EASCO Series FST, ESP, SM4, SM5, PLW 3-Pass and Series FPS 4-Pass Water-backed Steel Horizontal Firetube Boilers

Manufactured in Accordance to Current Approved Edition of the ASME Boiler and Pressure Vessel Code Section IV 'Rules for the Construction of Heating Boilers'

Installation, Operation and Maintenance Manual

PREFACE AND STATEMENTS

EASCO Boiler Corp. (EASCO) is committed to providing equipment of lasting quality and value to each of its many customers. It is our goal that every piece of EASCO equipment (Equipment) purchased provides the same reliable operating excellence that was built into it by skilled craftsmen at our EASCO factory (Factory).

The following Installation, Operation and Maintenance Manual (Manual) is designed to help you properly install, operate and care for your Equipment. We recommend that you read the Manual through to familiarize yourself with its contents before installing and operating your Equipment.

Due to a wide variety of ever-changing state and local codes, the Manual contains information designed to show how a basic unit operates. The operation of all Equipment must comply with all applicable regulations and codes by any authorities having jurisdiction. The legal requirements take precedence over anything contained herein. At EASCO, engineering research and development toward product improvements are a continuing process; therefore, the specific information in this book may be subject to change without notice.

Every EASCO boiler (Boiler) has been designed and manufactured to produce a long lifetime of dependable efficient service. All components of Equipment were chosen for their ability to enhance this design goal. Although these components provide high degree of protection and safety during normal operating conditions, we highly advise that you pay close attention to any Notes, Cautions and Warnings and maintain an awareness of the Hazards and Dangers inherent in careful handling of Equipment.

In our many years in business, we have found that two things alone greatly impact the dependable operation and long life of our Equipment:

- operator responsibility and knowledge
- consistent preventive maintenance

Operator Responsibility

It is the operator's responsibility to provide the daily care and attention required to properly maintaining your EASCO boiler room equipment. This Manual is intended to act as a guide and reference source for those operations, but it cannot replace the keen eye and experienced touch of a trained boiler room operator. It is recommended that a boiler room log be maintained to record daily, weekly, monthly and yearly activities as well as any unusual occurrences.

Consistent Preventive Maintenance

Regular effective maintenance is the best way to obtain the most efficient operation of your EASCO boiler room equipment. We have found that the life and efficiency of Equipment are dependent upon the consistency of care it receives. Often efficient operation is a matter of keeping the Boiler clean and the firing equipment property regulated. With proper installation, regular care and the use of genuine EASCO renewal parts, your quality EASCO equipment will last indefinitely.

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IMPORTANT INFORMATION

This Installation, Operation and Maintenance Manual (Manual) has been prepared for the purpose of assisting design, installation, operating, maintenance, and service personnel. The information contained herein is therefore general, in order to adequately address most, if not all, design specification requirements, Federal, State and Local Jurisdictional, Utility and Insurance underwriter requirements and applicable Codes and Standards of the most current approved and/or accepted Editions. It is of utmost importance and concern that all personnel responsible for the proper and safe design, handling, installation, commissioning, operation, care and continued maintenance of this Equipment are thoroughly familiar with the Equipment, system application and ancillary support systems, accompanying installation, operation and maintenance manuals and procedures (Manuals and Procedures), provided with the Boiler. Please read this Manual to become thoroughly familiar, and knowledgeable, prior to engaging in such activities.

WARNING!! Improper design, handling, installation, commissioning, operation, care, maintenance and service of the Equipment, and ancillary support systems, can create a potential hazard to equipment, operating personnel and building occupants resulting in serious equipment and/or property damage, personal injury and/or death. Boilers, fuel burning and handling equipment, components, ancillary device and equipments must be maintained and operated only by competent and qualified operating and service personnel, who are fully trained, and thoroughly familiar, with same equipment, system application and ancillary support systems, and accompanying Manuals and Procedures, provided with the Equipment.

WARNING!! Do NOT attempt restart of the Equipment unless the failure, or manual reset, condition that occurred is thoroughly investigated and the cause of it identified, and fully corrected, prior to restart. Service to Boilers, fuel burning and handling equipment, components, ancillary device and equipment, must be performed only by competent and qualified service personnel.

1. This Boiler has a Limited Warranty.

2. Prior to installation of this Equipment, this Manual shall be read and thoroughly understood by those responsible for such installation requirements. Maintain a copy of the Manual, at or about the Equipment, for ready reference by personnel responsible for the proper and safe design, handling, installation, commissioning, operation, care continued maintenance of the Equipment.

3. All heating systems should be designed by an experienced and competent Licensed Design Professional Engineer, and further, should be installed by a competent, qualified and, where mandated by Local Jurisdiction, Licensed Mechanical, Heating and/or HVAC Contractor to assure the proper and safe design, handling, installation, commissioning, operation, care and continued maintenance of the Equipment. Servicing of this Equipment should only be undertaken by competent and qualified service personnel who are, regularly engaged in such services, fully trained, and thoroughly familiar, with the same equipment, system application, ancillary support systems, and accompanying Manuals and Procedures, provided with the Equipment to assure the proper and safe commissioning, operation, care and continued maintenance of the Equipment.

When applicable, competent, qualified and/or, where mandated by Local Jurisdiction, Licensed Electrical and/or Plumbing Contractors and Water Quality Service Providers may be required to perform such installation and/or service procedures, as deemed necessary, to assure the proper and safe installation, commissioning, operation, care and continued maintenance of the Equipment.

4. Operation, care and continued maintenance of this Equipment should only be undertaken by competent, qualified and, where mandated by Local Jurisdiction, Licensed Operating Personnel who are, regularly engaged in such services, fully trained, and thoroughly familiar, with same equipment, system application, ancillary support systems, and accompanying Manuals and Procedures, provided with the Equipment to assure the proper and safe commissioning, operation, care and continued maintenance of the Equipment. When applicable, competent, qualified and/or, where mandated by Local Jurisdiction, licensed Mechanical, Heating, HVAC, Electrical, Plumbing, Authorized Repair Contractors and Water Quality Service Providers, may be required to perform such care services and/or maintenance procedures, as deemed necessary, to assure the proper and safe commissioning, operation, care and continued maintenance of the Equipment.

5. This Equipment must be installed in accordance with any, and all, applicable Codes and Standards of the most current approved and/or accepted Editions, governing the design, handling, installation, commissioning, operation, care and continued maintenance of such equipment including those Codes and Standards and Specification requirements which are mandated by Local Jurisdictions, and/or Utilities, having authority. Local Jurisdictions, and/or Utilities, having authority should be consulted prior to installation to assure applicable Codes and Standards compliance. Furthermore, those Manuals and Procedures, as published by manufacturers of any and all component parts of this Equipment, must be adhered to assure the proper and safe design, handling, installation, commissioning, operation, care and continued maintenance of the Equipment and component parts.

   Reference should be made, however shall not be limited in scope, to the following Codes, Standards and Guidelines of the most current approved and/or accepted Editions , where applicable, of, for the proper and safe design, handling, installation, commissioning, operation, care and continued maintenance of the Equipment:

   - ASME B&PV Code Section I: *Rules for Construction of Power Boilers*
   - ASME B&PV Code Section IV: *Rules for Construction of Heating Boilers*
   - ASME B&PV Code Section VI: *Recommended Rules for the Care and Operation of Heating Boilers*
   - ASME B&PV Code Section VII: *Recommended Guidelines for the Care of Power Boilers*
   - ASME CSD-1: *Controls and Safety Devices for Automatically Fired Boilers*
   - NFPA 70: *National Electrical Code*
   - NFPA 31: *Installation of Oil Burning Equipment*
   - NFPA 54: *National Fuel Gas Code*
   - NFPA 211: *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances*
   - UL 795: *Standard for Commercial Industrial Gas Handling Equipment*
   - UL 726: *Standard for Oil Fired Boiler Assemblies*

- UL 2096: *Standard for Heating Assemblies with Emissions Reduction Equipment*
- UL 2106: *Field Erected Boiler Assemblies*
- UL 296: *Standard for Oil Burners*
- UL 1738: *Venting Systems for Gas Burning Appliances*
- ANSI Z21.13: *Gas Fired Low Pressure Steam and Hot Water Boilers*
- ASHRAE 90.1: *Energy Standard for Buildings Except Low-Rise Residential Buildings*
- ABMA: *Combustion Control Guidelines for Single Burner Firetube and Watertube Industrial/Commercial/Institutional Boilers*
- ABMA: *Guideline for the Integration of Boilers and Automated Control Systems in Heating Applications*
- ABMA: *Boiler Water Requirements and Associated Steam Purity for Commercial Boilers*
- NFPA 211m: *Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances*
- GAMA-HI: *Operation and Maintenance Manual for Steel Boilers (Including Water Treatment)*
- Applicable Federal, State and Local Jurisdictional, and/or Utility, Specifications and Requirements

6. All Equipment component part cover plates, enclosures, guards, service access ports, doors, and service connections and discharges shall remain in place at all times, except during, and as required to perform emergency or periodic inspection, service and/or maintenance procedure.

7. Any and all combustible materials such as rags, paper, wood, paint or other debris shall be kept clear of boiler room environs. Boiler room shall be kept clean and free of fire hazards.

8. Safety Precautionary Notes, Cautions and Warnings: Throughout this Manual the following Precautionary Notations will appear to advise of considerations, procedures and circumstances which could, if not heeded, lead to the improper and unsafe design, handling, installation, commissioning, operation, care and maintenance of the Equipment, thus possibly causing serious equipment and/or property damage, personal injury and/or death.

NOTE: This safety precaution provides information, which is deemed necessary to assure proper and safe design, handling, installation, commissioning, operation, care and continued maintenance of the Equipment and component parts.

CAUTION! This safety precaution provides information regarding a potentially hazardous situation or condition which, if not averted, could result in improper operation and/or serious equipment and/or property damage.

WARNING!! This safety precaution provides information regarding a potentially hazardous situation or condition which, if not averted, could result in serious equipment and/or property damage, personal injury and/or death.

DANGER!!! This safety precaution provides information regarding a hazardous situation or condition, which, if referenced procedure or standard is not precisely followed, could result in serious equipment and/or property damage, personal injury and/or death.

9. Abbreviations and Symbols:

A) Technical:

- **AI** Authorized Inspector
- **B&PV** Boiler and Pressure Vessel
- **BHP** Boiler Horsepower
- **BTU** British Thermal Unit
- **BTUH** British Thermal Unit per Hour
- **CFM** Cubic Feet per Minute
- **°F** Degrees Fahrenheit
- **FEB** Field Erect Boiler
- **GPM** Gallons Per Minute
- **HP** Horsepower
- **in** Inches
- **lb(s)** Pound(s)
- **LPWL** Lowest Permissible Water Level
- **LWCO** Low Water Cut-Off
- **MAWP** Maximum Allowable Work Pressure
- **MAWT** Maximum Allowable Work Temperature
- **MB** Master Bill
- **MBH** Thousands of BTUH
- **MDR** Manufacturer's Data Report, ASME
- **NWL** Normal Water Level
- **PBA** Packaged Boiler Assembly
- **PPM** Parts per Million
- **PSI** Pounds per Square Inch
- **PSIG** Pounds per Square Inch Gage
- **QCM** Quality Control Manager

B) Institutions, Organizations, Insurance and Jurisdictions:

- **ABMA** American Boiler Manufacturers Association
- **ANSI** American National Standards Association
- **ASHRAE** American Society of Heating Refrigeration Air-conditioning Engineers
- **ASME** American Society of Mechanical Engineers
- **EPA** Environmental Protection Agency
- **FM** Factory Mutual
- **GAMA-HI** Gas Appliance Manufacturers Association-Hydronics Institute
- **IRI** Industrial Risk Insurance
- **NFPA** National Fire Protection Association
- **NB(BPVI)** National Board (of Boiler and Pressure Vessel Inspectors)
- **UL** Underwriters Laboratories

SECTION 1: GENERAL

1.1 Introduction

EASCO Series FST, ESP, SM4 Scotch-Marine, Series SM5 Modified-Scotch-Marine, Series PLW Firebox and Series FPS Scotch-Marine boilers are 3-Pass and 4-Pass (only Series FPS), respectively, Water-backed Steel, Horizontal Firetube boilers built in accordance with ASME B&PV Code Section IV *Rules for The Construction of Heating Boilers*. Specifically designed for forced draft firing utilizing fuel burning equipment capable of firing commercial standard light and heavy fuel oils, natural gas, or combination gas/oil fuel burning apparatus, these Boilers are available for low pressure steam (LPS 15 PSIG MAWP) and hot water (HW 160 PSIG MAWP / 250 °F MAWT) applications providing thermal or combustion efficiencies that meet, or exceed, the minimum efficiency criteria and requirements of ASHRAE Standard 90.1 *Energy Standard for Buildings Except Low-Rise Residential Buildings (I-P Edition).*

This Manual provides the required information necessary to successfully and properly install, commission, operate, maintain and service the Boiler Equipment.

1.2 Specification Requirements and Approvals

EASCO Packaged Boiler Assemblies (PBA) are available to meet with any specific requirement and applicable standard such as ASME CSD-1, Factory Mutual (FM), Industrial Risk Insurers (IRI), Underwriters Laboratories (UL) and specific Federal, State, Local Municipality, Local Jurisdictional Authority and/or Utility requirements, Codes and Standards.

As indicated above, all EASCO products, covered by this Manual, are manufactured in accordance with ASME B&PV Code Section IV. All vessels are inspected by an independent, third party, Authorized Inspector (AI), commissioned by The National Board of Boiler and Pressure Vessel Inspectors (NBBPVI). The AI is an employee of an Independent Authorized Inspection Agency, an insurance company who underwrites EASCO's insurance policy.

SECTION 2: REQUIREMENTS

2.1 Installation and Service Qualification

Equipment to be installed, which is covered by this Manual, should be designed for installation by an experienced and competent Licensed Design Professional Engineer, and further, should be installed by a competent, qualified and, where mandated by Local Jurisdiction, Licensed Mechanical, Heating and/or HVAC Contractor to assure the proper and safe design, handling, installation, commissioning, operation, care and continued maintenance of the Equipment.

Servicing of this Equipment should only be undertaken by competent and qualified service personnel who are, regularly engaged in such services, fully trained, and thoroughly familiar with same equipment, system application, ancillary support systems, and accompanying Installation, Operation and Maintenance Manuals, and Procedures, provided with the Equipment to assure the proper and safe commissioning, operation, care and continued maintenance of the Equipment.

When applicable, competent, qualified and/or, where mandated by Local Jurisdiction, Licensed Electrical and/or Plumbing Contractors and Water Quality Service Providers may be required to perform such installation and/or service procedures, as deemed necessary, to assure the proper and safe installation, commissioning, operation, care and continued maintenance of the Equipment.

2.2 Operation, Care and Continued Maintenance Qualification

Operation, care and continued maintenance of this Equipment should only be undertaken by competent, qualified and, where mandated by Local Jurisdiction, Licensed Operating Personnel who are, regularly engaged in such services. They should be fully trained, and thoroughly familiar with same equipment, system application, ancillary support systems, and accompanying Installation, Operation and Maintenance Manuals, and Procedures, provided with the Equipment to assure the proper and safe commissioning, operation, care and continued maintenance of the Equipment.

When applicable, competent, qualified and/or, where mandated by Local Jurisdiction, Licensed Mechanical, Heating, HVAC, Electrical, Plumbing, Authorized Repair Contractors and Water Quality Service Providers, may be required to perform such services and/or maintenance procedures, as deemed necessary.

2.3 Codes, Standards, Local Jurisdictions and Utilities

This Equipment must be installed in accordance with any, and all, applicable Codes and Standards of most current approved and/or accepted Editions, governing the design, handling, installation, commissioning, operation, care and continued maintenance of such equipment including those Codes and Standards and Specification requirements which are mandated by Local Jurisdictions, and/or Utilities, having authority.

Local Jurisdictions, and/or Utilities, having authority should be consulted prior to installation to assure applicable Codes and Standards compliance.

Furthermore, Installation, Operation and Maintenance Manuals, and Procedures, as published by Manufacturers of any and all component part of this Equipment, must be adhered to assure the proper and safe design, handling, installation, commissioning, operation, care and continued maintenance of the Equipment and component parts.

2.4 Warranty

This Boiler has a Limited Warranty, a copy of which is included within this Manual. Please read the same to become familiar with and knowledgeable about additional requirements.

SECTION 3: IDENTIFICATION AND CONFIGURATION

3.1 Manufacturer's Data Plate

Each Boiler has a Manufacturer's Data Plate or Name Plate, similar to the following, attached to the access door of its front flue gas reversing assembly, This Name Plate OR Data Plate includes information regarding the Manufacturer, manufacturer's series/model number, heating surface area, gross input and output, MAWP, NB number (as required), and the year built.

Easco Boiler Corp.
Mfg By: A.L. Eastmond & Sons Inc.
1175 Leggett Ave., Bronx, N.Y. 10474

Model:	Nat'l BD No __
Heating Surface __FS __ WS	Serial No: __
Input __ MBH __ GPH	Steam Sq. Ft. __
Gross __ MBH __ HP	Net MBH __

Maximum Working Pressure Date __

__Lbs. Steam __Lbs. Water

See Figure 1 in Section 4 of this Manual for image of a sample Data Plate.

3.2 ASME Name Plate

Each Boiler has an ASME Name Plate or Stamp Plate, attached to the front of a Scotch Marine vessel shell at about 15° and to the front tube sheet of a Firebox Vessel at about 90°. This Stamp Plate includes information, explicitly 'Certified By' the Manufacturer, regarding MAWP and MAWT, heating surface area, minimum relief valve capacity, Manufacturer's serial number, the year built, and an applicable official Code symbol or Stamp authorized by ASME.

Nat'l BD No.
Certified By
A.L. Eastmond & Sons Inc.
Max WP steam __ psi
Water __psi
Max Water Temp __ F
Heating Surface __ SqFt
Min Relief Valve Cap __ Lb/Hr or MBH
Mfgrs Serial No ___
Year Built ____

See Figure 2 in Section 4 of this Manual for image of a sample Stamp Plate.

3.3 Manufacturer's Data Report

Upon completion of manufacture and inspection by AI, all Boilers are issued a Manufacturer's Data Report (MDR). The MDR, signed by the Quality Control Manager (QCM) of the Manufacturer and certified by the AI, includes information such as Manufacturer's serial number, customer and project installation address, materials and components used in Code construction, together with the Manufacturer's Certification of Authorization Number and AI's Certificate of Inspection Number. The purchaser of the Equipment will be issued a copy of MDR upon EASCO Credit Departments' determination of satisfactory account status. Boilers, which are assigned an

NB Number, when required by the Local Jurisdiction having authority, will have an original MDR filed with The NBBPVI, Columbus, Ohio 43229. A copy of the MDR, along with Installation, Operation and Maintenance Manual for the Equipment, should always be maintained for inspection and/or review by Local Jurisdiction, or Authorized Repair Contractor, as necessary.

3.4 Configurations

EASCO offers three types of 3-pass steel horizontal firetube boiler configurations, i.e., Scotch Marine (Series FST, ESP, and SM4), Modified Scotch Marine (Series SM5) and Firebox (Series PLW), and a 4-pass Scotch Marine (Series FPS) configuration, too.

The 3-pass Scotch Marine configuration comprises a cylindrical furnace or combustion chamber and a reversing chamber of a segmental cross-section, completely submerged within water contained in the vessel shell, whereby flue gases are reversed into the second-pass fire tubes towards the front of the boiler. The flue gases are once again reversed from the front flue gas reversing assembly into the third-pass fire tubes and accommodated through to the rear flue gas exit assembly whereby Contractor provided breeching connection is accommodated to safely discharge the products of combustion. The firetubes used are 2-1/2-in boiler tubes.

The 3-pass Modified Scotch Marine configuration has a small-diameter cylindrical furnace or combustion chamber and a narrow-width reversing chamber, also completely submerged within water contained in the vessel shell, a therefore narrow-width firetube layout pattern, an relatively extended vessel length to compensate the small-diameter furnace, and similar flue gas passes, in order to fit through a standard 36-in wide doorway without knocking down wall. The firetubes used are 2-in boiler tubes.

The Firebox Boilers' basis in design is much like that of the Scotch Marine. However, in lieu of a completely submerged furnace, or combustion chamber, the combustion chamber walls and that of the outside shell are flat, thus requiring considerable 'stays' to resist the exertion of internal pressure upon the combustion chamber and shell walls. Furthermore, the firebox floor, being non-water cooled, is refractory lined thus no heat transfer mechanism is provided for. Both the front combustion chamber and rear-reversing chamber are water backed. The firetubes used are 3-in boiler tubes.

The 4-pass Scotch Marine configuration, differing from the 3-pass, comprises a furnace or combustion chamber and a reversing chamber, both fully cylindrical and completely submerged within the water contained in the vessel shell, whereby flue gases are reversed into the second-pass fire tubes towards the front of the boiler. The flue gases are then reversed from the lower chamber of the divided front flue gas reversing assembly into the third-pass fire tubes towards the rear of the boiler. The flue gases are then, once again, reversed at rear flue gas reversing assembly into the fourth-pass fire tubes towards the front of the boiler and, this time, into the upper chamber of the divided front flue gas reversing assembly, and finally accommodated through gas exit assembly whereby Contractor provided breeching connection is accommodated to safely discharge the products of combustion. The firetubes used are 2-1/2-in boiler tubes.

SECTION 4: INSTALLATION INSTRUCTIONS

4.1 Inspection of Equipment Shipment

4.1.1 Equipment is carefully manufactured, inspected and packaged, for delivery to Purchaser/Consignee via an independent transportation carrier/agent.

4.1.2 Carefully inspect and check the Equipment together with containers, pallets, boxes and/or crates for any signs of external and internal damage, general abuse or shortages, immediately upon receipt.

4.1.3 Protective enclosures including Equipment wrap, containers, pallets, boxes and/or crates, together with component part cover plates, enclosures, guards, service access ports, doors, service connections and discharges may require temporary removal, opening and/or general access to perform such inspections, as necessary, to assure Equipment integrity upon receipt. Immediately secure any and all wrap, containers, pallets, boxes and/or crates and replace any and all cover plates, enclosures, guards, service access ports, doors, service connections and discharges protective devices, once inspected, until ready for final placement and installation.

4.1.4 Purchaser/Consignee must note any and all signs of external and internal damage, general abuse or shortages on the Bill of Lading Receipt, provided for signature, by the transportation carrier/agent of this eat time of delivery, regardless of any dispute, which may ensue with transportation carrier/agent, regarding Equipment condition or shortage.

4.1.5 Equipment is shipped Freight on Board (FOB). This indicates EASCO's responsibility for providing Equipment, as indicated on Bill of Lading and/or Delivery Receipt, in good condition, free of external and internal damage, general abuse or shortage, ceases with the transportation carrier/agent receipt of Equipment at the factory.

4.1.6 Should any external and internal damage, general abuse or shortage is noted and subsequent claim for replacement or repair is sought, it is the Purchaser/Consignee responsibility to make such claim directly against transportation carrier/agent. Any and all replacement or repair authorizations by Purchaser/Consignee to EASCO shall be done so as an added cost. These costs may be applied to any claim against the transportation carrier/agent, which the Purchaser/Consignee may institute.

4.1.7 The Purchaser/Consignee must file claims, for any external and internal damage, general abuse or shortage, within seven (7) days upon receipt, against the transportation carrier/agent.

4.1.8 Claims for variances from Purchase will not be allowed by EASCO unless presented in writing within thirty (30) days after receipt of Equipment.

4.1.9 Freight costs are categorized as Full Freight Allowed (FFA) indicating freight costs are borne by EASCO, Collect (COL) whereby the Purchaser/Consignee shall pay transportation carrier/agent at time of receipt, or Pre-Paid and Charge (PPC) indicating EASCO payment of freight costs and charge of same, along with administrative charges, to Purchaser/Consignee. Unless specifically directed by Purchaser/Consignee, the transportation carrier/agent shall be contracted by EASCO, at its sole discretion. Mode of transportation, unless specifically directed by Purchaser/Consignee at time of purchase, shall be at the discretion of the transportation carrier/agent.

4.2 Placement Setting of Equipment

4.2.1 All EASCO Factory Packaged Boiler Assemblies (PBA) are equipped with Rigging Lifting Lugs to accommodate rigging maneuvers for final Equipment placement. Extreme care and caution is to be adhered to, during this procedure, and in preparation of Project site for general safety, access, shoring and security, as required. Rigging procedures shall be accomplished only by competent, qualified and, where mandated by Local Jurisdiction, a Licensed Master Rigger Contractor, to assure the proper and safe handling, placement and installation of Equipment.

4.2.2 When necessary, it is recommended that Equipment be rolled into position using rigger 'skates'. Use of pipe, as rollers, is not recommended as the weight of Equipment, on pipe, may cause deflection of skid rails, or service platform when provided, if ample numbers of 'pipe rollers' are not utilized to uniformly distribute weight. Skid rails shall not be utilized and altered, in any manner, to accommodate a safety, hold back and/or steering line.

4.2.3 Equipment shall be so located as to provide for proper venting and adequate clearances, and means, for general access, inspection, maintenance, serviceability and installation of field piping and electrical connections. Minimum tube pull clearances must be adhered to in order to facilitate future replacement, as required.

4.2.4 This Equipment is designed only for use on noncombustible flooring. Floor construction shall be a level setting and have load-bearing characteristics to support operating weight of Equipment. A foundation, or housekeeping pad, properly designed by an experienced and competent Licensed Design Professional Engineer, is recommended, particularly for existing flooring construction, which may be structurally inadequate, not level and/or subject to periodic water flooding, and/or seepage, conditions.

4.2.5 Clearances at, and about, this Equipment, shall be provided for in accordance with the most current accepted editions of any, and all, applicable Codes and Standards governing the design, handling, installation, commissioning, operation, care and continued maintenance of such equipment including those Codes and Standards, and Specification requirements, which are mandated by Local Jurisdictions, and/or Utilities, having authority. Provide for Minimum

Clearances of 18-in at top, sides, rear and flue gas breeching venting and 48-in from front of Equipment. Local Jurisdictions, and/or Utilities, having authority, should be consulted prior to installation to assure applicable Codes and Standards compliance.

4.3 Flue Gas Venting Requirements

4.3.1 Venting systems shall be provided for in accordance with the most current accepted editions of any, and all, applicable Codes and Standards governing the design, handling, installation, commissioning, operation, care and continued maintenance of such systems including those Codes and Standards, and Specification requirements, which are mandated by Local Jurisdictions, and/or Utilities, having authority. Local Jurisdictions, and/or Utilities, having authority, should be consulted prior to installation to assure applicable Codes and Standards compliance.

4.3.2 Venting systems, incorporating flue gas exit breeching and chimney systems, shall be properly designed by an experienced, and competent, Licensed Design Professional Engineer.

4.3.3 This Equipment is factory sealed to accommodate pressurized firing and specifically designed for forced draft fuel burning firing equipment. A standard breeching slip connect locking quadrant butterfly flue gas outlet damper is provided to assist adjustment and setting for proper combustion characteristics. Optional opposed multi-blade dampers, for use with a sequence draft control system, are available, for use on multiple boiler installations utilizing common breeching and/or where breeching and chimney natural draft effect may inhibit adjustment and setting of proper combustion characteristics.

4.3.4 Flue gases shall be directed towards main chimney by a natural draft breeching, or stub vent system. It is recommended that flue gas venting be accommodated through a natural draft breeching system in order to prevent positive pressurization of breeching and chimney systems during normal operation. Breeching and chimney systems shall be designed, installed and maintained in a manner as to prevent any source of leakage, or directive path of flue gases, into, or about, any and all environments, which may be occupied. Use extreme care in placement of fresh air intake louvers, vents or mechanical ventilators so as to assure flue gas venting directive path is free and clear of fresh air intakes in order to prevent introduction of vented flue gases into, or about, any and all environments, which may be occupied.

4.4 Combustion and Ventilation Air Supply

4.4.1 Combustion and ventilation air supply systems shall be provided for in accordance with the most current accepted Editions of any, and all, applicable Codes and Standards governing the design, handling, installation, commissioning, operation, care and continued maintenance of such systems including those Codes and Standards, and Specification requirements, which are mandated by Local Jurisdictions, and/or Utilities, having authority. Local Jurisdictions, and/or

Utilities, having authority, should be consulted prior to installation to assure applicable Codes and Standards compliance.

4.4.2 Combustion and ventilation air supply systems, shall be properly designed by an experienced, and competent, Licensed Design Professional Engineer.

4.4.3 Adequate combustion and ventilation air supply systems shall be provided to accommodate proper combustion of fuel oil, and/or natural gas, maintenance of ambient temperatures to assure safe and required equipment and component temperature limits and provide comfort levels for operating and maintenance personnel within environment.

4.4.4 Means for introduction of combustion and ventilation air supply shall be provided through permanent unobstructed openings and/or properly designed mechanical ventilation systems incorporating means to provide Equipment shutdown upon system failure.

4.5 Equipment Field Connections

NOTE: Equipment installation must comply with minimum piping requirements to ensure proper, safe and reliable performance. Attention should be given to the construction of the near boiler lead piping and distribution header on steam boilers.

CAUTION! FOR WATER BOILERS: Hot Water Return Temperature must be above 150 °F. The Recommended Temperature Differential, between Hot Water Supply and Return, is 20 °F. Thermal Shock could occur when the Temperature Differential, between Hot Water Supply and Return, approaches 40 °F. Utilization of a Hot Water Supply Blend Pump, to Return connection, controlled by Minimum Water Temperature Aquastat, is recommended to assure above guideline.

CAUTION! Equipment should not be operated at temperature, or pressure, limits, or fuel input turn down ratios, that permit condensation within Firetubes, Front and/or Rear Flue Gas Reversing Assembly and Front or Rear Flue Gas Exit Assembly. During cold start up procedures, condensation will likely occur until Equipment reaches operating temperature limits. If condensation persists, the low temperature, or pressure, limit, or fuel input turn down ratio, control should be adjusted to prevent such occurrence. Cold start cycling should be avoided in order to limit thermal stress cycling of Equipment and reduce condensation, which are likely experienced during such high load demand periods. Use of Minimum Water Temperature and Low Fire Hold Aquastats, in conjunction with Outside Air, or Period Set Back, Controls, will minimize, or prevent, cold start cycling and condensation occurrences.

4.5.1 Electrical, Fuel and Hydraulic systems, shall be properly designed by an experienced, and competent, Licensed Design Professional Engineer.

4.5.2 Attach supplies and returns piping lines and apply plugs and/or bushings in appropriate connections as required. Supply and return piping connections are detailed in submittal package.

4.5.3 All required field wiring systems should be in accordance with applicable requirements of most current and accepted edition of NFPA 70 *National Electrical Code*.

4.5.4 All required field fuel oil piping systems, together with flue gas handling, shall be in accordance with applicable requirements of most current and accepted edition of NFPA 31 *Installation of Oil Burning Equipment.*

4.5.5 All required field fuel gas piping systems, together with flue gas handling, shall be in accordance with applicable requirements of most current accepted edition NFPA 54 *National Fuel Gas Code*.

4.5.6 Combustion air systems shall be in accordance with applicable requirements of most current accepted edition of NFPA 54 *National Fuel Gas Code* and pursuant to requirements as provided for within fuel burning equipment manufacturers operation and maintenance manual.

4.5.7 For hot-water boiler application, a water re-circulation loop is recommended to accommodate reduced system return water temperature fluctuation providing for tempered return water flow through the boiler. The Hot Water Supply Re-circulation Blend Pump to return connection should deliver at a minimum rate of 1/2 GPM/BHP and is controlled by a Minimum Water Temperature Aquastat. The Blend Pump should operate at any time, to assure minimum water temperature, regardless of system load demand.

4.6 Operating Controls and Safety Devices

4.6.1 STANDARD STEAM TRIM – McDonnell & Miller No.157S Float-Type Primary Low Water Cut-Off (LWCO)/Pump Control with Alarm Contacts & Gauge Glass Set & hand operated gage try cocks and No.63-M Float-Type Secondary LWCO with Manual Reset; Honeywell L404F Operating Pressure Control, L4079B High Limit Pressure Control with Manual Reset, L4006A or L4006B Low Fire Hold Aquastat and L91B Modulating Pressure Control; National-Standard Pressure Gauge of 4-1/2-in dial & 0-30 PSIG & ASME accuracy; ASME Safety Valve(s).

4.6.2 STANDARD WATER TRIM – McDonnell & Miller No.63-M (MAWP 50 PSIG), or No.150S (MAWP 150 PSIG), Float-Type LWCO with Manual Reset or PS-850-M Probe-Type LWCO with Manual Reset; Honeywell L4006A Operating Limit Temperature Control Aquastat, L4006E High Limit Temperature Control Aquastat with Manual Reset, L4006A Low Fire Hold Aquastat, L4006A Minimum Water Temperature Control Aquastat recommended and L991A Modulating Temperature Control; Industrial Thermometer of 7-in scale & adjustable angle and National-Standard Pressure Gauge of 4-1/2-inch dial & 0-60 PSIG & ASME accuracy or Combination Pressure/Temperature Gauge of 3-1/2-in dial & 0-75 PSIG & ASME accuracy; Bell & Gossett 250°F Seal In-Line Blend Pump recommended; ASME Safety Relief Valve(s).

4.6.3 ACCESSORIES AND OPTIONAL EQUIPMENT COMPONENTS – EASCO Boiler Corp. manufactures and offers a variety of optional and accessory equipments to meet with system requirements. For additional information, contact EASCO Local Area Representative, or EASCO Boiler Corp., 1175 Leggett Avenue, Bronx, NY 10474, Telephone (718) 378-3000, Fax (718) 378-4560, E-mail webmaster@easco.com or visit us at www.easco.com.

Accessories and optional equipment are available at extra cost, including but not limited to:

- Annunciators,
- Alternate or Optional steam or water pressure or water temperature controls or LWCO,
- Built-in domestic hot water tankless heater coils – for low pressure boilers only,
- Motorized or pneumatic feed valves,
- Bottom blowdown valves and drain valves,
- Feed stop and check valves,
- Furnace and/or sequence draft controls,
- Lead/lag sequencing systems,
- Boiler feed systems.

4.7 Fuel Burning and Handling Equipment

4.7.1 Please refer to burner manufacturer's Installation, Operation and Maintenance Manuals furnished with this Equipment for proper installation, fuel piping, wiring, burner adjustment and service instructions.

4.7.2 EASCO Boiler Corp. offers a variety of Forced Draft Air, or Pressure, Atomizing Fuel Oil and Natural Gas Firing equipment, emissions and operating controls to meet with particular specification, system or jurisdictional requirements. For additional information, contact EASCO Local Area Representative, or EASCO Boiler Corp., 1175 Leggett Avenue, Bronx, NY 10474, Telephone (718) 378-3000, Fax (718) 378-4560, E-mail webmaster@easco.com or visit us at www.easco.com.

4.8 Domestic Hot Water Tankless Heater

DANGER!!! High water temperature increases the risk of burns or scalding injury. Install an automatic mixing valve at the tankless heater outlet to avoid risk of burns or scalding due to excessively hot water at the fixtures. Adjust and maintain the mixing valve in accordance with its manufacturer's instructions.

4.8.1 If Boiler is ordered with tankless heater(s), connect the tankless heater piping as recommended by its manufacturer.

4.8.2 The following guidelines should be followed when piping tankless heater:

a) FLOW REGULATION – If flow through the heater is greater than it's rating, the supply of adequate hot water may not be able to keep up with demand. For this reason a flow regulator matching the heater rating should be installed in the cold water line to the heater. The flow regulator should preferably be located below the inlet so that the regulator is not subjected to excess temperatures that may occur during 'off' periods when it is possible for heat transfer conducted back through the supply line. The regulator also limits the flow of supply water regardless of inlet pressure variations in the range of 20 to 125 psi.

b) TEMPERING OF HOT WATER – Installation of an automatic mixing valve will lengthen the delivery of the available hot water by mixing some cold water with the hot. This prevents excessive and possibly scalding hot water at the fixtures. In addition, savings of hot water will be achieved since the user will not waste as much hot water while seeking water temperature to his liking. Higher temperature hot water required by dishwashers and automatic washers is available by piping the hot water from the heater prior to entering the mixing valve. The mixing valve should be 'trapped' by installing it below the cold-water inlet to heater to prevent lime formation in the valve.

c) FLUSHING OF HEATER – All water contains some sediment, which settles on the inside of the coil. Consequently, the heater should be periodically backwashed. This is accomplished by installing hose bibs as illustrated and allowing water at city pressure to run into hose bib A, through the heater and out hose bib B until the discharge is clear. The tees in which the hose bibs are located should be the same size as heater connections to minimize pressure drop.

d) HARD WATER – May be applicable to some city water and particularly to well water. Have your water analyzed by a qualified water treatment specialist to determine if a water softener, conditioner or filtration is required. Treated water will ensure longer tankless heater life and performance and is also beneficial to all the piping and fixtures in the building.

4.9 Boil-Out Instructions

4.9.1 Before operating the new Boiler, it should be washed (boiled) out to remove oil, grease, pipe joint compound, etc. that has accumulated during construction and installation. This is usually taken care of by the heating contractor. Washing (boil) out, must not be neglected because impurities may damage the Boiler or cause an unsatisfactory operating condition.

4.9.2 The following steps are quite general in nature. If a local water treatment company is going to be part of your boiler maintenance program, they should be contacted for recommendation as to what boil out chemicals they recommend and how they will affect their overall treatment program.

1) Remove any foreign materials, which may be left in the Boiler.

2) Check out burner equipment up to, but not including, the actual firing. Refer to burner manufacturer's service manual.

3) Remove any controls or accessories that may be damaged by the chemicals used.

4) Remove a plug from a tapping on the highest part of the Boiler. (If no other opening is available, remove the safety valve carefully to avoid damaging it).

5) Determine the water content of the Boiler, to the applicable level in step (9) or (10) bellow. This information is provided to you on your respective Boiler's record MB drawing in your submittal package, record print package or burner manufacturer's service manual.

6) Measure out tri-sodium phosphate at the rate of 1 lb of tri-sodium phosphate per 50 gallons of boiler water. Mix the chemical with sufficient water to make a concentrated solution for later pouring into the steam boiler or the hot water boiler system.

CAUTION! Use Extreme Care in handling tri-sodium phosphate. It is very Corrosive and Harmful to skin, eyes and clothing. Use of a face mask, goggles, rubber gloves, and protective clothing is required. Do Not Permit the dry material or concentrated solution to come into contact with skin, eyes or clothing.

7) Fill the Boiler to the lowest permissible water level (LPWL), at which all firetubes are fully submerged in the water, and then pour in the concentrated cleaning solution from the exposed tapping with its plug or safety valve removed in step (4) above.

8) Replace the plug or safety valves, and close up other openings that may have been opened.

9) Steam Boilers shall then be filled with additional water to the normal water level (NWL, about 3-in or higher in gauge glass).

10) Water Boilers and the entire system may be filled with additional water up to the expansion tank. To assure a full system, open all air vents until water is emitted.

11) Start the firing equipment, and check the operating limit and safety controls in accordance with burner manufacturer's service manual.

NOTE: On cold light off the operator should be aware that a significant amount of condensate could form in the firesides and become evident at the drains provided in the smoke-boxes. This is normal and should not be cause for alarm.

12) Operate the Boiler as though in conventional service, reaching normal operating temperature for water or normal pressures for steam. Maintain at low fire until Boiler is warmed up to prevent thermal shock.

13) Steam Boilers should be operated for a few days to bring oil and dirt from the system back to the Boiler. If desired, the condensate return may be discarded to the drain and operation continued until the condensate runs clear.

14) Water Boilers should be operated for one day with pumped circulation throughout the entire water system.

15) Stop the firing equipment.

16) Drain the Boiler and water system to a location that can safely handle hot water. Be aware of Local EPA regulations with regards to discharge of wastewater.

17) Use a high-pressure water stream to hose down the waterside of the Boiler.

18) Refill the boiler system with fresh water: steam Boiler to proper water level; water Boiler to expansion tank, venting air as it is filled.

19) Bring water temperature up to at least 200 °F.

20) Add boiler water treatment chemicals as required.

21) Tighten man-hole/hand-hole covers and plugs while Boiler is hot.

22) The Boiler is now ready to put into service or on standby.

In stubborn cases, another boil-out may be necessary by repeating steps (1) to (22) above, or, by conducting a seventeen-step procedure for Boil-out with Surface Blow-off in GAMA-HI *Operation and Maintenance Manual for Steel Boilers (Including Water Treatment).*

4.9.3 If not to be used, the Boiler shall be drained, flushed, and inspected. The surfaces are then thoroughly dried by means of hot air. If the boiler room is dry and well ventilated, the Boiler may be left open to the atmosphere. An alternate procedure is to use suitable moisture absorbent, such as quicklime or silica gel, which is placed, in the Boiler in a suitable location. The Boiler is then tightly closed. Every two or three months the Boiler should be checked and the lime gel replaced or regenerated, if necessary.

4.9.4 The outside surface of the Boiler should be insulated and jacketed to prevent unnecessary heat loss from the shell. By reducing the heat loss from the Boiler, excessive boiler room temperatures are avoided and better operation economy can be obtained. Packaged Boilers are jacketed at Easco factory. If done on the job, this is usually not accomplished until the Boiler has been in operation for a week or so to ensure joint tightness.

4.9.5 The Boiler must be fired at a low rate for at least one day to dry out the refractory linings. Adjust the firing apparatus for a low firing rate and operate intermittently to keep combustion chamber warm. Drying procedure should be carried out together with the boil out.

4.10 Cleaning a New Steam Boiler

Oils, greases and sediments that accumulate in a new Boiler and piping must be removed from the system in order to prevent an unsteady water line and carry over of the water supply main above Boiler. Operate the Boiler with steam in the entire system for a few days allowing the condensate to return to the Boiler. If the condensate temporarily be wasted, operate the Boiler only for the length of time it takes for condensate to run clear. If the latter cannot be achieved or if the condensate is returned to the Boiler, boil out the Boiler using the Surface Blow-off connection.

The Boiler then can be cleaned by the following steps:

1) Drain Boiler until water is just visible in gauge glass. Run a temporary pipeline from the Surface Blow-off connection to an open drain or some other location where hot water may be discharged safely. Do not install valve in this line.

NOTE: Certain State and Local Codes may restrict the use of some of the chemicals listed for cleaning and maintaining the Boiler. Check with local authorities before proceeding to use any chemicals.

2) Drain about 5 gallons of hot water from Boiler into a container and dissolve into it tri-sodium phosphate at the rate of 1 lb of tri-sodium phosphate per 50 gallons of boiler water. Refer to boiler specification sheet for boiler water content in pounds and divide by 8.33 lbs/gal to get water content in gallons. Additional containers may be required to dissolve sufficient chemicals for large boiler models. Remove a safety valve with extra care to avoid damaging it and add solution to boiler water through the exposed tapping.

CAUTION! Use Extreme Care in handling tri-sodium phosphate. It is very Corrosive and Harmful to skin, eyes and clothing. Use of a face mask, goggles, rubber gloves, and protective clothing is required. Do Not Permit the dry material or concentrated solution to come into contact with skin, eyes or clothing.

3) Close all valves leading to and from the system to isolate the cleaning solution from the system.

4) Start burner and operate sufficiently to boil the water without producing steam pressure. Boil for about 5 hours. Open boiler feed pipe sufficiently to permit a steady trickle of water from the surface blow-off pipe. Continue this slow boiling and trickle of overflow for several hours until the water coming from the overflow is clear.

5) Stop burner and drain Boiler in a manner and to a location that hot water can be discharged with safety.

6) When the Boiler has cooled down to 120 °F or below, refill it to the normal water line. If water in gauge glass does not appear to be clear, repeat steps (1) through (5) above, boiling out the Boiler for a longer time.

7) Remove the temporary surface blow-off pipeline and plug the tapping and reinstall the safety valve. Boil or bring water temperature to 180 °F promptly to drive off any dissolved gases in the fresh water.

4.11 Cleaning a New Hot Water Boiler

The oil and grease, which accumulate in a new hot water Boiler, can be washed out in the following manner:

1) Remove a safety relief valve using extreme care to avoid damaging it.

NOTE: Certain State and local codes may restrict the use of the chemicals listed for cleaning and maintaining the Boiler. Check with local authorities before proceeding to use any chemicals.

2) Dissolve caustic soda or tri-sodium phosphate into a container of water at the rate of 1 lb of either chemical per 50 gallons of total boiler water in the system. See Table 1 for boiler water content in pounds and divide by 8.33 lbs/gal to get water content in gallons.

CAUTION! Use Extreme Care in handling caustic soda or tri-sodium phosphate. They are very Corrosive and Harmful to skin, eyes and clothing. Use of a face mask, goggles, rubber gloves, and protective clothing is required. Do Not Permit the dry material or concentrated solution to come into contact with skin, eyes or clothing.

3) Add solution through the exposed tapping and then reinstall safety valves.

4) Fill the entire system with water.

5) Start firing the Boiler.

6) Circulate the water through the entire system.

7) Vent the system, including the radiation.

8) Allow boiler water to reach operating temperature, if possible.

9) Continue to circulate the water for a few hours.

10) Stop firing the Boiler.

11) Drain the system in a manner and to a location that hot water can be discharged with safety.

12) When the Boiler has cooled down to 120 °F or below, remove plugs from all available tappings and thoroughly wash the waterside of the Boiler with a high-pressure water stream.

13) Refill the system with fresh water and bring water temperature to 180 °F or above promptly to drive off any dissolved gases in the fresh water.

SECTION 5: OPERATION INSTRUCTIONS

NOTES:

1) All tests MUST BE conducted by qualified personnel under the direct control of a qualified supervisor.

2) Refer to burner manufacturer's Installation, Operation and Maintenance Manual furnished with the Boiler for proper venting of the gas train components that require atmospheric air pressure to balance a diaphragm.

3) It is the responsibility of the installing contractor to see that all controls are correctly installed and are operating properly when this installation is completed.

4) Always inspect installation thoroughly before starting burner.

5) Fill system with water.

CAUTION! Anytime raw water is introduced into the Boiler it must be heated at least 180 °F immediately to dissipate the dissolved gases, which can otherwise cause internal corrosion to the Boiler.

5.1 Boiler Operation

Water level must be maintained in the Boiler with strict compliance to the ASME Code.

5.1.1 Section I (High-Pressure) Power Boilers – Top of lower gauge glass nut (lowest visible water level) must be located 3-in above the top of the highest firetube projection.

5.1.2 Section IV (Low-Pressure) Heating Boilers – Top of lower gauge glass nut (lowest visible water level) must be located 1-in above the top of the highest firetube projection where the Lowest Permissible Water Level (LPWL) tag is aligned to.

WARNING!! On a hot water system the pressure must not exceed 30 psig, unless the Boiler is especially designed for a higher working pressure. If boiler pressure exceeds the pressure setting of safety relief valve(s), valve(s) will relieve immediately. The cause of relief must be investigated and corrected. Excess pressure is dangerous and can cause damage to the heating system, personal injury and serious property damage.

5.1.3 The water level in Boiler will be maintained by a water level controller, if the Boiler is equipped with this type of control. The valves at the top and bottom of the water gauge glass must be kept open so that true boiler water level will show in the glass.

5.1.4 Care must be taken to insure that the steam and water equalizer lines to the water column and controller are kept clean and free from fouling. These should be 'rotted' out at least on an annual basis and be blown down with a frequency as dictated by water quality.

5.2 Feed Water Connection

It is imperative that all feed-water entering the Boiler be fed through the designated return connection with baffle inside to avoid the low-temperature feed-water directly flushing the high-temperature combustion chamber walls. This allows even temperature distribution and lowers down thermal stress and risk of thermal shock.

5.3 Firing Apparatus

5.3.1 Depending on configuration, Easco boilers can be fired with a number of devices. Regardless of the fuel or method employed, all systems should be operated in accordance with burner manufacturer's instructions. These are obtained either from the contractor or directly from the burner manufacturer.

5.3.2 Your Easco boiler is a quality product engineered to extract usable heat from the fuel burned, and will continue to do so as long as the burner is adjusted properly and heating surfaces are kept clean. Safety and economy are prime objectives in the operation of every boiler plant. Everyone in daily contact with the boiler room should acquaint himself with all rules pertaining to the care and maintenance of his Equipment as set forth by state, local and insurance regulations.

5.3.3 Adjust burner according to the burner manufacturer's specifications. Refer to burner manufacturer's Installation, Operation and Maintenance Manual furnished with the Boiler.

5.4 Pressure and Temperature Controls

CAUTION! Before the installation of Boiler is considered complete, the operation of the boiler controls must be checked, particularly the Low Water Cut-Off and High Limit Control.

5.4.1 Careful consideration must be taken when determining what pressure or temperature the Boiler should be operated at. On steam Boilers, the pressure should be high enough to support the load, but in the case of high pressure Boilers, it should never be reduced too low so as to allow high exit steam velocities to aggravate water carry-over through the steam supply nozzle.

5.4.2 Hot water Boilers must be controlled hot enough to carry the system load, but should never be allowed to go below the point where the Boilers can be thermally shocked or where dew point is reached in the breeching and stack. A good 'rule of thumb' is to never allow the return water temperature to fall below 150 °F and never allow the differential temperature across the Boiler to exceed 40 °F.

5.4.3 Always warm up your Boilers at the 'low' firing rate and leave them there until pressure is indicated on the steam boiler pressure gauge or until hot water boilers return water temperature is above 150 °F. Never allow system pressure to exceed designed MAWP of the boiler vessel.

5.5 Water Level Controls

Water level controls are essential to the safe operation of a Boiler. Depending on the application, they indicate water level (gauge glass), control the starting and stopping of a boiler feed pump secure the burners if water level gets dangerously low. Though often neglected, they need regular attention to ensure smooth and safe operation. They should be blown down daily to ensure the float chamber remains free of foreign matter. When blowing down, the level in the gauge glass should be observed and the feed pump control function and low water cut-off function tested as well.

5.6 Maintenance of Low Water Cut-Off Devices

NOTE: Probe and float type low water cut-off devices require annual inspection and maintenance.

5.6.1 PROBE TYPE LOW WATER CUTOFF – Although these devices are solid state in the operations, the probe is exposed to possible contamination in the boiler water and subject to fouling. It is important to physically remove the probe from the boiler tapping annually and inspect that probe for accumulation of scale or sediment.

Follow these steps to inspect, clean and/or replace the probe:

1) Turn off electric service to the Boiler.

2) Drain boiler water to a level below the tapping for the probe.

3) Disconnect wiring connections between the low water cutoff control and the probe.

4) Dismount the low water cutoff control from the probe.

5) Unscrew the probe from the boiler tapping.

6) Inspect that portion of the probe that is exposed to the boiler water for scale or sediment buildup.

7) Light deposits may be removed by wiping the probe with a damp cloth. Wiping the probe with a cloth soaked in vinegar will remove more tenacious lime deposits. The most stubborn deposits may be removed from the probe by using a diluted amount (3 parts of water to 1 part) of phosphoric acid (H2 PO4).

CAUTION! Exercise caution when handling phosphoric acid and follow the instruction label on its container.

8) Wire bushing of the probe is not recommended.

9) Clean the pipe threads of the probe to remove old hardened pipe dope and other foreign matter.

10) Apply a moderate amount of good quality pipe dope to the pipe threads on the probe, leaving the two end threads bare. Do not use PTFE (Teflon) tape.

11) Screw the probe into the boiler tapping.

12) Mount the low water cutoff control on the probe.

13) Reconnect the control to probe wiring.

14) Fill the Boiler to its normal waterline.

15) Add boiler water treatment compound as needed.

16) Restore electric service to the Boiler.

17) Fire burner to bring the water in the Boiler to a boil to drive off free oxygen.

WARNING!! Before returning Boiler to service, follow the low water cut-off check procedure.

5.6.2 FLOAT TYPE LOW WATER CUTOFF – During the heating season, if an external low water cutoff is on the Boiler, the blow off valve should be opened once a month (more frequently where conditions warrant), to flush out the sediment chamber so the device will be free to function properly.

Low water cutoffs and water feeders should be dismantled annually by qualified personnel, to the extent necessary to insure freedom from obstructions and proper functioning of the working parts. Inspect connecting lines to Boiler for accumulation of mud, scale, etc., and clean as required. Examine all visible wiring for brittle or worn insulation and make sure electrical contacts are clean and that they function properly. Give special attention to soldered joints on bellows and float when this type of control is used. Check float for evidence of collapse and check mercury bulb (where applicable) for mercury separation or discoloration. DO NOT ATTEMPT TO REPAIR MECHANISMS IN THE FIELD. Complete replacement

mechanisms, including necessary gaskets and installation instructions, are available from the manufacturer.

a) CHECK BURNER AND CONDTROLS at least once a year. See operating Instructions for control checks. See Burner Manual for burner tests and adjustments.

b) LUBRICATE BOILER COMPONENTS according to manufacturer's instructions. Generally, this involves the burner and circulator. This includes the type of lubricant to use, frequency of lubrication, and points to lubricate.

c) CHECK SAFETY VALVE at the start of each heating season and once or twice during the season to be sure it is in working condition. To do this, fasten wire or cord to lever of valve and pull lever standing a safe distance away from valve.

5.7 Safety and Safety Relief Valves

Safety and safety relief valves are used to relieve excessive pressure generated within the Boiler. The safety or safety relief valve(s) is the final line of protection against over pressurization.

5.7.1 Safety Valves – Used for steam service, a safety valve is an automatic pressure relieving device, actuated by the pressure generated within the Boiler and characterized by full opening pop action.

5.7.2 Safety Relief Valves – Used for hot water service, a safety relief valve is an automatic pressure-relieving device, actuated by the pressure generated within the Boiler. Valves of this Type are spring loaded without full opening pop action.

5.7.3 Safety and safety relief valves should be lifted by hand on a monthly basis. They should be under pressure test on an annual basis. Any problem whatsoever with the valve should be referred to an ASME Authorized Repair Station.

5.8 Blow-Off

Boiler blow-off (blow-down, sometimes) is utilized to remove impurities from the Boiler. Impurities may be either dissolved or non-dissolved. Frequency of blow-down is dictated by water treatment program. Blow-off on Firebox Boilers is typically from a 'T' in the Return in the rear adjacent to the boiler inlet. In severe cases the washouts in the mud legs (at bottom four corners) can be utilized also.

5.8.1 Low Pressure Boiler – The use of the blow-off or drain valve in a low pressure-heating Boiler is for discharging rust colored water and sediment, which settles to the bottom of the Boiler. Quantity and frequency of blow-down are based on water quality and site-specific conditions. Excessive discharge is wasteful and should be avoided.

5.8.2 High Pressure Boilers – The use of the blow-off in high-pressure Boilers is to remove concentration of dissolved and un-dissolved solids to prevent foaming and undesirable water carry-over in the steam. The amount and blow-down frequency depend on the severity of boiler service, amount of makeup water used and types of chemical treatment utilized. Amount and blow-down frequency should be determined by chemical analysis. 'Guessing at it' should be avoided at all cost. Blow down only during periods of light load. On Boilers equipped with a quick opening and slow opening valves, the quick opening valve should be opened first and shut last. The actual blow-down should be performed with the slow opening valve.

5.9 System Design, Application and Operating – Hot Water Boilers

Excessive stresses in a Boiler can lead to leaks at flue joints and to component fatigue due to thermal stress cycling, resulting in failure of stays and crack of tube sheets. When the burner is at its maximum firing rate, the furnace temperature in a hot water boiler is strongly influenced by the boiler operating pressure, or more accurately, the saturation temperature corresponding to the operating pressure. The fire tube and shell metal temperatures are mainly controlled by the operating boiler water temperature regardless of burner firing rate. Thermal expansions of the flue tubes and shell are, therefore, controlled by water temperature, but thermal expansion of the furnace is restricted by water pressure. Because differential thermal expansions between the furnace and the flue tubes or shell can result in excessive stresses in boiler components, it is essential to consider the relationship between the boiler operating temperature and boiler operating pressure. Consideration of this relationship leads to the conclusion that a hot water Boiler should operate at a temperature not much below the saturation temperature corresponding to the operating pressure.

5.9.1 Every effort should be made to keep the operating temperature of a hot water Boiler as high as possible, thereby reducing temperature differentials between the furnace tube and the flue tubes or shell. Easco has determined that for medium sized Boilers this temperature difference should never exceed 100 °F. It is intuitive that for larger Boilers the maximum temperature Difference should be even smaller.

5.9.2 For 30-psi hot water Boilers, the minimum permissible return water temperature is 150 °F. For Boilers operating at higher pressures, the minimum permissible return water temperature is a function of the operating pressure and the boiler size.

5.9.3 The return water temperature should always be within 40 °F to the supply temperature.

5.9.4 Return water temperature should be continuously monitored. Anytime when the return water temperature falls below any of the critical values, the burner firing rate should be brought down to low fire. A low fire hold aquastat is provided for this purpose. A low fire hold timer may be used in addition to the aquastat, but never in place of it.

5.9.5 A minimum water flow rate of 1/2 GPM/BHP is required to eliminate thermal stratification. The burner circuit may be interlocked with a flow switch to assure that this minimum flow rate is established prior to starting the burner.

5.9.6 The heating system must be designed to eliminate any possibility of a large volume of cool water returning to a hot Boiler as may occur when pumps cycle or when zone valves open.

5.9.7 Changes in boiler water temperature must occur gradually and should not exceed 2 °F per minute.

5.9.8 The burner-firing rate should be constant and as low as possible consistent with the load demand in order to reduce the effects of component fatigue due to thermal stress cycling. Any control system that causes a burner to cycle on and off at any rate above low fire must be corrected.

5.9.9 The direction of water flow through the Boiler should always agree with the instructions contained in the Care and Operations Manual provided with the Boiler.

5.9.10 In order to satisfy the Boiler's operating requirements as listed above, the judicious use of re-circulating pumps, slow-opening water valves and temperature controls is encouraged and may be required in many applications of hot water Boilers.

5.10 Water Circulation System Guidelines – Hot Water Boilers

The following guidelines relating to system water temperature fluctuation and flow through the Boiler must be observed.

5.10.1 It is important to operate your Boiler in such a manner as to prevent temperature fluctuation of more than 40 °F at any time. Rapid temperature changes within the Boiler can create stresses in boiler metal. These stresses can cause damage to the Boiler by loosening tubes, or in more severe instances can crack tube sheet ligaments, furnaces, or access rings.

5.10.2 It is equally important to ensure that there is circulation through the Boiler of at least 1/2 GPM/BHP at all times when the burner is firing.

SECTION 6: SERVICE AND MAINTENANCE INSTRUCTIONS

IMPORTANT: See Operating Instructions if it becomes necessary to add water to Boiler more frequently than once a month.

GENERAL – Inspection should be conducted annually. Service the Boiler as frequently as specified in paragraphs below. Before service starts electrical power to Boiler must be 'off' and remain 'off' while service or maintenance is being done.

CLEAN THE BOILER HEATING SURFACES AND FLUE at least once each year, preferably at the end of the heating season.

ADJUST BURNER according to the burner manufacturer's specifications. Refer to burner manufacturer's installation and operation manuals furnished with the Boiler.

6.1 Optimum Performance and Serviceability

For optimum performance and serviceability from this unit, adhere to the following recommendations:

6.1.1 Clean firetubes at least once a year – preferably at the end of the heating season to remove soot and scale. Inside of furnace, front and rear smoke-boxes, and reversing chamber should also be cleaned at the same time.

6.1.2 Have burner and controls checked at least once a year or as may be necessitated.

6.1.3 Retain your contractor or a competent serviceman to assure that the unit is properly adjusted and maintained.

6.1.4 Clean the vent system – Vent system should be checked annually for obstructions, accumulations of soot, deterioration of vent pipe or vent accessories due to condensation or other reasons, proper support – no sags, particularly in horizontal runs and tightness of joints.

6.1.5 Deterioration of vent pipe or vent accessories due to condensation or other reasons.

6.1.6 Proper support – no sags, particularly in horizontal runs.

6.1.7 Tightness of joints.

6.1.8 Remove all accumulations of soot with wire brush and vacuum. Remove all obstructions. Replace all deteriorated parts and support properly. Seal all joints.

6.2 Cleaning Boiler Heating Surfaces

6.2.1 At the end of the heating season clean the boiler heating surfaces thoroughly. Access to boiler fire tubes may be gained through the front smoke box doors and rear smoke box access opening. Clean fire tubes with flue brush furnished with Boiler. Remove soot and rust and reseal the Boiler.

6.2.2 Always inspects installation before starting burner.

6.3 Filling Heating System with Water

NOTE: Anytime that raw water is introduce into the Boiler it must be heated to at least 180 degrees F immediately to dissipate the dissolved gases, which can otherwise cause internal corrosion to the Boiler.

6.3.1 STEAM BOILERS – Fill Boiler to normal water line. Water should be visible in the gauge glass. After Boiler is in operation, make up water should be added slowly to maintain the water level.

6.3.2 HOT WATER BOILERS – In a hot water heating system, the Boiler and entire system (other than the expansion tank) must be full of water for satisfactory operation. Water should be added to the system until the boiler pressure gauge registers normal system design operating pressure. To insure that the system is full, water should come out of all air vents when opened.

WARNING!! On a hot water system the pressure must not exceed 30 psig, unless the Boiler is especially designed for a higher working pressure. If boiler pressure exceeds the pressure setting of safety relief valve(s), valve(s) will relieve immediately. The cause of relief must be investigated and corrected. Excess pressure is dangerous and can cause damage to the heating system, personal injury and serious property damage.

6.3.3 DO NOT draw water from Boiler while in use. When adding water while Boiler is in operation, do not open supply valve fully but add water slowly.

6.4 Testing Limit Controls

WARNING!! Before the installation of Boiler is considered complete, the operation of the boiler controls must be checked, particularly the Low Water Cut-Off and High Limit Control. Always inspects installation before starting burner.

6.4.1 CHECK LOW WATER CUTOFF controls at normal water level. Run operating control setting to allow burner to operate. Open boiler drain to allow water level to drop to the bottom of sight glass until burner operation is shut down by low water cutoff. Close the boiler drain and refill to normal water level. Unless Boiler is equipped with a manual-reset low water cutoff, burner should automatically restart during fill. Reset operating control.

NOTE: Probe and float type low water cut-off devices require annual inspection and maintenance. Refer to Service Instructions for proper cleaning instructions.

6.4.2 CHECK HIGH LIMIT CONTROL OPERATION. Disconnect power to Boiler controls. Jump the operation control terminals with a test lead. Check and ensure that the setting of high limit control is lower than the maximum required by the ASME B&PV Code but higher than the setting of operating limit control. Restore the power to the controls. Allow burner to operate until shutdown by the high limit. Disconnect power and remove the jumper. Restore power and manually reset the high limit control. For completeness, start the burner and observe the boiler for proper operation.

WARNING!! – Check High Limit Control – Always Disconnect Power to Boiler Controls before Adding and Removing the Jumper for Operating Control Terminals. Installation is not considered complete until this check has been made. REMOVE THE JUMPER after the checking is done.

6.4.3 CHECK OPERATING CONTROL on Boiler equipped with tankless heaters. With burner off, draw hot water until burner starts, then turn off hot water and check burner shutdown.

6.4.4 CHECK OPERATING CONTROL OPERATION. Raise and lower operating control setting as required to start and stop burner. With burner off, draw how water until burner starts, then turn off hot water and check burner shutdown.

6.5 General Maintenance Considerations

6.5.1 Keep radiators and convectors clean.

6.5.2 If a hot water radiator is hot at the bottom but not at the top, it indicates that air has accumulated inside and should be vented. To vent radiator, hold small cup under air vent (located near top of radiator), open vent until water escapes and then close.

6.5.3 If mush water is added to system, it is advisable to heat system to high temperature and vent again. This will make less venting necessary during the winter.

6.5.4 Where an expansion tank is used, makes sure that neither the tank nor its drainpipe is exposed to freezing temperatures. Never place valves in piping leading to or from expansion tank.

6.5.5 Boiler and system cleaning will help assure trouble free operation. See Item 5 and 6 Operating Instructions for procedure.

6.5.6 ATTENTION TO BOILER WHILE NOT IN OPERATION

NOTE: If Boiler is not used during winter time, it must be fully drained to prevent freeze damage.

6.5.7 STEAM BOILERS – Procedure for taking steam Boilers off line at the end of the heating season. Drain off boiler water until it runs clear while holding the boiler temperature between 180 and 200 °F. Then refill to the top of the gauge glass.

6.5.8 WATER BOILERS – Procedure for taking water Boilers off line at the end of the heating season. While the boiler temperature is still between 180 and 200 °F, drain water from the bottom of the Boiler until it runs clear. Then refill the system to normal water pressure.

NOTE: Any time raw water is introduced into the Boiler, it must be immediately heated to 180 °F to drive off dissolved gases. If water treatment is used, sufficient water treatment compound should be added to condition to make up water.

6.6 Repair Parts

Give Boiler Series and Model Number when ordering repair parts. All repair parts can be ordered through the commercial sales office.

EASCO Boiler Corp.
1175 Leggett Avenue
Bronx, NY 10474
(718) 378-3000
Fax: (718) 378-4560
www.easco.com
E-mail: webmaster@easco.com

SECTION 7: WATER TREATMENT

NOTE: The information contained in this section is general in nature. The specific treatment program for your Boiler should be dictated by local conditions. Easco Boiler Corp. will not be held responsible for owner's failure to exercise sound engineering practices with regards to proper water treatment that results in premature failures of boiler components.

7.1 Boiler Water Treatment Considerations

Consult with a local water treatment company regularly engaged in the treatment of boiler water for advice on maintaining the proper feed-water, boiler water, and condense chemistry.

NOTE Certain State and local codes may restrict the use of some of the chemicals listed for cleaning and maintaining the Boiler. Check with local authorities before proceeding to use any chemicals.

Boiler water treatment will help maximize the effectiveness and prolong the life of pressure vessels. The general objectives of boiler water treatment are:

1) Remove corrosive gases from feed-water and boiler water.
2) Prevent sludge and scale deposits on the waterside heating surfaces.
3) Prevent foaming and carryover.

7.2 Make pH or Alkalinity Test

After Boiler and system have been cleaned and refilled as previously described, test the pH of the water in the system. This can easily be done by drawing a small sample of boiler water and testing with hydroid paper which is used in the same manner as litmus paper, except it gives specific readings. A small color chart on the side of the hydroid dispenser gives the reading in pH. Hydroid paper is expensive and obtainable from any chemical supply house or through your local druggist. The pH should be higher than 7, but lower than 11. Add some of the washout chemical (caustic soda), if necessary, to bring the pH within the specified range.

IMPORTANT: If, during normal operation, it is necessary to add water to this Boiler more frequently than once a month consult a qualified service technician to check your system for leaks. A leaky system will increase the volume of make-up water are dissolved minerals and oxygen. When the fresh, cool makeup water is heated in the Boiler the minerals fall out as sediment and the oxygen escapes as a gas. Both can result in reduced boiler life.

Problems caused by oxygen and mineral contamination of boiler water are not covered by EASCO's standard warranty. Therefore, it is in everyone's best interest to prevent this type of failure. The maintenance of system integrity is the best method to achieve this.

In deciding what type of treatment to use, the following factors should be considered:

- The type of Boiler, i.e., steam or hot water,
- The nature of the raw water, i.e., hard or soft, corrosive or scale forming,

- Preliminary treatment of the water, i.e., softeners, pre-heaters, deaerators,
- The amount of makeup water and blow-down required,
- The use of the steam, i.e., for heating only or for other purposes,
- The amount of supervision and control testing available.

7.3 Services of Water Treatment Specialist

Each Boiler installation should be considered on an individual basis. Review the final decision with a reputable water treatment company. These companies furnish a service and/or chemicals for boiler water treatment. They are in a position to make recommendations based on local water conditions and the particular insulation in evolved. They also furnish test kits accompanied by simple analytical procedures for day-to-day analyzing by the local maintenance people. Samples are taken at suitable intervals and sent to their laboratories for confirmatory analysis. When setting up arrangements with such concerns, do not hesitate to ask for the chemical formula of the treatments prescribed.

7.4 Conformity with Local Ordinances

Make sure the boiler compound used does not violate any local ordinance with respect to disposal of blow-downs, draining of Boiler, etc.

7.5 Boiler Water Troubles

7.5.1 Corrosion – Raw water, as received from the city mains or wells, contains impurities including dissolved gases such as oxygen and carbon dioxide. When the water is soft, this makes the water acidic and corrosive. The boiler metal and condense return lines will be attacked. This can be general overall corrosion or localized pitting or cracking in stressed metal. High temperatures accelerate these reactions. If left uncorrected, serious pitting can result with possible rupture of boiler tubes. Rusty water in the gauge glass is a sure sign of corrosion in the heating system or in the Boiler itself.

7.5.2 Scale Deposits – All raw water contains dissolved salts. Where water is hard, these are mainly calcium and magnesium compounds. Under boiler operating conditions, these salts come out of solution and form scale deposits on the hot water boiler metal. This is due to decomposition of the bicarbonates and to the decreased solubility of calcium salts at higher temperatures. As the water is evaporated, the solids are left behind and the scale deposits build up. Scale forms an insulating barrier on the boiler tubes, resulting in heat losses and lower efficiency. Scale deposits can also cause overheating and failure of boiler metal.

7.5.3 Metal (Caustic) Embattlement – Under certain conditions of high caustic alkalinity where the metal is under stress, cracks can develop in the metal below the waterline and in welds and longitudinal seams.

7.5.4 Foaming, Priming and Carryover – These difficulties, occurring in steam Boilers only, are closely associated and refer to the formation of froth and suds on the surface of the water.

Where this is severe, boiler water is carried over with the steam. Excessive dissolved solids carried over can form deposits in the steam piping and valves.

7.6 Chemicals Used

The following chemicals are commonly used for boiler water treatment.

A) Inorganic

- Caustic Soda (sodium hydroxide) – NaOH
- Trisodium Phosphate (TSP) – Na_3PO_4
- Sodium Acid phosphate – NaH_2PO_4
- Sodium Tripolyphosphate – $Na_5P_3O_{10}$
- Sodium Borate – NaB_4O_7
- Sodium Sulphite – Na_2SO_3
- Sodium Nitrate – $NaNO_3$
- Sodium Nitrate – $NaNO_2$

B) Organic

- Sodium Alginate and other seaweed derivatives
- Quebrancho Tannin
- Lignin Sulfonate
- Starch

7.7 Functions of Chemicals

7.7.1 Caustic Soda – Use of caustic soda is one way to insure proper pH and complete precipitation of the magnesium salts. The optimum pH is 9.5 with a permissible minimum of 9.0. Recommended level is 9.0 – 9.5.

7.7.2 Chromates and Sulphites – Sodium chromate and sodium sulphite are used to control corrosion. Sodium sulphite is an oxygen scavenger picking up the oxygen, which converts the sulphite to sodium sulfate.

NOTE: Chromate id still recognized as one of the best inhibitors for protection of metal, although it is now prohibited by most states or cities for use as water treatment due to the toxic effect of the chromate when dumped in rivers, streams and sanitary sewage systems.

7.7.3 Phosphates – The various sodium phosphates serve to precipitate the hard water salts as insoluble lime and magnesia phosphates. Polyphosphates are a form of phosphate that sequesters rather than precipitate.

7.7.4 Nitrates and Nitrites – Nitrates serve to prevent metal embattlement. Nitrites act similarly to sulphites, but under certain conditions where dissimilar metals are immersed in the boiler water, particularly copper or brass and soft solder, nitrites can cause very severe localized

corrosion unless suitable inhibiting agents are present. Until recently, nitrites have not been commonly used where the water is boiled. Their use is generally confined to hot water systems.

7.7.5 Organic Agents – The organic agents act as protective colloids. When the inorganic treatment chemicals precipitate the hard water salts, these organic agents tend to keep the insoluble matter in suspension as sludge and prevent the information of dense adherent scale on the heat transfer boiler surfaces.

7.7.6 Boiler Compounds – Commercial boiler compounds are, for the most part, mixtures of the chemicals described in the above part. They may be either solid or liquid. The latter are solutions of the chemicals and blow-down, or loss of condensate; additional treatment will be necessary from time to time. A number of different types may be employed. These include open-type gravity feeders where the treatment is to be fed manually in one slug or in periodic small shots; closed-type gravity-drip and bypass feeders where the treatment is to be fed in proportion to the amount of makeup water; and pot type proportional feeders where slowly dissolving treatment crystals or briquettes are used.

7.8 Water Treatment Procedure

7.8.1 Determination of Water containing Capacity – Determine the water containing capacity of the Boiler so instructions can be given regarding the required amount of boiler water treatment compound. If this information is not given on the Boiler, in the Boiler catalog, or other publications, then meter the water at the time of the initial filling and record the information. Easco records this information on the System MB drawing found on the submittal and record prints and in Burner Service Manual.

7.8.2 Making a pH or Alkalinity Test – The condition of the boiler water can be quickly tested with hydrion paper which is used in the same manner as litmus paper, except it gives specific readings. A color chart on the side of the small hydroid dispenser gives the reading in pH. Hydroid paper is inexpensive and obtainable from any chemical supply house or through your local druggist. If a more precise measurement of pH is desired, a color slide comparator kit is recommended.

7.8.3 Mixing and Handling Chemicals – The chemicals, if liquid, should be diluted; or if solid, dissolved in accordance with the supplier's directions before adding them to the system. If the treatment is a solid, make sure it is fully dissolved. A simple hand paddle to stir the solution is frequently all that is necessary. If the chemicals are slow to dissolve, a steam line for heating the water and agitating the mixture may be used to accelerate solution. The use of compressed air for this purpose is undesirable since additional oxygen will be introduced, which will neutralize reducing agents such as sodium sulphite. Since the treatment chemicals may be highly alkaline or skin irritating, it is advisable to wear goggles and gloves when they are being handled and mixed.

CAUTION! Do not permit the dry material or the concentrated solution to come in contact with skin, eyes or clothing.

7.8.4 Treatment of Laid-up Boilers – When steel Boilers are out of service for any length of time, such as a lay-up for the summer, they must be protected from corrosion. This may be done either by draining them and keeping the surfaces thoroughly dry or by completely filling the Boiler with properly treated water.

Dry Method – The Boiler is drained, flushed, and inspected. The surfaces are then thoroughly dried by means of hot air. If the boiler room is dry and well ventilated, the Boiler may be left open to the atmosphere.

7.9 Maintain Drip Tight Connections

Repair all minor leaks promptly. If serious leaks occur shut the Boiler down immediately and cool gradually. All piping connections must be maintained leak proof as even minor leaks, if neglected, may become serious. This applies especially to water column, gage glass, water level control piping, man hole and hand holes. Pipe nipples should be replaced if there is evidence of leaking. Leaky plugs in boiler shell should be replaced with new plugs or nipples and caps. Tube joints must be inspected periodically to ensure they are leak free. All support systems and auxiliary equipment must be maintained in top condition to ensure long and trouble free operation of the boiler room system.

7.10 Foaming and Priming

Foaming and priming in the steam Boiler will cause large quantities of water to be carried over into the steam main. It will be detected by violent fluctuations of the water in the glass or by sudden dropping of the water level from the glass. Impurities will show as tiny specks or flakes floating in the boiler water. The following reasons may be the cause of the trouble:

- Dirt or oil in boiler water,
- Over-dose of water treatment,
- Carrying too high a water level in Boiler,
- Load demand exceeds boiler rating,
- Sudden increases in load (sudden pressure drop).

In case of serious trouble, stop the burner and decrease the load on the Boiler until the true level can be determined. Then alternately blow down and feed fresh water several times. If trouble continues, it will be necessary to wash out the Boiler and refill with fresh water. Test safety valve and connections of pressure gauge, water column and gage glass to make sure that they are clear and unobstructed by the impurities, which are responsible for priming.

A practical check to determine if impurities are causing foam is to place samples of boiler water in a beaker and brings it to a boil. If contaminants exist, it will foam. A similar test in a second beaker filled with tap water will determine how bad the boiler water is.

7.11 Corrosion and Pitting

Corrosion of the Boiler on either the waterside or the fireside can be of very serious consequence and should be guarded against. Waterside corrosion is generally caused by an unfavorable water condition or oxygen, which attacks the metal and forms pit marks or holes in the tubes. Control of the boiler water alkalinity and desertion is considered the best means of preventing waterside corrosion. The proper alkalinity for boiler operation is recommended as a minimum pH value of 9.0. The Boiler should be examined regularly for corrosion.

7.12 Periodic Inspecting of Existing Boilers

The main purposes for re-inspection include protection against loss or damage to the pressure vessel because of corrosion, pitting, etc. protection against unsafe operating conditions possibly caused by changes in piping or controls or lack of testing of safety devices. It is important that inspections are thorough and complete, and so those important elements may be all checked. The following recommended directions and instruction for such inspections are given.

a) All Boilers should be prepared for inspection, whenever necessary, by the owner or user when notified by the inspector. The owner or user should prepare for and apply the hydrostatic test whenever necessary on the date specified in the presence of the authorized inspector.

b) Before inspection, every part of a Boiler that is accessible should be open and properly prepared for examination, internally and externally. In cooling down a Boiler for inspection or repairs, the water should not be withdrawn until the setting is sufficiently cooled to avoid damage to the Boiler, and when possible, it should be allowed to cool down naturally.

c) Preparation – The owner or user should prepare a Boiler for internal inspection in the following manner:

   1) Water should be drained and Boiler washed thoroughly.

   2) All man-hole and hand-hole plates, washout plugs and water column connections should be removed and the furnace and combustion chambers thoroughly cooled and cleaned.

   3) All grates of internally fired Boilers should be removed.

   4) Brickwork should be removed, as required by the inspector, in order to determine the condition of the furnace, supports or other parts.

5) Any leakage of water into the Boiler should be cut off by disconnection the pipe or valve at the most convenient point.

d) It is not necessary to remove insulation material, refractory or fixed parts of the Boiler unless defects or deterioration are suspected. Where there is moisture or vapor showing through the covering, the covering should be removed at once a complete investigation made. Every effort should be made to discover the true condition, even if it means drillings holes or cutting away parts.

e) The inspector should get as close to the parts of the Boiler as is possible in order to obtain the best possible vision of the surface and to use a good artificial light if natural light is not adequate.

f) Whenever the inspector deems it necessary to test boiler apparatus, controls, etc., these tests should be made by a plant operator in the presence of the inspector, unless otherwise ordered.

g) Scale, Oil, Etc. – The inspector should examine all surfaces of the exposed metal inside to observe any action caused by treatment, scale solvents, oil or other substances which may have entered the Boiler. Any evidence of oil should be noted carefully, as a small amount is dangerous, and immediate steps should be taken to prevent the entrance of any more oil into the Boiler.

h) Corrosion, Grooving – Corrosion along or immediately adjacent to a seam is more serious than a similar amount of corrosion in the solid plate away from the seams. Grooving and cracks along longitudinal seams are especially significant, as they are likely to occur when the material is highly stressed. Severe corrosion is likely to occur at points where the circulation of water is poor; such places should be examined very carefully. For the purpose of estimating the effect of corrosion or other defects upon the strength of a shell, comparison should be made with the efficiency of the longitudinal joint of the same boiler, the strength of which is usually less than that of the solid sheet.

i) Manholes and Other Openings – The manhole(s) and other reinforcing plates, as well as nozzles and other connections flanged or screwed into the Boiler, should be examined internally, as well as externally, to see that they are not cracked or deformed. Wherever possible, observation should be made from the inside of the Boiler as to the thoroughness with which its pipe connections are made to the Boiler. All openings to external attachments, such as connections to a low water cut-off and openings to safety/safety relief valves should be examined to see it they are free from obstructions.

j) Fireside Surfaces – Bulging, Blistering, Leaks – Particular attention should be given to the plate or tube surface exposed to fire. The inspector should observe whether any part of the

Boiler has become deformed during operation by bulging or blistering. If bulges or blisters appear, it could seriously weaken the plate or tube, especially when water is leaking from such a defect, the Boiler should be discontinued from service until the defective part or parts have received proper repairs. Care should be made to detect leakage from any part of the boiler structure, particularly in the vicinity of seams and tube ends. Firetubes sometimes blister but rarely collapse; the inspector should examine the tubes for such defect. If bulges or blisters are found, they should be examined by an authorized inspector.

k) Testing Stay-bolts – The inspector should test stay-bolts by tapping one end of each with a hammer and, when practicable, a hammer or other heavy tool should be held at the opposite end to the test more effective.

l) Tube Defects - Tubes in horizontal fire tube Boilers deteriorate more rapidly at the ends toward the fire, and they should be carefully tapped with a light hammer on their outer surface to ascertain if there has been a significant reduction in thickness. They should be reached, as far as possible, either through the hand holes, if any, or inspected at the ends. The surface of tubes should be carefully examined to detect bulges or cracks or any evidence of defective welds. Where there is a strong draft the tubes may become thinned by erosion produced by the impingement of particles of fuel and ash. A leak from a tube frequently causes a corrosive action on a number of tubes in its immediate vicinity.

m) Ligaments between Tube Holes – The ligaments between tube holes in the heads of all firetube Boilers and in shells of water tube boilers should be examined. If leakage is noted, broken ligaments are probably the reason.

n) Pipe Connections and Fittings – All piping should be examined for leaks. If any are found, it should be determined whether they are the result of excess strains, due to expansion or contraction, or other causes. The general arrangement of the piping in regard to the provisions for expansion and drainage, as well as adequate support at the proper points, should be carefully noted. The arrangement of connections between individual Boilers and the supply and return headers should be especially noted to see that any change of position of the Boiler due to settling or other causes has not placed an undue strain on the piping. It should be ascertained whether all pipe connections to the Boiler possess the proper strength in their fastenings, whether tapped into or welded to the boiler shell. The inspector should determine whether there is proper provision for the expansion and contraction of such piping and that there is no undue vibration tending to damage the parts subjected to it. This includes all water pipes. Special attention should be given to the blow-off pipes with their connections and fittings because the expansion and contraction, due to rapid changes in temperature and water-hammer action, bring a great strain upon the entire blow-off system. The freedom of the blow-off and drain connection on each Boiler should be tested, whenever possible, by opening the valve for a few seconds, at which time it can be determined whether there is excessive vibration.

o) Low Water Cut-Off – All automatically fired Boilers are required to be equipped with an automatic low water fuel cutoff so located as to automatically cut off the fuel supply when the surface of the water falls below the lowest safe waterline. Such a fuel control device may be attached directly to the boiler shell or to the tapped openings provided or attaching a water glass direct to a Boiler.

p) Localization of heat – localization of heat brought about by improper or defective burner or stoker installation or operation, creating a blowpipe effect upon the Boiler, should be cause for shutdown of the Boiler until this condition is corrected.

q) Suspended Boilers – Freedom of Expansion – Where Boilers are suspended (i.e. high firebox). The supports and settings should be examined carefully, especially at points where the boiler structure comes near the setting walls or floor to make sure that ash and soot will not bind the boiler structure owing to the expansion of the parts under operating conditions.

r) Safety Valve/Safety Relief Valves – As these devices are the most important safety devices on the Boiler, it should be inspected with utmost care. There should be no accumulation of rust, scale or other foreign substances in the body of the valve, which will interfere with its free operation. The valve should not leak under operating conditions. The opening pressure and freedom of operation of the valve should be tested by raising the pressure to the point of opening. It this cannot be done, the valve should be tested by opening with the try lever. Where the valve has a discharge pipe, the inspector should determine at the time the valve is opening whether or not to drain opening in the discharge pipe is free and in accordance with the Code requirement. If the inspector deems it necessary, in order to determine freedom of discharge from as safety relief valve, the discharge connection should be removed. Under no circumstance shall a stop valve by permitted between a Boiler and its safety relief valve.

s) Combination temperature and pressure Gauges – A test gauge connection is provided on the Boiler so that the gauge on the Boiler can be tested under operating conditions.

t) Incorrect Repairs – When repairs have been made especially tube replacements, the inspector should observe whether the work has been done safely and properly. Excessive rolling of tubes, where they are accessible, is a common faucet of inexperienced workmen. When it is difficult to reach the tube end, they are frequently under rolled. This inevitably results in separation of the parts.

u) Hydrostatic Tests – When there is a question or doubt about the extent of a defect found in the Boiler, the inspector, in order to more fully decide upon its seriousness, should cause the application of hydrostatic pressure under the Code provisions. As dictated by the inspector, a hydrostatic test shall not exceed that specified by applicable code. During the test, the

safety/safety relief valve should be removed from the Boiler, as should all controls and devices unable to withstand the test pressure without damage. It is suggested that the minimum temperature of the water be 70F and maximum 160F.

v) Suggestions – The inspector weather he is the employee of a state, province, municipality or insurance company, should be well informed of the natural and neglectful causes of defects and deterioration of Boilers. He should be extremely conscientious and careful in his observations, taking sufficient time to make the examinations thorough in every way, taking no one's statement as final as to conditions not observed by him, and in the event of inability to make a thorough inspection he should note it in his report and not accept the statement of others. The inspector should make a general observation of the boiler room and apparatus, as well as of the attendants, as a guide in forming an opinion of the general care of the Equipment. He should question responsible employees as to the history of old boilers their peculiarities and behavior ascertain, what if any repairs have been made and their character, and he should investigate and determine whether they were made properly and safely.

SECTION 8: REPAIRS

DANGER!!! Do not attempt or permit repairs on a Boiler while it is in service or under pressure.

All repairs should be properly supervised by an Authorized Boiler Inspector or responsible engineer.

8.1 Notification

Before any repair work is attempted, the AI commissioned by the NBBPVI should be notified and the scope of the work should be reviewed and approved by the AI.

8.2 Requirements

All repair work should be conducted by an Authorized Boiler Repair organization carrying a repair stamp "R" issued by the NBBPVI. This will ensure that the Boiler Repair organization is thoroughly acquainted with approved procedures for making pressure vessel repairs. All procedures should be conducted in accordance with the applicable Code and approved by the AI. All material specifications can be found on its ASME Data Report came with the Boiler to be repaired.

8.3 Safety

Every precaution must be taken to insure against injury to personnel who are working in the boiler room, and particularly to those working inside the Boiler. The main burner power switch must be pulled tagged out. All isolation valves to the fuel systems must be shut and locked. All isolation valves to the steam or hot water systems must be shut and locked. Wherever possible, two-valve protection is desirable. The area to be worked on must be thoroughly ventilated to insure against toxic fumes and there should always be a safetyman outside the Boiler anytime a man is working inside.

8.4 Additional Applicable Publications

All operators and supervisors should be thoroughly familiar with the following sections of the ASME Boiler and Pressure Vessel Code or as they relate to the boilers and pressure vessels covered by this Manual:

a. Section I: *Power Boilers*
b. Section II – A: *Material Specifications – Ferrous Materials*
c. Section IV: *Heating Boilers*
d. Section VI: *Recommended Rules for the Care and Operation of Heating Boilers*
e. Section VII: *Recommended Guidelines for the Care of Power Boilers*
f. Section IX: *Welding and Brazening Qualifications*

NOTES