

Boilerroom Equipment, Inc.

HeatSponge.com

**High Performance
Boiler Economizer**

**Standard Operation and
Maintenance Manual**



This manual is provided for general guidance only and does not relieve the customer from obtaining qualified site engineering and installation support. Plant operating personnel should thoroughly familiarize themselves with the content of this manual and the physical installation and equipment provided before attempting to energize and operate the equipment. It is not possible to cover in written form all possible operating scenarios and conditions. Any deviation from the operating discipline outlined in this document should be based on extensive operating experience, sound engineering judgment and consultation with your Boilerroom Equipment Inc. engineering contact. **Boilerroom Equipment Inc. strongly recommends that an authorized BEI Field Service Representative be retained for initial system commissioning and plant personnel training.** BEI will not be responsible for problems beyond its knowledge or control.

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Important Instructions For Receiving Unit In Case Of Loss Or Damage

1. Examine the shipment carefully before signing freight bill. If any DAMAGE is noted or if the number of pieces received DOES NOT agree with the BILL OF LADING, DO NOT ACCEPT SHIPMENT without shortage or damage noted on the freight bill by the carrier's agent. Failure to do so may jeopardize your recovery and at your own risk.
2. If any concealed DAMAGE OR SHORTAGE is discovered with unpacking, LEAVE MATERIAL AND PACKING AS IS and NOTIFY Agent or carrier to inspect and make reference thereto on the freight bill.
3. All packaged material should be unpacked and inspected within 24 hours after receipt of same. If damage could not be detected until goods were unpacked, contact the transportation company and request IMMEDIATE inspection. Require him to give you a "concealed" bid order report, stating the condition of the goods when examined. It is his duty to do this, and this service should be insisted upon. This, with other documents, will properly support your claim.
4. When the above instructions are complied with, we will assist you in establishing claims against the transportation companies for loss or damage in transit. We cannot, however, be responsible for entry or collection of claims or replacement of lost or damaged material.
5. Claims for loss or damage on transportation charges resulting there from must not be deducted from our invoice, non payment of invoices withheld awaiting adjustment of such claims, since it is the function of the carrier to guarantee safe delivery of the equipment.
6. **DO NOT RETURN GOODS WITHOUT WRITTEN AUTHORIZATION.** Returned goods will not be accepted BEI from the transportation company unless written authorization has been issued by an official of our Company. Credit for goods returned by authorization will depend on the market value, less a fair charge to cover expense of shipping, rehandling, inspection, refinishing, etc., providing material is received in good condition.

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Important Instructions for Owners, Operators or Maintenance Personnel

1. 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.
2. Only trained and authorized personnel should be allowed to operate, adjust or repair this equipment.
3. Boilerroom Equipment, Inc.'s products are designed and engineered to provide long life and excellent service on the job. The devices supplied as part of the unit were chosen because of their known ability to perform. 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 operating this equipment.
4. 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.
5. The operation of this equipment by the Owner and his operating personnel must comply with all requirements or regulations of his insurance company and/or any other authority having jurisdiction. These legal requirements take precedence over anything contained herein.
6. BEI's Service Representatives present for start-up or service are present only in an advisory capacity. The operation of the equipment is under the scope of work to be performed by the Owner's operating personnel at the Owner's risk, and under the Owner's insurance protection. Recommendation for proper adjustments required to make the equipment perform can be made by these Service Representatives.

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Description Of Economizer

The economizer section is typically the final stage of heat recovery in a boiler system. The economizer is a fully drainable unit in either the typical vertical or horizontal position, square pitch, counter flow economizer with finned tubes.

The economizer is provided with inlet and outlet headers. Drains and vents must be included in the supply and return piping to ensure complete draining and venting. The economizer tube bank is enclosed 3/16" carbon steel casing with adequate stiffeners and is insulated with 2" of mineral wool insulation and a corrugated lagging.

The temperature of the feedwater to the economizer is critical to a long system life. When the feedwater temperature falls below that shown in the performance data below, there is a risk of water or sulfur condensing from the flue gas stream and causing "cold end corrosion" of the tube bundle. This economizer has been designed for use only with low sulfur fuels. Prior to operation with fuels that include higher amounts of sulfur, contact BEI for revised performance evaluations and recommendations.

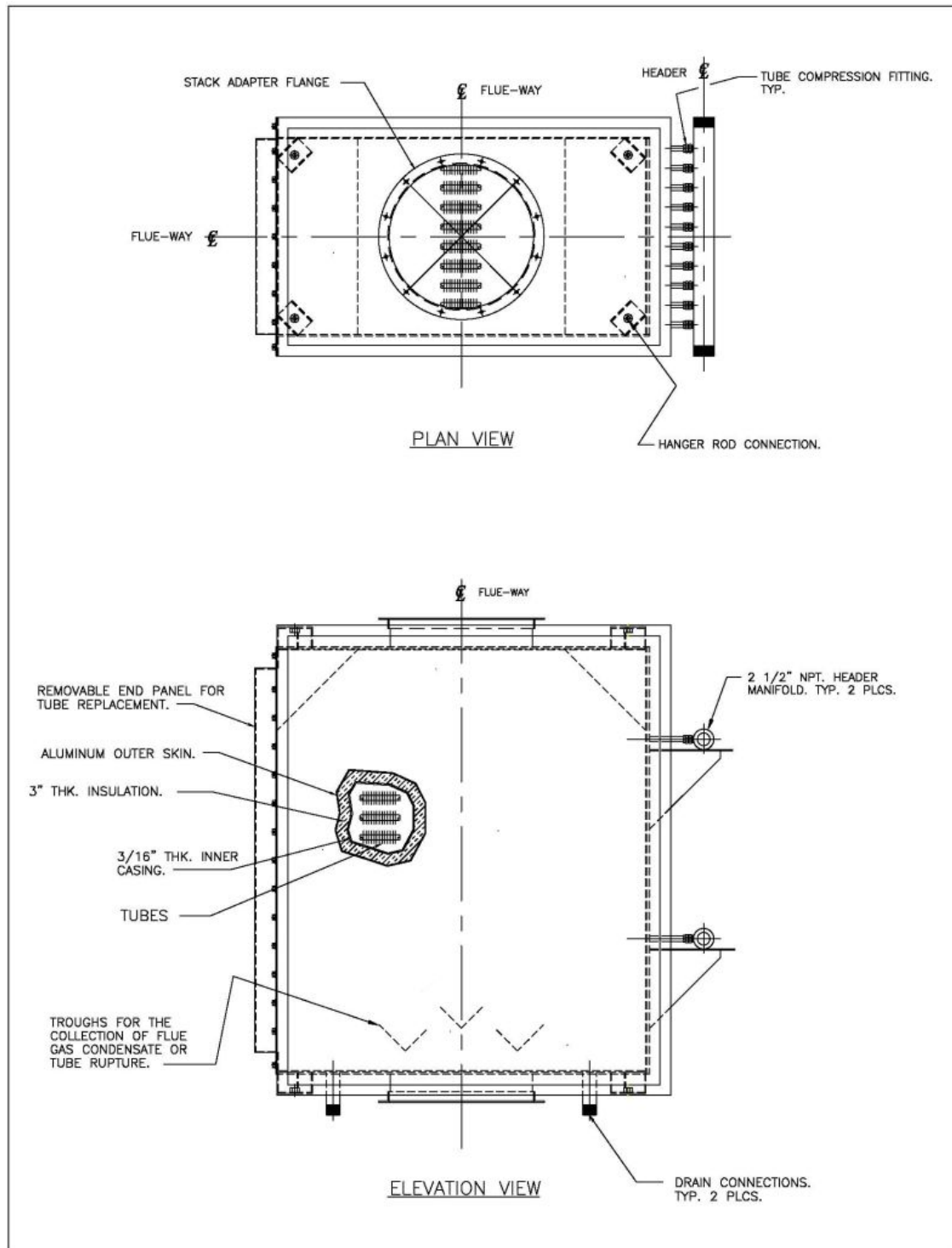
For deaerated water applications the economizer is typically supplied with carbon steel boiler tubing and fins. Non-deaerated applications will be supplied with stainless steel tube and fin economizer tubes. Units supplied with stainless steel tubes will also utilize a stainless steel inner casing and stainless steel tube supports to provide for long life in a potentially condensing environment.

A water trap system incorporated into the bottom of the unit will collect and drain condensate, rain, or any other water that develops inside of the economizer. The HeatSponge unit is specifically designed to accommodate applications that could potentially go into condensing. Note the unit is designed to handle the water created by condensing and not necessarily the acid byproducts that can be formed on oil fired boilers. Contact BEI with any specific application. The water trap must have a drain installed to safe location.

The HeatSponge unit features removable tube elements to provide for fast and easy unit repair. There are no ASME welds on a HeatSponge allowing plant personnel the ability to replace tubes simply by loosening compression fittings. The fittings used on the HeatSponge can be found at any plumbing supply house, we do not use any proprietary fittings in our unit. The rear panel of the HeatSponge unbolts to provide maintenance accessibility.

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Typical Unit Cross Sectional Drawing



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Operating Procedures

Installation

It is not within the scope of this manual to provide installation instructions. These should follow the design specifications of the Architect, Engineer or Contractor.

Good engineering practices must prevail

Installation of the unit will require connection of the water lines to the 2 ½" threaded headers. The HeatSponge unit has a rolled angle flange welded to the inlet and outlet transitions. Supply of mating flanges is by the installing contractor. The water trap has a connection for a drain line than must be run to a drain. A P-trap or similar assembly should be installed to block potential flue gas leakage.

A safety relief valve is required for any economizer per ASME boiler code. HeatSponge includes the supply of a new SRV to ASME code and the unique application requirements.

Both ends of each header are threaded on the HeatSponge. This allows the installing contractor to utilize one end of each header for the feedwater lines and the other end utilized for the safety relief valve, drains, vent, and recirculation line as required. Supply of a threaded fitting is by the installing contractor. BEI recommends that the feedwater inlet and outlet be staggered on the inlet to balance water side pressure drop across the unit. This means if feedwater enters the upper right header it should discharge the lower left header or vice versa.

The HeatSponge can be installed in either a counter-flow or parallel flow orientation. All performance is based on a more effective counter-flow installation where the coldest water enters the header on the discharge side of the economizer. For most typical gas flow up vertical installations this means the inlet header is the upper header and the lower header is the outlet header. Parallel flow units, where the inlet water enters the header on the inlet gas side of the unit, are typically not utilized as they provide lower performance efficiency. Parallel flow units should only be considered on boilers firing fuel oil with relatively cold water entering the unit. Contact a BEI representative for additional assistance.

Provisions must be provided in the piping to avoid stagnation of water inside of the economizer during boiler operation. Your installing engineer is responsible for making all final installation decisions however the following guidelines can be utilized. For boilers equipped with a modulating feedwater regulating valve and continuous running pumps a recirculation line back to the feedwater tank allows for easiest installation. The economizer can be installed upstream of the feedwater regulating valve. A manually adjustable water flow valve sized for approximately 5% of steaming capacity should be located in the piping to the upper header and allowed to flow back to the feedwater tank. A check valve should be installed. The boiler operators should manually adjust the valve to limit the amount of recirculation to such a point that the economizer does not steam. This will be a function of many site-specific factors. If the economizer is located downstream of the regulating valve then the recirculation line is not required as the water in the economizer will expand into the boiler under steaming conditions. Although simpler than the alternative this arrangement provides the potential for long-term economizer erosion from the potential of steaming inside of the unit. This arrangement should only be considered for boilers that will be expected to run at consistent high firing rates where the demand for feedwater will always be required. Supply of the recirculation valve and line by others.

Boilers that are equipped with on-off feedwater pumps will require the recirculation valve be replaced with a solenoid valve. The solenoid should be wired into the feedwater pump circuit to open when the pump is not running. This will allow pressure inside of the economizer to be relieved to the feedwater tank when the pump is offline. BEI strongly recommends that the customer consider upgrading their boiler to modulating feedwater operation from on-off systems when installing a new economizer. Contact your BEI representative for all site-specific information. Supply of the solenoid valve and line by others.

The HeatSponge unit is not designed to carry any dynamic stack loading. The unit can carry a 1,500 lb static load only. All dynamic loads or excessive dead weight must be supported by other method. The unit is not designed to accommodate nozzle loading on the headers.

The HeatSponge can either carry its own weight or can be suspended by hanger rod. It is the responsibility of the installing engineer to insure the boiler or stack that the HeatSponge is to be installed on can support all loads. The HeatSponge is not designed to accommodate any expansion loads. Supply and installation of an expansion joint, it deemed required by the installing engineer or contractor, is by others.

Since the HeatSponge unit utilizes a true square-pitch tube arrangement it is 100% drainable by gravity in either the horizontal or vertical orientation. There is no change in performance or price for either installation orientation however at time of order placement this must be made known to BEI. In a horizontal orientation the water trap assembly is moved to a side of the unit from the bottom. Being 100% drainable by gravity in any orientation insures the unit can be fully drained prior to any lay-up period, a feature of critical importance in freezing climates.

All HeatSponge economizers are built to the ASME Boiler Code and is National Board Registered. The equipment must be installed to conform to applicable local, state, and national codes. Compliance with codes will help insure a safe and dependable installation as the codes have been formulated to safeguard life and property. Failure to comply with established codes and regulations may necessitate costly modification and reconstruction.

The proper authorities should be consulted before preparation of a permanent installation is started. Application should be made immediately for all permits required by law for construction and installation.

The following generalizations are intended for assistance and do not supplant any codes or construction criteria.

Handling

Necessary lifting attachments are an integral part of the structural frame of the equipment. When the components are received at the plant, they must be inspected for signs of damage prior to accepting the shipment or releasing the shipper. All boxes and cartons should be uncrated carefully and checked against the packing slip. In case of damage or shortage, immediately notify the carrier and file a claim. The equipment must be inspected during each phase of installation so that if any damage has occurred, repairs can be processed without delay.

When the contractor begins installation, his experience and discretion must prevail and it must be clear that he is totally responsible for the proper care of the unit as it is moved into position.

Setting the System

The layout of the system has been designed with sufficient access for maintenance and inspection of all internal components. The equipment must be set in a level position. Client foundations must be designed with adequate load bearing characteristics to handle the weight of the equipment, filled with water, and applicable snow, wind, and seismic loads. All applicable codes relating to minimum clearances to combustible materials must be observed.

It is recommend that at least 36" is allowed in the front of the unit for access to the compression fittings and 60" on the rear of the unit for tube replacement space. There is no need to access the sides of the unit therefore no provisions are provided.

Pre-Service Inspection

All piping and valves must be installed in accordance with good engineering practices. Suitable strength piping and valves are to be used. All drain and discharge piping must be piped to a safe point of discharge. The discharge end of the piping should not be near platforms or elevated walkways.

The discharge piping from the safety valves and the method of connecting the piping is especially important. Safety valves should be inspected externally to see that they are free to operate and that their vent and drain piping are open to atmosphere and free to expand without imposing strain upon the safety valve body. Make sure that any gags used during testing are removed. Verify that the discharge piping from the safety valves, blowdowns, vents and drains are piped to a safe point of discharge.

Aisles, ladders, and stairs should be completed and accessible for the convenience and safety of the operating personnel. All obstructions such as scaffolding, refuse, tools, etc. must be removed from ducts, breechings, and platforms. Insulation of piping and duct work should be done in accordance with accepted practices or project specifications.

When installation of the unit is completed but before operation, the entire system should be inspected. A minimum check list to aid the operator in checking the entire system prior to start up is presented on the following page:

CHECKLIST

External

- _____ Check integrity of casing.
- _____ Check that the structural supports have been installed.
- _____ Check nozzle alignment for bent or damaged nozzles.
- _____ Check casing and insulation for damage.

Piping

- _____ Check that all valves are oriented in the proper flow direction.
- _____ Check all piping for leakage during field hydrostatic test.
- _____ Check with Owner's water treatment consultant to assure that feedwater and chemical feed piping arrangement is appropriate.
- _____ Check that all flange bolting has been torqued to proper levels.

Vent and Drain Piping

- _____ Check all drain and vent lines for obstructions.
- _____ Check that all drain and vent lines terminate away from platforms and walkways.

Safety Valves

- _____ Check for blockage on the outlet.
- _____ Check that all vent pipe supports have been installed in accordance with recommendations.
- _____ Verify all valves for manufacturer's settings (set pressures are shown on valve tag).

Others

- _____ Check proper alignment on all ducting and expansion joints.
- _____ Check that all temporary shipping supports and temporary bolting have been removed. Normally these items are painted with yellow or red paint.
- _____ Remove any structural timber from gas passages.
- _____ If provided, check that all temporary shipping gaskets and manways have been properly removed. The temporary gaskets allow internal inspections of the equipment prior to operation.
- _____ Check that all normal service gaskets, for the manways, handholes, ducts, and pipe flanges, have been installed and have been properly torqued.

Final Preparation for Service

When the inspection is completed and all problems have been corrected, then the system can be subjected to its final testing before pre-commissioning and start-up.

Hydrostatic Testing

The equipment has been hydrostatically tested in accordance with ASME Code requirements in the factory, and copies of the Manufacturers' Data Report, signed by the Authorized Inspector witnessing and evidencing the test has been forwarded to all jurisdictional bodies. A copy is also included in this manual.

System Contamination

Water piping systems connected to the unit may contain oil, grease or foreign matter. In new systems, the piping usually has an accumulation of oil, grease and dirt. Old systems have an additional hazard in that the piping and receivers may be heavily limed and full of scale as the result of improper water treatment. These impurities must be prevented from entering the unit.

If oil, dirt and scale accumulations are permitted to get into the economizer system, it may be necessary to repeat the initial cleaning procedure. The waterside of the pressure vessel must be kept clean from grease, sludge and foreign material. Such deposits, if present, will not only shorten the life of the pressure vessel and interfere with efficient operation and functioning of control or safety devices, but might possibly cause unnecessary and expensive re-work, repairs and down time. The waterside should be inspected on a periodic basis, which will serve as a check against conditions indicated by chemical analysis of the feedwater. Inspection should be made three months after initial starting and at regular 6, 9 or 12 month intervals thereafter. The frequency of further periodic inspections will depend upon the internal conditions found.

Water Treatment Considerations

For prolonged equipment life, a water treatment program recommended by a water consultant is a must.¹ Economizer systems are sensitive to even minor deposits on tube walls. Therefore, most feedwater treatment programs are oriented toward scale control. However, internal corrosion control cannot be ignored. Scale with locally high caustic concentrations can develop on metal components, strip away the protective magnetite film, and attack the base metal. This attack is characterized by gouging of the metal and its severity is directly proportional to increasing operating pressures.

Oxygen is highly corrosive when dissolved in water, and can result in corrosion pitting of heat transfer surfaces. Mechanical deaeration of the feed water using a deaerator is the typical first step in eliminating dissolved oxygen and other corrosive gases such as ammonia and carbon dioxide. Mechanical deaeration will reduce oxygen to as low as 0.005 cc/liter.

In most boiler systems in the capacity range that will install a HeatSponge, the oxygen scavenging chemical is fed continuously, preferably at the storage compartment of deaerator or at suction of boiler feed pump, to provide turbulence and time for mixing. Specification of chemicals and dosages should be in accordance with the recommendations of the Owner's water consultant.

Improper and nonexistent feedwater treatment is the major factor causing economizer failure, which ultimately results in down time and costly repairs. All fresh water available from natural sources requires varying degrees of treatment prior to use. The impurities in fresh water are many and each required special attention. Solids in the form of minerals, chemicals, and organic material are all found in so-called fresh water and all have a different effect on the internal surfaces of an economizer.

¹ Boilerroom Equipment, Inc. cannot enumerate specific treatments, this must be delineated by a specialist in the water treatment field, after an analysis is made of the local make-up water chemistry and the evaluation of plant external pretreatment systems.

Feedwater treatment by a competent water treating company will result in prevention of scale and deposits, removal of dissolved gases (free oxygen), protection against corrosion, elimination of carry-over of water with steam, maximum efficiency, and maintenance savings. It is imperative that you contact a company specializing in feedwater treatment and obtain their recommendation and service.

Units supplied with 300 series stainless steel tubes are potentially subject to failure from chloride corrosions stress cracking. Your water treatment service company should insure chlorides are within acceptable levels.

Failure to heed the above warning will cause excessive damage to the economizer. The warranty does not cover this type of maintenance. This is the Owner's responsibility.

Suggested Start-Up

It must be recognized that all equipment requires operator attention during start up. Special care must be exercised in the manipulation of feed water and fuel systems to protect against damaging the unit and to insure personnel safety.

The unit should be slowly filled with properly treated feedwater. The filling rate depends on the temperature of the feedwater. The feedwater should be as close as possible to the metal temperature to prevent excessive temperature stresses that could cause tube leakage. The minimum recommended feedwater temperature is 70°F. Fill slowly from the bottom of the unit and vent fully to allow air to escape from the system.

Suggested Shut-Down

When the unit is taken out of service, good care of the economizer during the idle periods is mandatory to prevent unnecessary corrosion damage. When the pressure has dropped sufficiently, open the vent valve to prevent a vacuum from forming within the economizer.

To insure that the safety valves are maintained in good working order it is recommended that the valves be inspected by a local representative or a qualified valve service technician.

Standby Protection

Many units used for heating or seasonal loads or for standby service may have extended periods of non-use. Special attention must be given to these, so that neither water side nor fire side surfaces are allowed to deteriorate from corrosion. Corrosion can be more serious during this down time than when the system is actually in service. The key factors responsible for corrosion are water, oxygen and pH. Elimination of either moisture or oxygen will prevent appreciable corrosion. Whenever the economizer is going to be out of service for a length of time, it should be fully drained. This will reduce the likelihood of internal corrosion or damage resulting from freezing.

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Maintenance Requirements

General Maintenance

A well planned maintenance program avoids unnecessary down time or costly repairs. It also promotes safety and aids boiler code and local inspectors. An inspection schedule listing the procedures should be established. It is recommended that a boiler room log or record be maintained, recording daily, weekly, monthly and yearly maintenance activities. This provides a valuable guide and aids in obtaining the availability factor to determine shut-down frequency, economies, length of service, etc.

Good housekeeping helps to maintain a professional boiler room appearance. Only trained and authorized personnel should be permitted to operate, adjust, or repair the equipment. The boiler room should be kept free of all material and equipment not necessary for operation of the system.

Alertness in recognizing unusual noises, improper gauge readings, leaks, signs of over-heating, etc., can make the operator aware of a developing malfunction and initiate prompt corrective action that may prevent excessive repairs or unexpected down time. All piping connections to the system and it's accessories must be maintained leak-proof because even a minor leak, if neglected, may soon become serious. If serious leaks occur, shut down the unit immediately and gradually reduce pressure. Do not attempt to make repairs while the system is under pressure.

Shift Maintenance

Monitor water chemistry to adjust the chemical feed treatment as required, to remain within water treatment guidelines established by the Owner's water treatment consultant.

Daily Maintenance

Maintain a daily schedule of sootblowing (if provided).

Monthly Maintenance

Follow the recommendations of your Authorized Inspector pertaining to safety valve inspection and testing. The frequency of testing and inspection of the SRV should be based on the recommendation of your Authorized Inspector. Test the safety valves in accordance with manufacturer's instructions to be absolutely sure that the valves have not corroded shut. Failure of the relief valves in an overpressure situation is **DISASTROUS!**

Annual Maintenance

Have the unit inspected and checked by an BEI service representative. If there is no representative in your area, contact the factory for assistance and direction.

Annual Inspection

Insurance regulations or local laws will require a periodic inspection of the pressure vessel by an Authorized Inspector. Sufficient notice is generally given to permit removal of the economizer from service and preparation for inspection. This major inspection can often be used to accomplish maintenance, replacements, or repairs that cannot easily be done at other times. This also serves as a good basis for establishing a schedule for annual, monthly or other periodic maintenance programs.

Fireside inspection and maintenance is easily accomplished by removing the rear access door. It is important that a new gasket be installed on the door when it is replaced. Any build up found inside of the unit can typically be rinsed with water or pressure washed. Be sure not to flow too much water as to overwhelm the water trap assembly at the bottom of the unit.

While this inspection pertains primarily to the waterside and fireside surfaces of the pressure vessel, it provides the operator an excellent opportunity for detailed inspection and check of all components of the system including piping, valves, gaskets², insulation, etc. Comprehensive cleaning, spot painting or re-painting and the replacement of expendable items should be planned for and taken care of during this time. Any major repairs or replacements that may be required should also, if possible, be coordinated with this period of shutdown. Replacement spare parts, if not on hand, should be ordered sufficiently prior to this shutdown.

Have available information on the economizer design, dimensions, generating capacity, operating pressure, time in service, defects found previously, and any repairs or modifications. Also have available for reference records of previous inspections. Be prepared to perform any testing required by the inspector including hydrostatic testing of the equipment.

Tube Element Replacement

Perhaps the single most important feature of the HeatSponge unit is the ability to replace individual finned tube elements without the need to performance any welding. Should a unit experience a failed tube the single tube can be isolated and taken out of service. This will allow the other elements to continue to recover energy until a convenient time to shut the boiler down for service. The operator should insure that the boiler is not starved of water as removing tubes from service will increase the water side pressure drop across the unit. Too many tubes removed from service could excessively restrict water flow to the boiler.

Diagnosing a failed tube element will typically be accomplished by unusual amounts of water exiting the water trap and draining from the unit. A reduction in water pressure to the end source can also indicate a system leak.

The procedure to replace or bypass failed tubes is provided on the following page.

²

Nominal leakage of manway and handhole gaskets may be observed during start-up until sufficient operational pressure is attained. Do not over tighten the gaskets!

The procedure for isolating or replacing a failed element is as follows:

1. Shut off boiler and insure that there is no potential source of fumes or gases from other boilers that could utilize a common duct.
2. Allow the unit to cool to a safe temperature
3. Remove the rear access panel providing access to the entire unit internals
4. Identify the failed tube
5. Break the compression fitting for the appropriate tube and slide it out. It may be required to cut the tube if the ferrules are fused onto the tubes.
6. Remove the tube element.
 - a. If bypassing only !
 - i. Install caps on the compression exposed compression fittings
 - b. If a replacement element is available
 - i. Install the new tube where the failed tube was located
 - ii. Install new ferrules on the compression fitting and tighten
7. The compression fittings should be firmly tightened to set the ferrule. Do not over tighten the fitting as it may result in damage or an inability to provide proper sealing. If in doubt contact a BEI service representative.
8. Replace the rear door with gaskets
9. Restart boiler and insure additional water pressure loss does not impact the safe operation of the boiler.
10. Once new tube is in place perform a hydrotest of the system
11. Check for any water or gas leaks

Spare Parts Inventory

The economizer system itself has NO moving parts. Therefore, parts inventory is almost non-existent. Most installations will want to maintain at least one spare tube element and two compression fittings. Spare gaskets for the rear access openings and header connections should be kept available. BEI can provide these as required.

Ordering Replacement Parts

How ?

When ordering parts for your economizer, be sure to include on your order the unit serial number. Your order should state the BEI job number and the name and description of the part required. Be sure to indicate what material is required.

Where ?

Repair or replacement parts should be ordered from your local representative. If you do not have a representative in your territory then please e-mail your requirements to sales@heatsponge.com

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