus the total Btu/hr input requirement at the burner is reduced, while still producing the same amount of steam as it had in the past. Since the firing rate is reduced in terms of Btu/hr required, the fuel bill will now be lower.

Figure 1.7 - Piping with circulating tank





Section 2 - Model C2X and C1X Condensing Economizers



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ECONOMIZER CONTROLS	2-24
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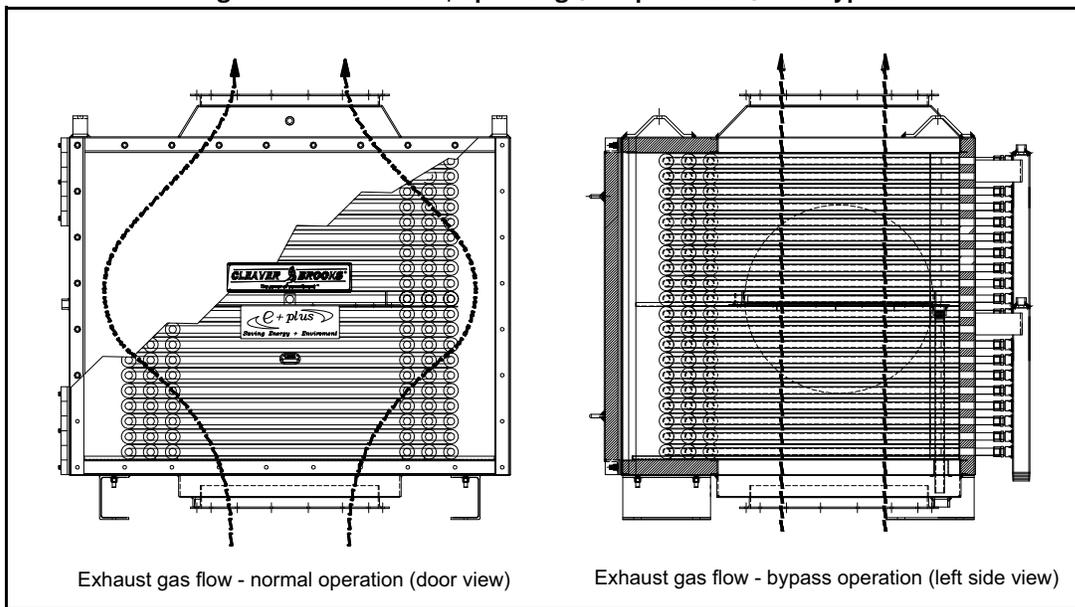
2.1-GENERAL

The C-B condensing economizers are essentially static reactive type heat exchangers. The performance of this type of exchanger is ultimately dependent upon the dynamic conditions of temperature, pressure and mass or flow available on both the liquid and gas side.

The units are virtually maintenance free, having no moving parts except the internal gas bypass assembly.

Each economizer includes the C-B exclusive internal stainless steel by-pass damper to divert the waste heat through the fin tubing or bypass a portion up through the center or modulate according to performance requirements.

Figure 2.1 - Gas flow, operating (damper closed) and bypass



The C2X condensing economizer consists of two sections - the upper section for preheating incoming boiler feedwater before it goes to the deaerator, and a lower section for further heating of the feedwater after it leaves the deaerator.

The C1X (or the C2X upper stage) can also be used to heat any other liquid besides boiler feedwater.

By matching the economizer with the appropriate motor and combustion air fan, fuel-to-steam efficiencies of over 90% can be reached.

2.2-UNLOADING

Prior to manufacture all exchangers were represented with the issuance of an AutoCAD drawing to scale for customer approval. This drawing can be used to prepare for installation and provide for special equipment movement needs.

Cleaver Brooks inspects all equipment prior to shipment and cannot be held responsible for damage caused in transit. In addition, all electrical devices are also thoroughly tested to assure that they operate according to design specifications.

All exchangers are shipped via common carrier. Take care to inspect the heat exchanger when you receive it and make any claims for damages immediately to the carrier within the allowable time limit.

The units are shipped in enclosed crates. To remove the economizer, first position the unit, while either still in the shipping container or on the skid, as close to the installation site as possible. Then attach a lifting hoist to all the lifting lugs located on the top lid or cone.

The economizer is generally shipped in the position it is designed to be installed in. Depending on size, some exchangers are shipped on wooden pallets and/or mounted on structural steel skid for fork lift removal and/or installation. The very large exchangers if installed in the vertical position are shipped on the side. Use all lifting lugs when lifting. To remove a large exchanger from the flat bed, attach a lifting hoist to all the lifting lugs as required when lifting from horizontal to the vertical position. For the extremely large heat exchangers be sure to have an experienced crane operator(s) for removal from the flat bed and positioning. If there are any questions during the removal and installation of the exchanger please do not hesitate to contact your authorized Cleaver-Brooks representative for suggestions. All exchangers include steel pads for mounting to the final support (supplied by others) as required by the installation.

NOTE: *Spare parts may be shipped within the crate or skid mounted unit. Spare parts shipped within the unit will be located beneath the damper bypass assembly in a separate shipping box.*

To avoid delays in moving the economizer into position, have a fork lift and scaffolding ready prior to receipt of the unit.

2.3-INSTALLATION

Consult submittal data for specific weights and dimensions to ensure a well designed and safe installation when either hanging or supporting the exchanger.

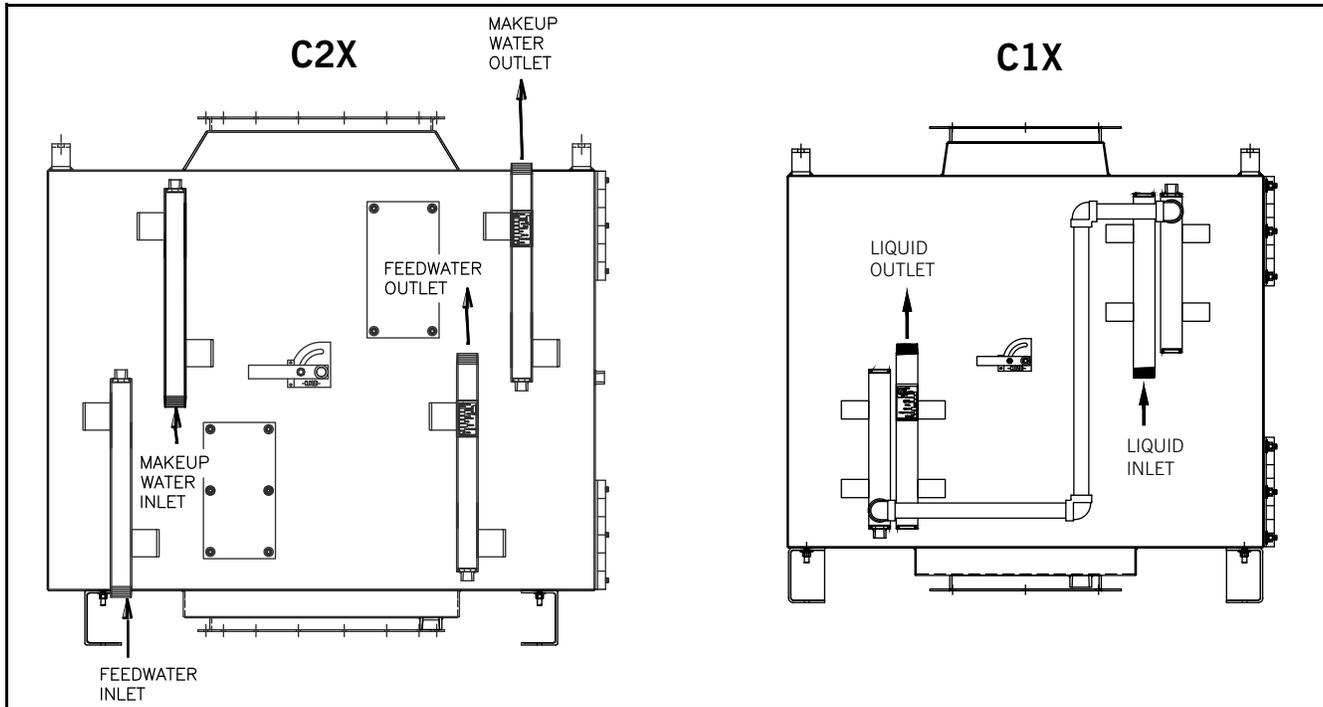
The exchanger is shipped ready to be mounted in the vertical or horizontal position as originally specified (consult the factory if a change in the gas flow direction is desired).

For existing retrofit installations, ensure that the combustion source has been turned off and has cooled.

In some installations a spool piece may be required between the boiler and the economizer to prevent interference with the davit arm. On some boilers it may also be required due to panels mounted on the front of the boiler.

A condensate drain connection is provided at the base of the unit. Header manifold inlet/outlet connections are provided for makeup water and feedwater.

Figure 2.2 - Header Connections



For retrofit installations the economizer is installed in line with the existing exhaust stack or duct unless otherwise noted. Generally a section of the exhaust stack is cut and removed to accommodate the insertion of the economizer. The remaining portion of the exhaust stack above the cut should not exceed a static load of 500 lbs. or exert any moments on the outlet flange, and must be adequately supported. In some cases the economizer may be placed directly on top of the combustion source, in effect forming the first section of the exhaust duct, with the existing exhaust stack lifted or cut to accommodate the economizer.

For vertical flow units it is recommended that the unit be completely supported either by a floor support structure or by threaded rods from the ceiling (design and supply of support by others). In no case should the static load on the economizer inlet or outlet flange exceed 500 pounds. In no case should any moment be applied to the economizer inlet or outlet. Four (4) lifting lugs are supplied on top of the economizer for support from the ceiling and (4) support pads are supplied on the bottom of the economizer for support from the floor.

For horizontal flow units the economizer must be set in place on a structural support (designed by others) and/or suspended from the ceiling as permitted.

Two (2) supported I-beams or channels can be used where larger economizers are being installed. The exchanger can then be set on the beams and slid to the lower stack and/or stack adapter for final securing. Position four (4) tie rods (as specified and supplied by others) which can be used to suspend units depending on upper support.

Warning

For all installations - no moments may be applied to the economizer inlet or outlet flanges. Static loads over 500 pounds are not permitted. Failure to follow these requirements may result in equipment damage or physical injury.

Structural integrity of the building should be verified (by others) prior to installing an economizer by suspending from the ceiling.

Apply expansion joints (supplied by others) as required by the installation to ensure that no outside forces from thermal expansion to either the exhaust gas connections or to the piping will be permitted.

Exhaust connections are generally mated with optional mating flanges and/or stack transitions. The mating flanges can be butt or slip fit welded to the stack breaching once aligned. Ensure that the economizer is level before final welding and/or bolting into position.

Figure 2.3 - Installation, vertical flow units

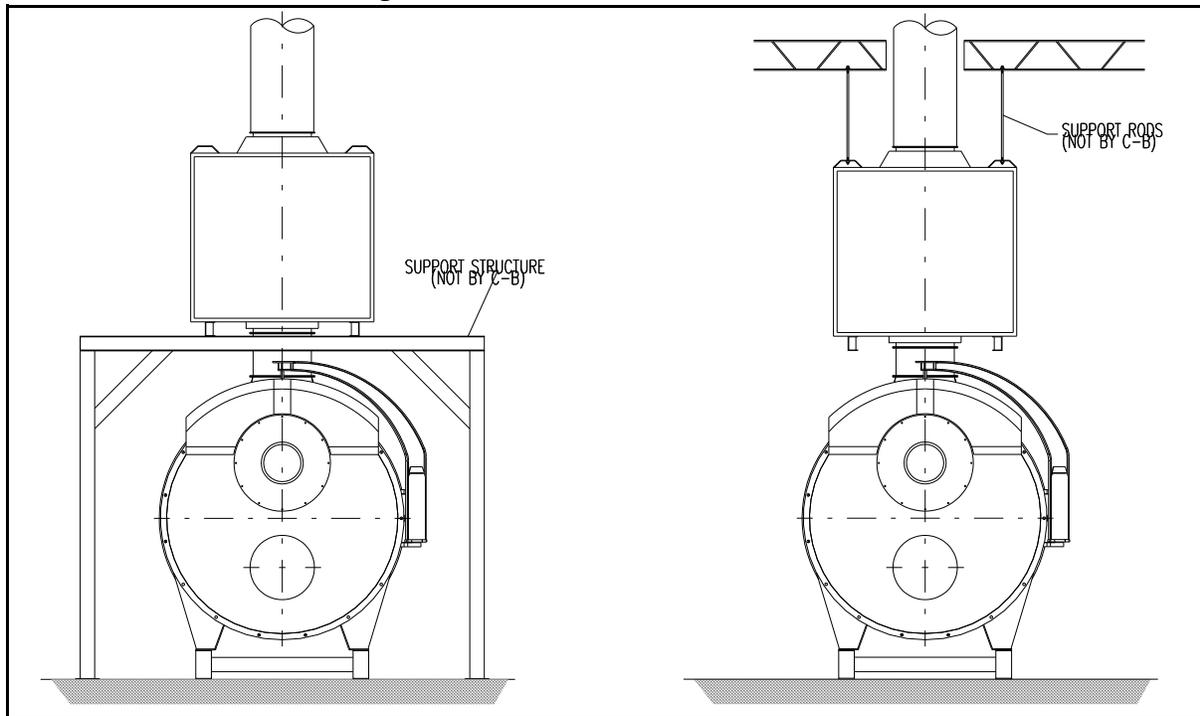


Figure 2.4 - Installation, horizontal flow unit w/floor support

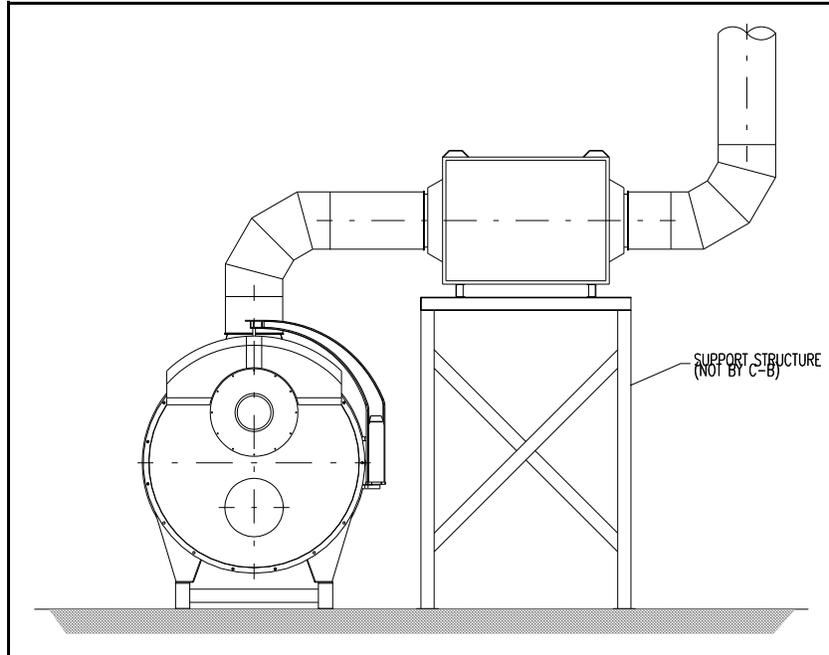
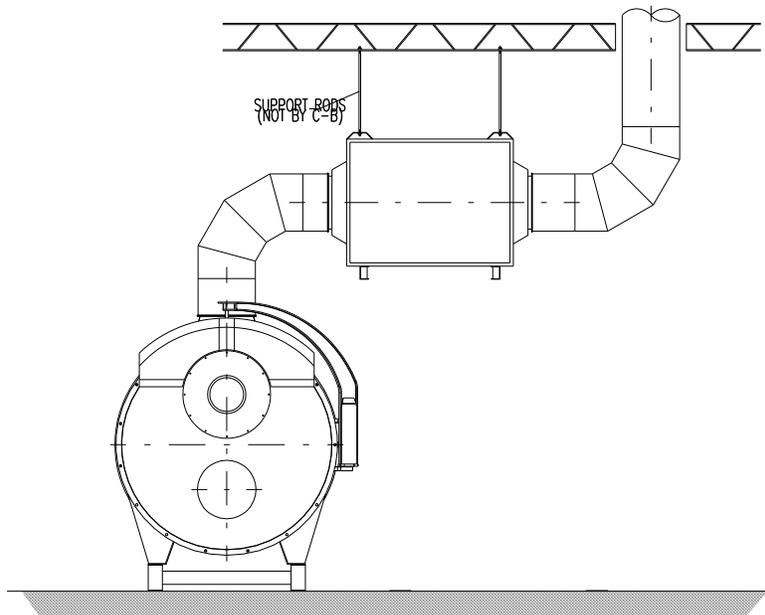


Figure 2.5 - Installation, horizontal flow unit w/ceiling support



Liquid connections are connected either with NPT threaded fittings or flange connections. Liquid piping should include shut-off, drain and bypass valve piping in the event the exchanger is required to be isolated.

Deaerated water is recommended with any C-B economizer. Generally, schedule 80 steel pipe is used in the piping installation. In some applications other piping material may be needed. Consider the type of liquid, operating pressures and temperatures, and any corrosive elements in the liquid or in the atmosphere when determining the best piping material for your installation. The use of unions and/or flanges is recommended where isolation might be required. Stainless steel piping is recommended if using non-deaerated water.

If a circulating pump is part of the system being installed, a ball or flow control valve installed on the suction side of the pump and one on the discharge side of the pump will allow for easier pump removal and replacement.

Drain piping should include valves of dependable manufacture in order to further reduce the possibility of an undetected leak.

Safety relief valves (2 on C2X units) are provided as standard and should be piped separately and safely to the drain.

NOTE: *The safety relief valves must be located between any isolation valves and the economizer and within close proximity of the exchanger. Liquid piping to and from the exchanger should allow the exchanger to be filled at all times especially when flow could stop.*

The installation of a vent valve at the highest point in the piping system is recommended in order to purge air out especially during initial start up.

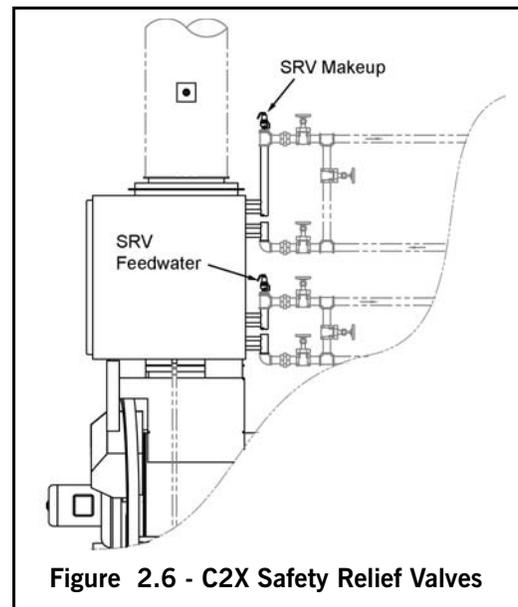


Figure 2.6 - C2X Safety Relief Valves

2.3.1- Special Installation Considerations

The C-B economizer may be installed inside or outside with appropriate drain piping installed for shutdown periods. If there is a remote chance the temperatures outside might fall below freezing it is recommended that care be taken to avoid potentially freezing the heat transfer core.

A drain connection and catch basin are provided in the bottom for all economizers and should be piped to a floor drain using a water trap to prevent the escape of flue gases. Please note the submittal drawing or consult C-B regarding location of the economizer drain.

Freeze protection concerns: During a system shutdown where combustion halts for an extended period of time (other than normal cycling), cold air will travel back down the stack and exhaust breechings, through the exchanger and into the combustion source. If the cold air is below freezing, it could freeze the finned tubing and cause a rupture, ultimately destroying the exchanger. For potential freezing applications where the water flow might stop, a manual system shut down routine should be incorporated. It is not recommended to use solenoid type drain valves for auto draining in sub zero environments unless absolutely necessary.

Do not insulate the exchanger where factory insulation has already been applied or damage to the exchanger can occur. Insulate piping and exhaust ducting as required.

Ensure that no liquid connections interfere with the opening of access door panels.

Economizer relief valves shall not have set pressure ratings higher than the rated pressure of the economizer. Liquid storage tank relief valves shall not have discharge pressure ratings higher than the rated pressure of the storage tank. To avoid safety valve leakage, ensure that safety valve set pressure is sufficiently higher than dead head pressure of the feed pump.

It is recommended that the pipe and circulating tank (if included) be insulated to reduce heat loss.

If existing conditions may subject the fin tubing to internal scale build up, pressure gauges (furnished by others) should be installed on the liquid inlet and outlet sides of the economizer. This will enable monitoring of liquid flow restriction. Capped tees, one on the liquid inlet side and one on the liquid outlet side, incorporated into the piping installation may allow a descaling solution to be used with the economizer in place. Consult the factory for suitable descaling solutions.

2.3.2 - Condensing economizer dimensions and weights*

Table 2-1 Economizer weights C2X (lbs)

Economizer Model	Economizer Dry Weight	Economizer Wet Weight
C2X-2M386AL	1980	2130
C2X-2M3A6AL	2220	2410
C2X-2R3A6AL	2520	2730
C2X-2R3B6AL	2820	3070
C2X-2S3B6AL	3240	3530
C2X-2S3C6AL	3720	4060

Table 2-2 Dimensions C2X (see Figure 2-7; all dimensions in inches)

Dimension	Economizer Model					
	C2X-2M386AL	C2X-2M3A6AL	C2X-2R3A6AL	C2X-2R3B6AL	C2X-2S3B6AL	C2X-2S3C6AL
A	62.1	70.7	76.0	84.6	87.7	98.5
B	25.2	29.5	29.5	33.8	33.8	38.1
C	58.0	58.0	66.0	66.0	73.0	73.0
D	28.4	32.7	32.7	37.0	37.0	41.3
E	55.6	66.4	66.4	77.2	77.2	87.9
F	32.0	32.0	40.0	40.0	46.0	46.0
G	20.0	20.0	24.0	24.0	24.0	24.0
H	71.7	71.7	82.0	82.0	90.0	90.0
I	13.3	13.3	15.1	15.1	16.1	16.1
J	32.0	32.0	38.0	38.0	44.0	44.0
K	13.3	13.3	15.1	15.1	16.1	16.1
L	69.0	69.0	77.0	77.0	84.0	84.0
M	27.2	27.2	30.2	30.2	33.2	33.2
N	41.8	41.8	46.8	46.8	50.8	50.8
O	25.4	25.4	28.4	28.4	31.3	31.3
P	65	65	75	75	83	83
Q	42	42	48	48	54	54
AA	2	2	2-1/2	2-1/2	2-1/2	2-1/2
BB	2	2	2-1/2	2-1/2	2-1/2	2-1/2

*Selected sizes only. Contact C-B for sizes not shown.

Figure 2.7 - Dimension diagram, C2X

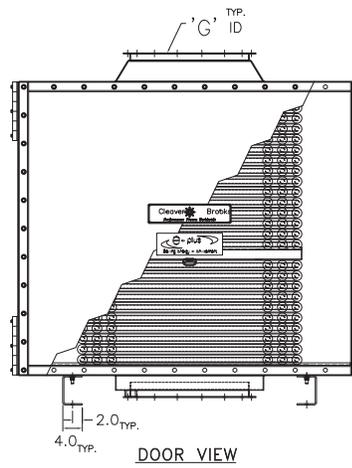
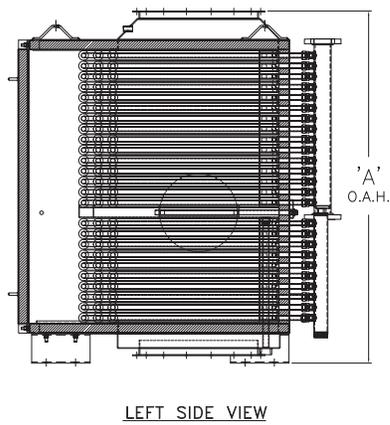
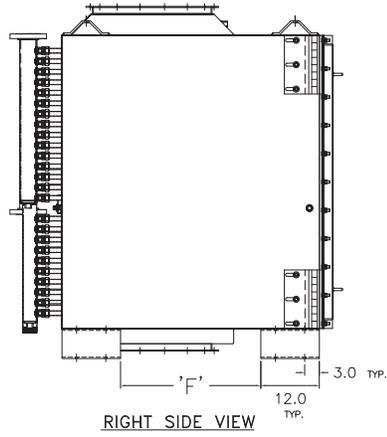
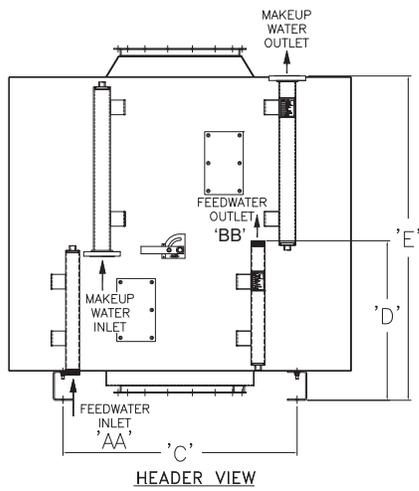
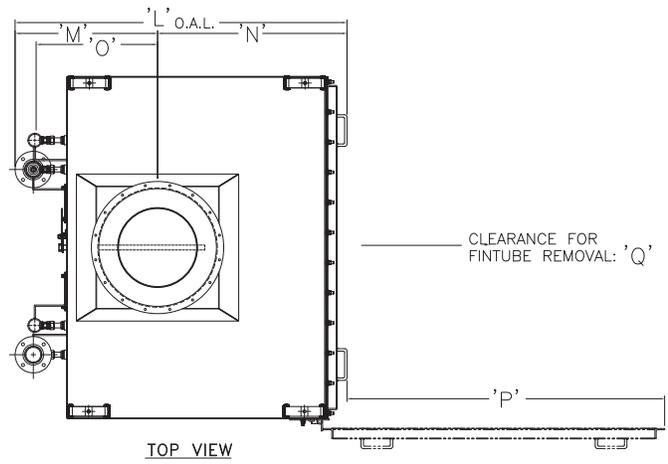
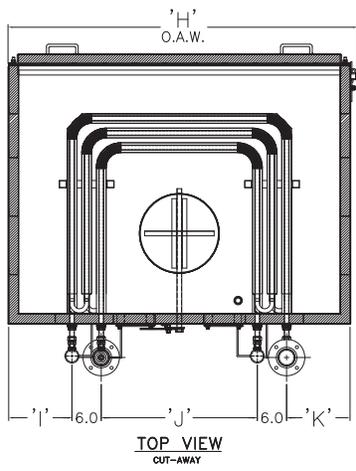
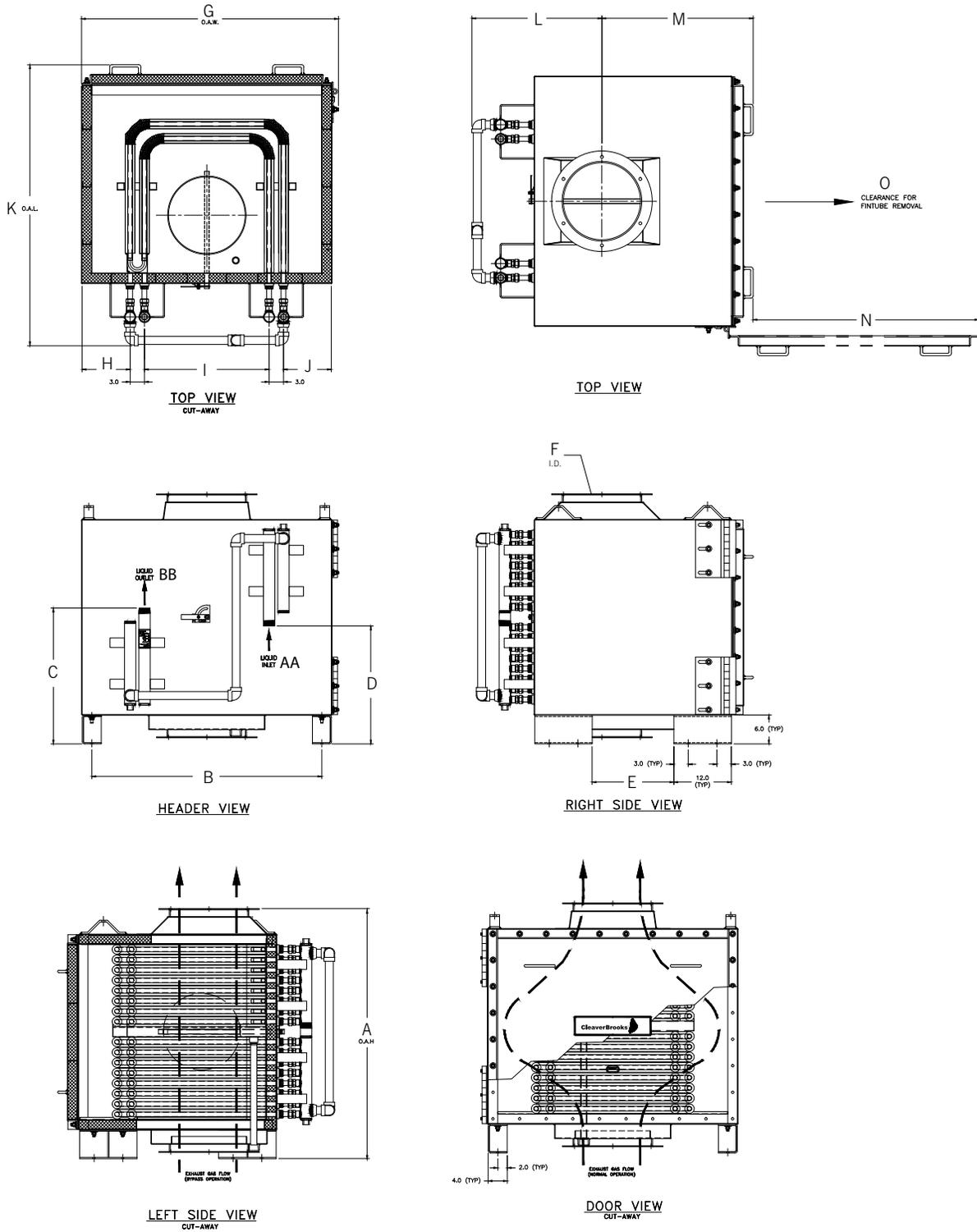


Table 2-1 Dimensions C1X (see Figure 2-8; all dimensions in inches)

Dimension	Economizer Model			
	C1X-L286AL	C1X-R2D6AL	C1X-S2F6AL	C1X-Z2N6AL
A	52.2	54.4	61.5	101.6
B	48.0	48.0	58.0	90.0
C	28.4	28.3	32.7	51.4
D	24.6	24.6	28.9	46.7
E	17.1	31.5	39.5	-
F	16.12	24.12	24.12	31.5
G	53.6	71.6	81.6	118.6
H	10.0	13.0	18.0	20.0
I	26.0	38.0	47.0	74.0
J	10.0	13.0	13.0	20.0
K	58.7	73.5	81.5	116.7
L	27.1	34.9	37.9	50.8
M	31.6	38.7	43.7	60.8
N	47.1	65.1	75.1	108.1
O	30.0	42.0	48.0	72
AA	2	2	2	4
BB	2	2	2	4

*Selected sizes only. Contact C-B for sizes not shown.

Figure 2.8 - Dimension diagram, C1X



2.4-OPERATING SEQUENCES / EXAMPLE INSTALLATIONS

This section describes four typical configurations utilizing the C2X 2-stage economizer. **NOTE:** the examples given are for illustrative purposes only; individual applications may vary. Contact CB to determine the specific requirements of your installation.

2.4.1 - Single boiler with deaerator (refer to Figure 2-9)

SEQUENCE OF OPERATION

COMMON OPERATION:

- DEAERATOR LEVEL CONTROL SENDS SIGNAL TO MAKE-UP VALVE TO MAINTAIN LEVEL IN THE DEAERATOR, SENDING MAKE-UP WATER THROUGH THE SECOND STAGE OF THE ECONOMIZER AND INTO THE DEAERATOR.
- VALVE 3 NORMALLY SENDS ALL CONDENSATE RETURN DIRECTLY TO THE DEAERATOR.
- IF SECOND STAGE OUTLET WATER TEMPERATURE CONTROL SENSES STEAMING, VALVE 3 MODULATES TO DIVERT CONDENSATE THROUGH THE SECOND STAGE OF THE ECONOMIZER THEREBY INCREASING FLOW.
- IF SECOND STAGE OUTLET WATER TEMPERATURE CONTROL CONTINUES TO SENSE STEAMING, VALVE 1 IS OPENED TO ADD MORE COLD MAKE-UP WATER.
- BOILER LEVEL CONTROL SENDS SIGNAL TO VALVE 4 TO MAINTAIN LEVEL IN THE BOILER
- VALVES 1 & 4 ARE MODULATING VALVES, ALL OTHER ARE NOT

#2 OIL FIRING PROVISIONS:

- UNDER ANY MAKEUP WATER CONDITION:
 - VALVES "A" & "B" MUST BE CLOSED WHILE VALVE "C" IS OPENED TO DIVERT MAKE-UP WATER DIRECTLY TO THE DEAERATOR. BY-PASSING THE SECOND STAGE PREVENTS CONDENSATION WITHIN THE ECONOMIZER.
 - VALVE "F" MUST BE CLOSED WHILE VALVES "D" & "E" ARE OPENED TO ROUTE FEEDWATER THRU THE SECOND STAGE TO PREVENT STEAMING IN THE SECOND STAGE COILS.
- WHEN SWITCHING BACK TO NATURAL GAS FIRING, RETURN VALVES "A" THRU "F" BACK TO THEIR ORIGINAL POSITIONS FOR OPTIMAL EFFICIENCY GAIN.

NOTES to Figure 2-9

NOTES:

1. THIS SYSTEM APPLIES TO HIGH PRESSURE STEAM BOILERS ONLY.
2. ECONOMIZERS ARE FURNISHED PAINTED BY C-B AND INCLUDE SQUARE AND ROUND MATING FLANGE GASKETS AND TWO .75" NPT RELIEF VALVES SET AT 300 PSIG. ECONOMIZER FLANGES ARE DESIGNED TO SUPPORT A MAXIMUM OF 500 lbs. STACK/ECONOMIZER SUPPORT BY OTHERS.
3. DEAERATOR TO BE EQUIPED WITH CONTINUOUS OPERATION BOILER FEED PUMP(S), SUCTION AND DISCHARGE PIPING. SPRAYMASTER DEAERATOR SHOWN BUT UNIT CAN ALSO BE A TRAYMASTER OR BOILERMATE STYLE.
 - A DEAERATOR IS REQUIRED FOR SYSTEM OPERATION.
 - (1) ADDITIONAL TAPPING MAY BE REQUIRED ON THE DEAERATOR BELOW THE WATER LINE FOR FIRST STAGE BYPASS. FOR EXISTING DEAERATORS, THE INSTALLING CONTRACTOR MUST ADD THIS CONNECTION TO THE TANK. (PIPE, FITTING & INSTALLATION BY OTHERS).
 - FOR NEW DEAERATORS, THIS CONNECTION MUST BE ADDED TO THE TANK BY THE REPRESENTATIVE SALES PERSON PLACING THE DEAERATOR ORDER.
4. THE SIZE OF VALVE #3 IS BASED ON QUANTITY OF CONDENSATE EXPECTED TO MAINTAIN PROPER FLOW AND VELOCITY. SEE CHART FOR APPROPRIATE PART NUMBER. INSTALLATION NOTE: SYSTEM FLOW DOES NOT FOLLOW ARROW ON VALVE BODY.
5. DEAERATOR LEVEL CONTROLS ARE NOT INCLUDED IN THE PACKAGE PRICING. EXISTING VALVES AND/OR CONTROLS MAY BE USED PROVIDED THE VALVE IS A MODULATING TYPE. IF NEW VALVES AND/OR CONTROLS ARE REQUIRED, CONTACT LOCAL CB REPRESENTATIVE FOR VALVE SIZING.
6. CONTROL PANEL IS SHIPPED LOOSE FOR FIELD MOUNTING TO WALL OR STAND (BY OTHERS). CEC100 CONTROL IS INCLUDED IN THE BASE PRICING. CEC200 TOUCH SCREEN CONTROL AND THE HAWK ICS ADVANCED PACKAGE ARE OPTIONAL UPGRADES. WHEN THE HAWK ICS IS SELECTED, CONSULT CB AFTERMARKET CONVERSIONS FOR INPUT/OUTPUT CONFIGURATION AND TEMPERATURE TRANSMITTING COMPONENTS.
7. CONDENSING ECONOMIZERS ARE DESIGNED FOR SYSTEMS FIRING PRIMARILY NATURAL GAS AND/OR PROPANE (VALVES AS SHOWN) WITH #2 FUEL OIL AS AN OPTIONAL BACK-UP FUEL ONLY (SEE SEQUENCE OF OPERATION). OTHER FUEL TYPES ARE NOT SUPPORTED. FOR GAS ONLY SYSTEMS, VALVES "D" & "E" ARE NOT REQUIRED.
8. A MODULATING FEEDWATER VALVE IS REQUIRED ON ALL SYSTEMS. A THREE VALVE BYPASS IS RECOMMENDED BUT NOT PART OF THE BASE PRICING.

2.4.2 - Single boiler with deaerator and surge tank (refer to Figure 2-10)

SEQUENCE OF OPERATION

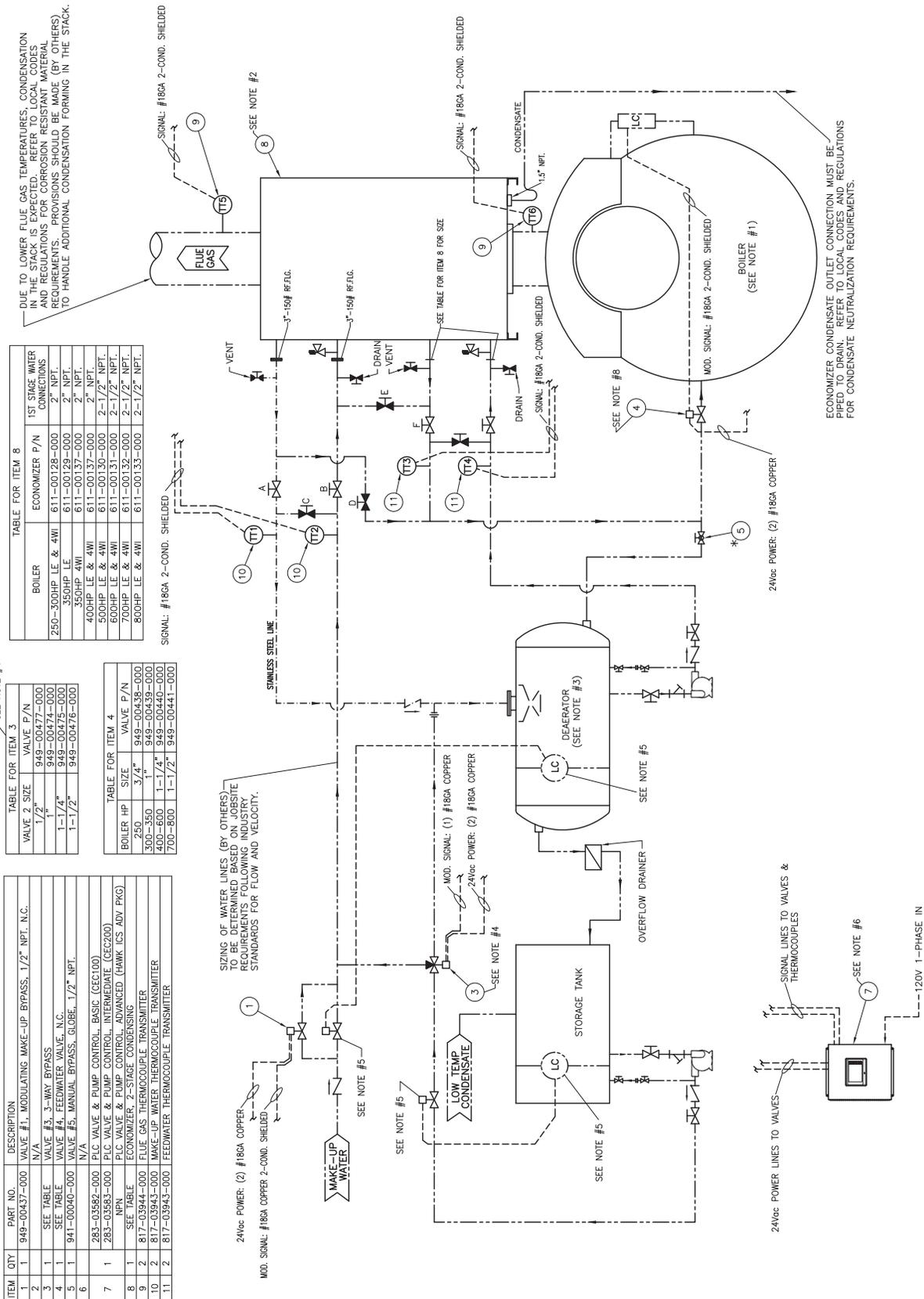
COMMON OPERATION:

- STORAGE TANK LEVEL CONTROL OPENS CONDENSATE VALVE WHEN LEVEL IN STORAGE TANK RISES, SENDING CONDENSATE TO DEAERATOR.
- DEAERATOR LEVEL CONTROL SENDS SIGNAL TO MAKE-UP VALVE TO MAINTAIN LEVEL IN THE DEAERATOR, SENDING MAKE-UP WATER THROUGH THE SECOND STAGE OF THE ECONOMIZER AND INTO THE DEAERATOR.
- IF SECOND STAGE OUTLET WATER TEMPERATURE CONTROL SENSES STEAMING, VALVE 3 OPENS TO DIVERT CONDENSATE THROUGH THE SECOND STAGE OF THE ECONOMIZER THEREBY INCREASING FLOW.
- IF SECOND STAGE OUTLET WATER TEMPERATURE CONTROL CONTINUES TO SENSE STEAMING, VALVE 1 IS OPENED TO ADD MORE COLD MAKE-UP WATER.
- BOILER LEVEL CONTROL SENDS SIGNAL TO VALVE 4 TO MAINTAIN LEVEL IN THE BOILER.
- VALVES 1 & 4 ARE MODULATING VALVES, ALL OTHER ARE NOT

#2 OIL FIRING PROVISIONS:

- UNDER ANY MAKEUP WATER CONDITION:
 - VALVES "A" & "B" MUST BE CLOSED WHILE VALVE "C" IS OPENED TO DIVERT MAKE-UP WATER DIRECTLY TO THE DEAERATOR. BY-PASSING THE SECOND STAGE PREVENTS CONDENSATION WITHIN THE ECONOMIZER.
 - VALVE "F" MUST BE CLOSED WHILE VALVES "D" & "E" ARE OPENED TO ROUTE FEEDWATER THRU THE SECOND STAGE TO PREVENT STEAMING IN THE SECOND STAGE COILS.
- WHEN SWITCHING BACK TO NATURAL GAS FIRING, RETURN VALVES "A" THRU "F" BACK TO THEIR ORIGINAL POSITIONS FOR OPTIMAL EFFICIENCY GAIN.

Figure 2.10 - Single boiler with deaerator and surge tank



DUE TO LOWER FLUE GAS TEMPERATURES, CONDENSATION IN THE STACK IS EXPECTED. REFER TO LOCAL CODES AND REGULATIONS FOR CORROSION RESISTANT MATERIAL REQUIREMENTS. PROVISIONS SHOULD BE MADE (BY OTHERS) TO HANDLE ADDITIONAL CONDENSATION FORMING IN THE STACK.

TABLE FOR ITEM 8

BOILER	ECONOMIZER P/N	1ST STAGE WATER CONNECTIONS
250-300HP LE & 4WI	611-00128-000	2" NPT.
350HP LE	611-00129-000	2" NPT.
400HP LE & 4WI	611-00137-000	2" NPT.
500HP LE & 4WI	611-00130-000	2-1/2" NPT.
600HP LE & 4WI	611-00131-000	2-1/2" NPT.
700HP LE & 4WI	611-00132-000	2-1/2" NPT.
800HP LE & 4WI	611-00133-000	2-1/2" NPT.

TABLE FOR ITEM 3

VALVE 2 SIZE	VALVE P/N
1/2"	949-00477-000
1-1/2"	949-00478-000
1-1/2"	949-00479-000
1-1/2"	949-00478-000

TABLE FOR ITEM 4

BOILER HP	SIZE	VALVE P/N
250-350	3/4"	949-00436-000
400-600	1-1/4"	949-00440-000
700-800	1-1/2"	949-00441-000

ITEM	QTY	PART NO.	DESCRIPTION
1	1	949-00437-000	VALVE #1, MODULATING MAKE-UP BYPASS, 1/2" NPT. N.C.
2	1	N/A	N/A
3	1	SEE TABLE	VALVE #3, 3-WAY BYPASS
4	1	SEE TABLE	VALVE #4, FEEDWATER VALVE, N.C.
5	1	941-00040-000	VALVE #5, MANUAL BYPASS, GLOBE, 1/2" NPT.
6	1	N/A	N/A
7	1	283-03582-000	PLC VALVE & PUMP CONTROL, BASIC (GEC100)
8	1	283-03583-000	PLC VALVE & PUMP CONTROL, INTERMEDIATE (GEC200)
9	2	817-03944-000	FLUE GAS THERMOCOUPLE TRANSMITTER
10	2	817-03943-000	MAKE-UP WATER THERMOCOUPLE TRANSMITTER
11	2	817-03943-000	FEEDWATER THERMOCOUPLE TRANSMITTER

SIZING OF WATER LINES (BY OTHERS) TO BE DETERMINED BASED ON LOCAL REQUIREMENTS FOLLOWING INDUSTRY STANDARDS FOR FLOW AND VELOCITY.

ECONOMIZER CONDENSATE OUTLET CONNECTION MUST BE PIPED TO DRAIN. REFER TO LOCAL CODES AND REGULATIONS FOR CONDENSATE NEUTRALIZATION REQUIREMENTS.

NOTES to Figure 2-10**NOTES:**

1. THIS SYSTEM APPLIES TO HIGH PRESSURE STEAM BOILERS ONLY.
2. ECONOMIZERS ARE FURNISHED PAINTED BY C-B AND INCLUDE SQUARE AND ROUND MATING FLANGE GASKETS AND TWO .75" NPT RELIEF VALVES SET AT 300 PSIG. ECONOMIZER FLANGES ARE DESIGNED TO SUPPORT A MAXIMUM OF 500 lbs. STACK/ECONOMIZER SUPPORT BY OTHERS.
3. DEAERATOR TO BE EQUIPED WITH CONTINUOUS OPERATION BOILER FEED PUMP(S), SUCTION AND DISCHARGE PIPING. SPRAYMASTER DEAERATOR SHOWN BUT UNIT CAN ALSO BE A TRAYMASTER OR BOILERMATE STYLE.
 - A DEAERATOR IS REQUIRED FOR SYSTEM OPERATION.
 - (1) ADDITIONAL TAPPING MAY BE REQUIRED ON THE DEAERATOR BELOW THE WATER LINE FOR FIRST STAGE BYPASS. FOR EXISTING DEAERATORS, THE INSTALLING CONTRACTOR MUST ADD THIS CONNECTION TO THE TANK. (PIPE, FITTING & INSTALLATION BY OTHERS).
 - FOR NEW DEAERATORS, THIS CONNECTION MUST BE ADDED TO THE TANK BY THE REPRESENTATIVE SALES PERSON PLACING THE DEAERATOR ORDER.
4. THE SIZE OF VALVE #3 SHOULD MATCH THE UPSTREAM CONDENSATE VALVE. SEE CHART FOR APPROPRIATE PART NUMBER. INSTALLATION NOTE: SYSTEM FLOW DOES NOT FOLLOW ARROW ON VALVE BODY.
5. DEAERATOR/SURGE TANK LEVEL CONTROLS ARE NOT INCLUDED IN THE PACKAGE PRICING. EXISTING VALVES AND/OR CONTROLS MAY BE USED PROVIDED THE VALVE IS A MODULATING TYPE. IF NEW VALVES AND/OR CONTROLS ARE REQUIRED, CONTACT LOCAL CB REPRESENTATIVE FOR VALVE SIZING.
6. CONTROL PANEL IS SHIPPED LOOSE FOR FIELD MOUNTING TO WALL OR STAND (BY OTHERS). CEC100 CONTROL IS INCLUDED IN THE BASE PRICING. CEC200 TOUCH SCREEN CONTROL AND THE HAWK ICS ADVANCED PACKAGE ARE OPTIONAL UPGRADES. WHEN THE HAWK ICS IS SELECTED, CONSULT CB AFTERMARKET CONVERSIONS FOR INPUT/OUTPUT CONFIGURATION AND TEMPERATURE TRANSMITTING COMPONENTS.
7. CONDENSING ECONOMIZERS ARE DESIGNED FOR SYSTEMS FIRING PRIMARILY NATURAL GAS AND/OR PROPANE (VALVES AS SHOWN) WITH #2 FUEL OIL AS AN OPTIONAL BACK-UP FUEL ONLY (SEE SEQUENCE OF OPERATION). OTHER FUEL TYPES ARE NOT SUPPORTED. FOR GAS ONLY SYSTEMS, VALVES "D" & "E" ARE NOT REQUIRED.
8. A MODULATING FEEDWATER VALVE IS REQUIRED ON ALL SYSTEMS. A THREE VALVE BYPASS IS RECOMMENDED BUT NOT PART OF THE BASE PRICING.

2.4.3 - Two boilers with deaerator (refer to Figure 2-11)

SEQUENCE OF OPERATION

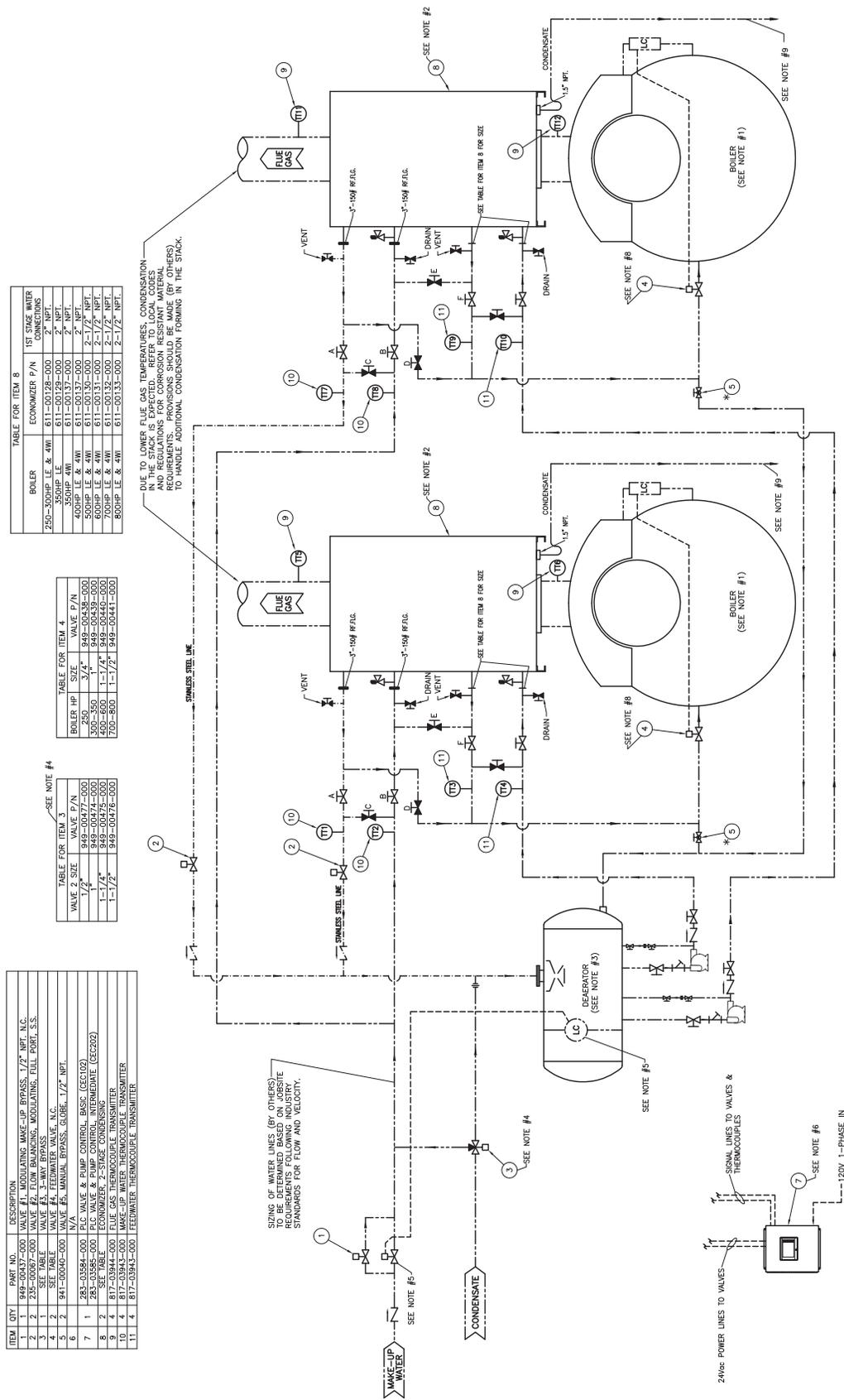
COMMON OPERATION:

- STORAGE TANK LEVEL CONTROL OPENS CONDENSATE VALVE WHEN LEVEL IN STORAGE TANK RISES, SENDING CONDENSATE TO DEAERATOR.
- DEAERATOR LEVEL CONTROL SENDS SIGNAL TO MAKE-UP VALVE TO MAINTAIN LEVEL IN THE DEAERATOR, SENDING MAKE-UP WATER THROUGH THE SECOND STAGE OF THE ECONOMIZER AND INTO THE DEAERATOR.
- IF SECOND STAGE OUTLET WATER TEMPERATURE CONTROL SENSES STEAMING, VALVE 3 OPENS TO DIVERT CONDENSATE THROUGH THE SECOND STAGE OF THE ECONOMIZER THEREBY INCREASING FLOW.
- IF SECOND STAGE OUTLET WATER TEMPERATURE CONTROL CONTINUES TO SENSE STEAMING, VALVE 1 IS OPENED TO ADD MORE COLD MAKE-UP WATER.
- BOILER LEVEL CONTROL SENDS SIGNAL TO VALVE 4 TO MAINTAIN LEVEL IN THE BOILER.
- VALVES 1, 2 & 4 ARE MODULATING VALVES, ALL OTHER ARE NOT.
- VALVES BV1 & BV2 BALANCE THE FLOW THROUGH EACH ECONOMIZER IN PROPORTION TO THE FIRING RATE OF EACH BOILER AND CAN ALSO BE TRIMMED BY THE SECOND STAGE OUTLET WATER TEMPERATURE.

#2 OIL FIRING PROVISIONS:

- UNDER ANY MAKEUP WATER CONDITION:
 - VALVES "A" & "B" MUST BE CLOSED WHILE VALVE "C" IS OPENED TO DIVERT MAKE-UP WATER DIRECTLY TO THE DEAERATOR. BY-PASSING THE SECOND STAGE PREVENTS CONDENSATION WITHIN THE ECONOMIZER.
 - VALVE "F" MUST BE CLOSED WHILE VALVES "D" & "E" ARE OPENED TO ROUTE FEEDWATER THRU THE SECOND STAGE TO PREVENT STEAMING IN THE SECOND STAGE COILS.
- WHEN SWITCHING BACK TO NATURAL GAS FIRING, RETURN VALVES "A" THRU "F" BACK TO THEIR ORIGINAL POSITIONS FOR OPTIMAL EFFICIENCY GAIN.

Figure 2.11 - Two boilers with deaerator



NOTES to Figure 2-11

NOTES:

1. THIS SYSTEM APPLIES TO HIGH PRESSURE STEAM BOILERS ONLY.
2. ECONOMIZERS ARE FURNISHED PAINTED BY C-B AND INCLUDE SQUARE AND ROUND MATING FLANGE GASKETS AND TWO .75" NPT RELIEF VALVES SET AT 300 PSIG. ECONOMIZER FLANGES ARE DESIGNED TO SUPPORT A MAXIMUM OF 500 lbs. STACK/ECONOMIZER SUPPORT BY OTHERS.
3. DEAERATOR TO BE EQUIPED WITH CONTINUOUS OPERATION BOILER FEED PUMP(S), SUCTION AND DISCHARGE PIPING. SPRAYMASTER DEAERATOR SHOWN BUT UNIT CAN ALSO BE A TRAYMASTER OR BOILERMATE STYLE.
 - A DEAERATOR IS REQUIRED FOR SYSTEM OPERATION.
 - (1) ADDITIONAL TAPPING MAY BE REQUIRED ON THE DEAERATOR BELOW THE WATER LINE FOR FIRST STAGE BYPASS. FOR EXISTING DEAERATORS, THE INSTALLING CONTRACTOR MUST ADD THIS CONNECTION TO THE TANK. (PIPE, FITTING & INSTALLATION BY OTHERS).
 - FOR NEW DEAERATORS, THIS CONNECTION MUST BE ADDED TO THE TANK BY THE REPRESENTATIVE SALES PERSON PLACING THE DEAERATOR ORDER.
4. THE SIZE OF VALVE #3 SHOULD MATCH THE UPSTREAM CONDENSATE VALVE. SEE CHART FOR APPROPRIATE PART NUMBER. INSTALLATION NOTE: SYSTEM FLOW DOES NOT FOLLOW ARROW ON VALVE BODY.
5. DEAERATOR LEVEL CONTROLS ARE NOT INCLUDED IN THE PACKAGE PRICING. EXISTING VALVES AND/OR CONTROLS MAY BE USED PROVIDED THE VALVE IS A MODULATING TYPE. IF NEW VALVES AND/OR CONTROLS ARE REQUIRED, CONTACT LOCAL CB REPRESENTATIVE FOR VALVE SIZING.
6. CONTROL PANEL IS SHIPPED LOOSE FOR FIELD MOUNTING TO WALL OR STAND (BY OTHERS). CEC102 CONTROL IS INCLUDED IN THE BASE PRICING. CEC202 TOUCH SCREEN CONTROL IS AN OPTIONAL UPGRADE.
7. CONDENSING ECONOMIZERS ARE DESIGNED FOR SYSTEMS FIRING PRIMARILY NATURAL GAS AND/OR PROPANE (VALVES AS SHOWN) WITH #2 FUEL OIL AS AN OPTIONAL BACK-UP FUEL ONLY (SEE SEQUENCE OF OPERATION). OTHER FUEL TYPES ARE NOT SUPPORTED. FOR GAS ONLY SYSTEMS, VALVES "D" & "E" ARE NOT REQUIRED.
8. A MODULATING FEEDWATER VALVE IS REQUIRED ON ALL SYSTEMS. A THREE VALVE BYPASS IS RECOMMENDED BUT NOT PART OF THE BASE PRICING.
9. ECONOMIZER CONDENSATE OUTLET CONNECTION MUST BE PIPED TO DRAIN. REFER TO LOCAL CODES AND REGULATIONS FOR CONDENSATE NEUTRALIZATION REQUIREMENTS.

2.4.4 - Two boilers with deaerator and surge tank (refer to Figure 2-12)

SEQUENCE OF OPERATION

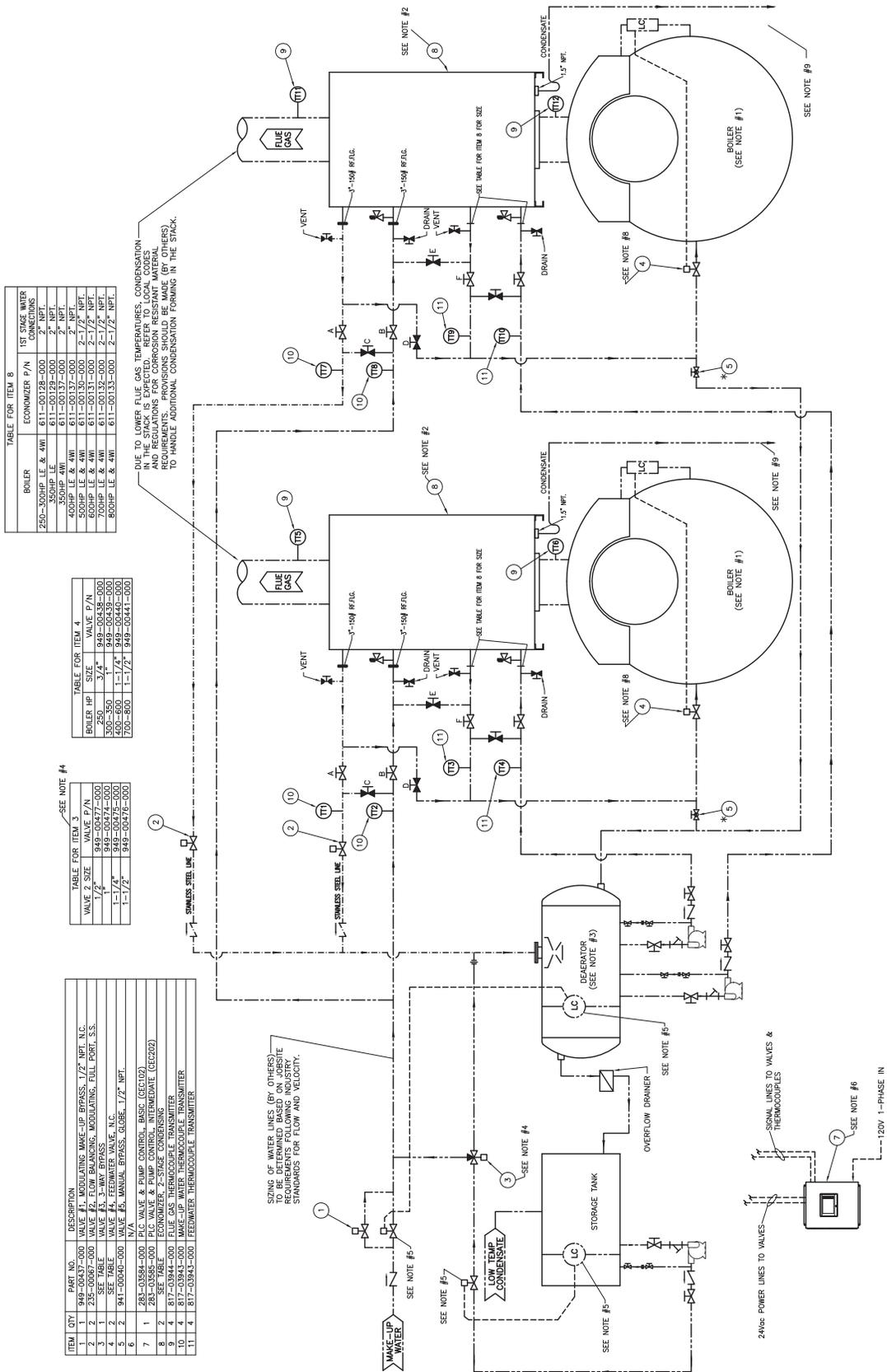
COMMON OPERATION:

- DEAERATOR LEVEL CONTROL SENDS SIGNAL TO MAKE-UP VALVE TO MAINTAIN LEVEL IN THE DEAERATOR, SENDING MAKE-UP WATER THROUGH THE SECOND STAGE OF THE ECONOMIZER AND INTO THE DEAERATOR.
- VALVE 3 NORMALLY SENDS ALL CONDENSATE RETURN DIRECTLY TO THE DEAERATOR.
- IF SECOND STAGE OUTLET WATER TEMPERATURE CONTROL SENSES STEAMING, VALVE 3 MODULATES TO DIVERT CONDENSATE THROUGH THE SECOND STAGE OF THE ECONOMIZER THEREBY INCREASING FLOW.
- IF SECOND STAGE OUTLET WATER TEMPERATURE CONTROL CONTINUES TO SENSE STEAMING, VALVE 1 IS OPENED TO ADD MORE COLD MAKE-UP WATER.
- BOILER LEVEL CONTROL SENDS SIGNAL TO VALVE 4 TO MAINTAIN LEVEL IN THE BOILER
- VALVES 1, 2 & 4 ARE MODULATING VALVES, ALL OTHER ARE NOT
- VALVES BV1 & BV2 BALANCE THE FLOW THROUGH EACH ECONOMIZER IN PROPORTION TO THE FIRING RATE OF EACH BOILER AND CAN ALSO BE TRIMMED BY THE SECOND STAGE OUTLET WATER TEMPERATURE.

#2 OIL FIRING PROVISIONS:

- UNDER ANY MAKEUP WATER CONDITION:
 - VALVES "A" & "B" MUST BE CLOSED WHILE VALVE "C" IS OPENED TO DIVERT MAKE-UP WATER DIRECTLY TO THE DEAERATOR. BY-PASSING THE SECOND STAGE PREVENTS CONDENSATION WITHIN THE ECONOMIZER.
 - VALVE "F" MUST BE CLOSED WHILE VALVES "D" & "E" ARE OPENED TO ROUTE FEEDWATER THRU THE SECOND STAGE TO PREVENT STEAMING IN THE SECOND STAGE COILS.
- WHEN SWITCHING BACK TO NATURAL GAS FIRING, RETURN VALVES "A" THRU "F" BACK TO THEIR ORIGINAL POSITIONS FOR OPTIMAL EFFICIENCY GAIN.

Figure 2.12 - Two boilers with deaerator and surge tank



NOTES to Figure 2-12**NOTES:**

1. THIS SYSTEM APPLIES TO HIGH PRESSURE STEAM BOILERS ONLY.
2. ECONOMIZERS ARE FURNISHED PAINTED BY C-B AND INCLUDE SQUARE AND ROUND MATING FLANGE GASKETS AND TWO .75" NPT RELIEF VALVES SET AT 300 PSIG. ECONOMIZER FLANGES ARE DESIGNED TO SUPPORT A MAXIMUM OF 500 lbs. STACK/ECONOMIZER SUPPORT BY OTHERS.
3. DEAERATOR TO BE EQUIPED WITH CONTINUOUS OPERATION BOILER FEED PUMP(S), SUCTION AND DISCHARGE PIPING. SPRAYMASTER DEAERATOR SHOWN BUT UNIT CAN ALSO BE A TRAYMASTER OR BOILERMATE STYLE.
 - A DEAERATOR IS REQUIRED FOR SYSTEM OPERATION.
 - (1) ADDITIONAL TAPPING MAY BE REQUIRED ON THE DEAERATOR BELOW THE WATER LINE FOR FIRST STAGE BYPASS. FOR EXISTING DEAERATORS, THE INSTALLING CONTRACTOR MUST ADD THIS CONNECTION TO THE TANK. (PIPE, FITTING & INSTALLATION BY OTHERS).
 - FOR NEW DEAERATORS, THIS CONNECTION MUST BE ADDED TO THE TANK BY THE REPRESENTATIVE SALES PERSON PLACING THE DEAERATOR ORDER.
4. THE SIZE OF VALVE #3 IS BASED ON QUANTITY OF CONDENSATE EXPECTED TO MAINTAIN PROPER FLOW AND VELOCITY. SEE CHART FOR APPROPRIATE PART NUMBER. INSTALLATION NOTE: SYSTEM FLOW DOES NOT FOLLOW ARROW ON VALVE BODY.
5. DEAERATOR/SURGE TANK LEVEL CONTROLS ARE NOT INCLUDED IN THE PACKAGE PRICING. EXISTING VALVES AND/OR CONTROLS MAY BE USED PROVIDED THE VALVE IS A MODULATING TYPE. IF NEW VALVES AND/OR CONTROLS ARE REQUIRED, CONTACT LOCAL CB REPRESENTATIVE FOR VALVE SIZING.
6. CONTROL PANEL IS SHIPPED LOOSE FOR FIELD MOUNTING TO WALL OR STAND (BY OTHERS). CEC102 CONTROL IS INCLUDED IN THE BASE PRICING. CEC202 TOUCH SCREEN CONTROL IS AN OPTIONAL UPGRADE.
7. CONDENSING ECONOMIZERS ARE DESIGNED FOR SYSTEMS FIRING PRIMARILY NATURAL GAS AND/OR PROPANE (VALVES AS SHOWN) WITH #2 FUEL OIL AS AN OPTIONAL BACK-UP FUEL ONLY (SEE SEQUENCE OF OPERATION). OTHER FUEL TYPES ARE NOT SUPPORTED. FOR GAS ONLY SYSTEMS, VALVES "D" & "E" ARE NOT REQUIRED.
8. A MODULATING FEEDWATER VALVE IS REQUIRED ON ALL SYSTEMS. A THREE VALVE BYPASS IS RECOMMENDED BUT NOT PART OF THE BASE PRICING.
9. ECONOMIZER CONDENSATE OUTLET CONNECTION MUST BE PIPED TO DRAIN. REFER TO LOCAL CODES AND REGULATIONS FOR CONDENSATE NEUTRALIZATION REQUIREMENTS.

2.5-ECONOMIZER CONTROLS (C2X)

Standalone C2X control offerings comprise the CEC-100 (standard) and optional CEC-200 with touch screen.

For an integrated system including boiler and economizer control C-B offers the Hawk 4000.

2.5.1 - CEC 20x

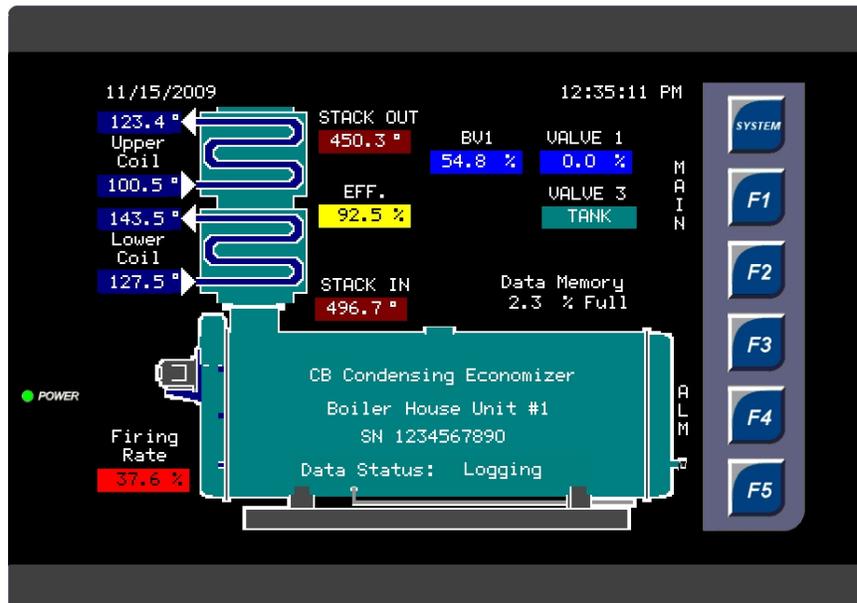
The system features:

- 5.7" color touchscreen display
- Digital inputs for fuel type selection
- Relay outputs for valve control and remote alarm indication
- Analog inputs for economizer water temperature, flue gas temperature and firing rate signals
- On-screen indication of economizer water temperatures, flue gas temperatures, firing rate, valve positions and estimated system efficiency.

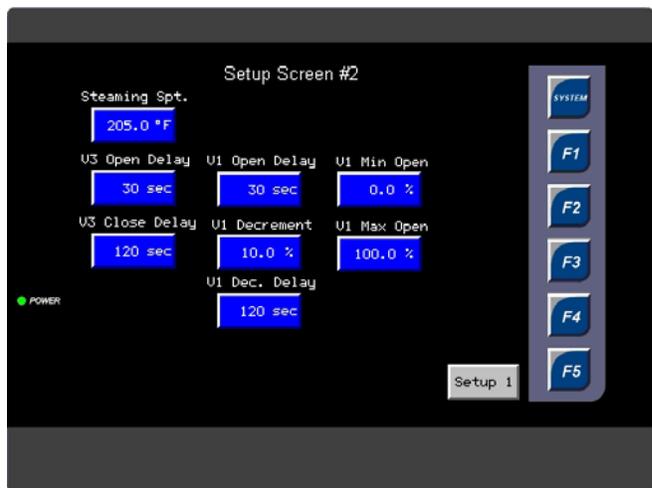
The main menu screen is used to easily navigate to the various screens used to configure and operate the system.



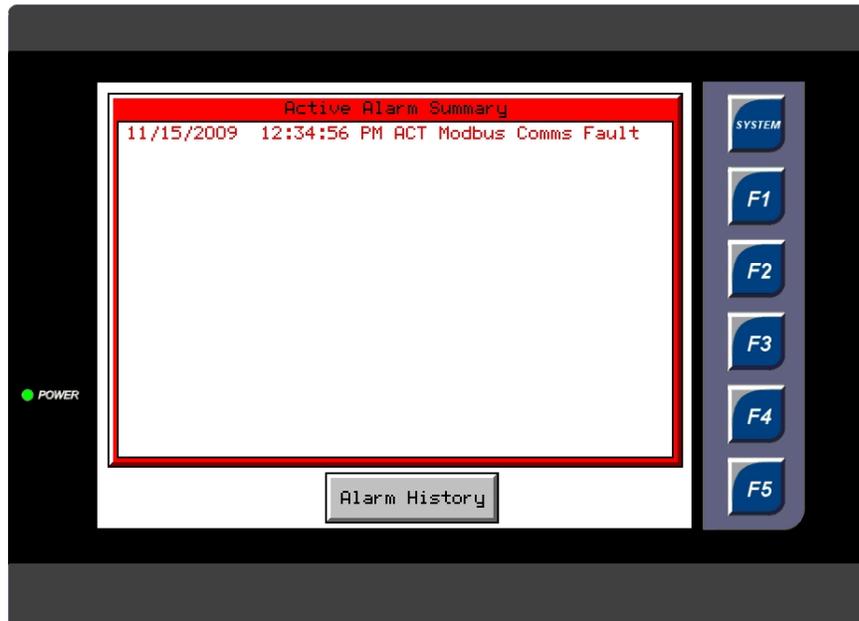
The graphical overview screen displays an overview of economizer performance.



The setpoint entry screens allow the user to configure the system to match individual project requirements. These screens are password protected to discourage unauthorized access.



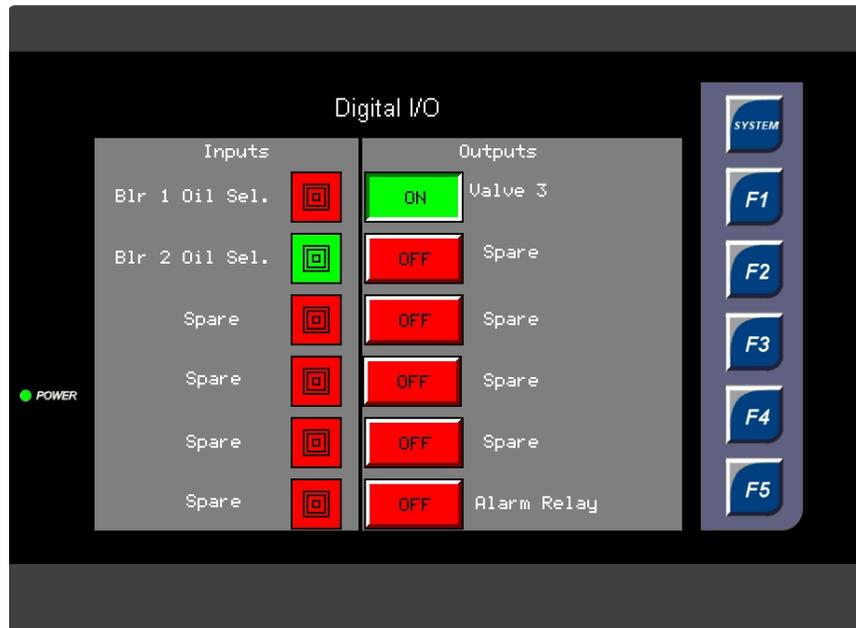
The alarm display screen informs the operator of any operating conditions that fall outside of the norm.



The analog configuration screens allows the user to easily set the scaling values for the analog I/O. These screens are password protected to discourage unauthorized access.



The digital I/O screen allows the user to manually stroke valves and verify input status of the system for setup and troubleshooting purposes. This screen is password protected to discourage unauthorized access.

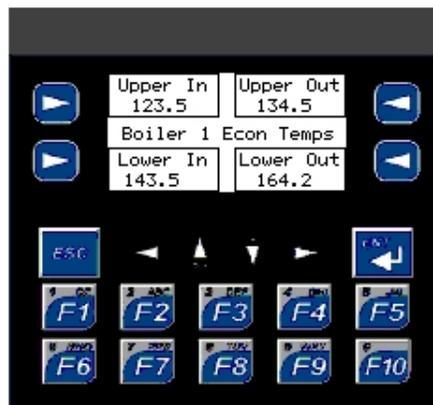


2.5.2 - CEC 10x

System features:

- 128x64 monochrome LCD display with push button style operator interface.
- Digital inputs for fuel type selection
- Relay outputs for valve control and remote alarm indication
- Analog inputs for economizer water temperature, flue gas temperature and firing rate signals
- On-screen indication of economizer water temperatures

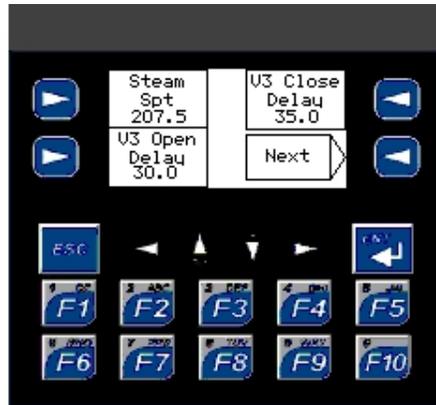
The system overview screen displays an overview of economizer performance.



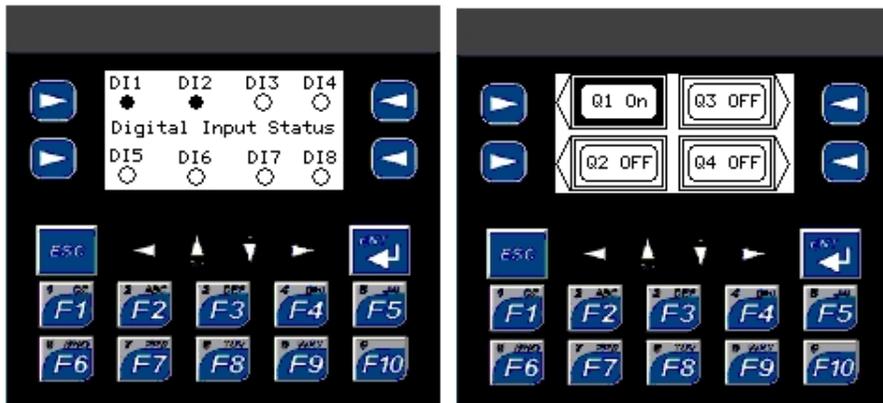
The alarm display screen informs the operator of any operating conditions that fall outside of the norm.



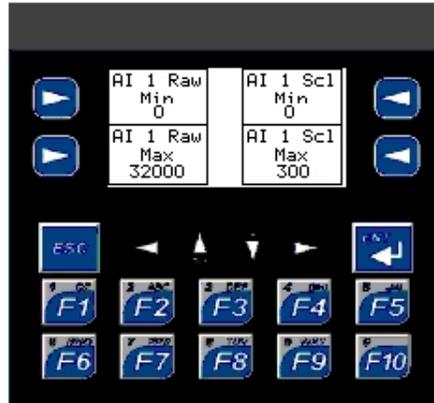
The alarm setpoint entry screens allows the user to configure the system to match individual project requirements. This screen is password protected to discourage unauthorized access.



The digital I/O screens allow the user to manually activate digital outputs and to verify the digital inputs of the system for setup and troubleshooting purposes. These screens are password protected to discourage unauthorized access.



The analog configuration screen allows the user to easily set the scaling values for the temperature transmitters. This screen is password protected to discourage unauthorized access.



2.5.3 - Hawk 4000

The Hawk 4000 is a totally integrated control system combining precise boiler/burner control and advanced safety features with logic-based ancillary devices and functions. Among the Hawk system's features is the ability to control the condensing economizer system for ensured maximum efficiency during all operating scenarios.

When firing natural gas, the system is controlled to maximize condensing. This is accomplished by routing all of the available cold makeup water through the upper economizer coil before it enters the deaerator. Water from the deaerator is then routed through the lower coil before it is used as boiler feed water.

When firing #2 oil, the system is controlled to operate in the 'near-condensing' mode. This prevents sulfur from the #2 oil from combining with condensate and forming sulfuric acid which would destroy the metallic components. In near-condensing mode, any cold makeup water is routed to the deaerator and not through the upper coil.

Hawk 4000 features specific to the C2X include:

- Digital inputs for makeup water and feedwater valve feedback
- Solid state outputs for valve control
- Additional analog inputs for economizer 2nd stage water temperature in and out
- On-screen indication of economizer stage 1 and 2 water temp. in and out

Note: For more information see the Hawk 4000 operating manual 750-342

2.6-MONITORING PERFORMANCE

It is recommended to inspect the core or coil if the performance (liquid temperatures leaving and Btu/hr recovery) begins to decrease. A good practice of maintenance is to keep a performance schedule starting when the economizer is installed to compare with any future changes.

A simple method of determining whether the heat exchanger is performing properly is to monitor the exit temperatures on the liquid and gas sides while in the new condition to establish a base of comparable data. If the stack temperature leaving the exchanger is higher than normal and the liquid

exit temperature is lower than normal, then either the heat transfer surface is fouled or scaled on the inside of the tubing. This requires cleaning as soon as possible during a convenient shut down period.

In a circulating system containing a pump and BTU storage tank, if the economizer pressure relief valve discharges, it is likely that there is no or little liquid circulating through the economizer. Check the pump operation and repair or replace as necessary. **DO NOT ATTEMPT TO REMOVE OR REPLACE THE PUMP UNLESS THE PUMP, PIPES AND LIQUID HAVE BEEN ALLOWED TO COOL.** You may also need to check for flow restrictions in the piping and/or the economizer.

If the economizer liquid and outlet temperatures are approaching being equal as compared to the original data, this may be a pump problem and/or a scale accumulation occurrence in the finned tubing. Remedy as indicated above. It is also possible that the fin coils are severely fouled. Refer to section 2.6 for cleaning.

2.7-MAINTENANCE

C-B condensing economizers are virtually maintenance free. Nevertheless, periodic inspections will ensure trouble-free operation and long equipment life.

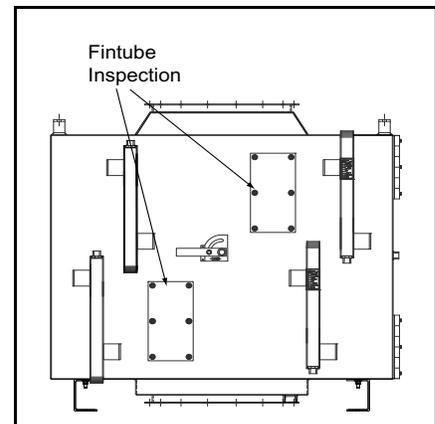
A routine physical inspection of the heat transfer core area will depend on the conditions of temperature and the quality of combustion within the flue gas stream. **NOTE:** Ensure that the combustion source is off and is cool, and that the economizer is cool before attempting to inspect or clean the fin coils.

With clean exhaust conditions, physical inspection will be minimal if proper combustion at the heat source is maintained

The inspection and maintenance procedure can be performed without dismantling any of the piping or the stack connections. Two removable panels on the C2X allow inspection of the 1st and 2nd stage fintube sections. A hinged access door is provided on C2X and C1X models for inspection, cleaning, or removal of tubes. Tube sections are individually connected by compression fittings to the header manifolds.

The following is the procedure for opening and closing the hinged door. **NOTE:** it may be necessary to provide a means of supporting the weight of the door.

1. Remove all nuts from the door flange studs, except one located opposite the hinges.
2. Loosen all hinge nuts.
3. Pull hinge side of door all the way out to where the hinge slots stop at the studs and retighten hinge nuts.
4. Remove the last nut opposite the hinge side.
5. Pull door out until adjusting bolt hits stop. The door should be out past the bolts.
6. Lower adjusting bolt until door hangs freely and adjusting bolt clears stop.
7. Door is ready to open.
8. Reverse steps to close.





e-mail: info@cleaverbrooks.com
Web Address: <http://www.cleaverbrooks.com>