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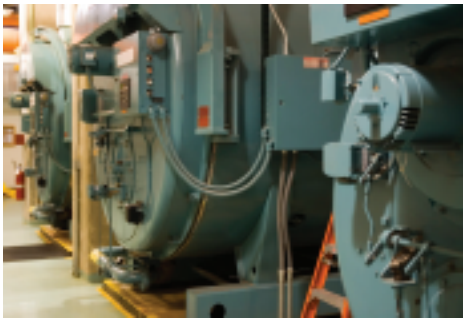

Steam, Heating Hot Water, and Outside Distribution Systems design manual

May 1, 2024

Volume 1
STEAM BOILERS
(Steam Generating Systems)

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1.0 DESIGN PARAMETERS/REQUIREMENTS

1.1 Requirements:

1.1.1 This volume of the design manual establishes VA requirements on the quantity, capacity, arrangement, and standby capability of the boilers and auxiliary equipment. It applies to the design of new boiler, boiler replacement, and modification of existing boiler(s), in all climates.

1.1.2 The requirements of this manual shall apply to all steam boilers whether they are centralized systems or decentralized systems.

1.1.3 Decentralized systems shall comply to all the equipment requirements defined herein however the following elements will only be required for mission critical, hospitals, CLCs and inpatient facilities.

1.1.3.1 The system shall be capable of supplying the maximum steam demand with the largest boiler not operating, and with the largest pump of each service not operating (N+1 capacity) .

1.1.3.2 Dual Fuel capability with appropriate reserve capacity

1.1.3.3 Emergency generator power requirements

1.1.4 Steam boilers and associated equipment whether central or decentralized shall be located in a secure, conditioned, and protected building and shall provide the appropriate security and weather protection in all climates. Additionally, the building/room shall be equipment with combustible gas and CO monitoring that is alarmed locally as well as reports to a central location that is continuously monitored.

1.1.5 Emergency Temporary Rental Boiler connections: Connection for a rental boiler will be located on the external side of and external wall where a rental boiler and office can be easily located/accessed, preferable on a concrete pad. The connections will include all systems required for operation of the rental boiler: Steam, feed water, primary and secondary fuels blow-down (bottom and surface), electric, etc.

1.2 Load Determination Capacity Calculations:

1.2.1 Maximum loads shall be determined by adding existing demand, new connected loads and an allowance for future expansion required for planned projects. Boiler auxiliary equipment loads and distribution line losses shall be included in load calculations. Existing loads should be determined by installing a calibrated flow meter that will log real time data at a minimum of 5-minute intervals and totalize daily during the winter periods when the outside temperature approaches ASHRAE design conditions, and for summer periods in order to determine minimum flow. The accuracy of the data must be verified through review of meter calibration data and measurement logging criteria (i.e., hourly, hourly average or peak hourly). In the review of the data, judgment must be utilized in determining realistic peak loads (loads which are sustained for at least ten minutes).

1.2.2 Heat recovery and/or combined heat and power boilers shall not be included in the boiler plant capacity calculation unless they can operate with their own burners independent of the device from which heat is being recovered.

1.3 Boiler System Capacity:

1.3.1 The boiler system shall be capable of supplying the minimum demand with the smallest boiler in a normal mode of operation and with all auxiliary equipment operating within recommended turn-down ranges. The capacity of the smallest boiler shall be sufficient for peak demand in the non-heating season.

1.3.2 The boiler system shall be capable of supplying the maximum demand with the largest boiler not operating, and with the largest pump of each service not operating.

1.4 Boiler header pressure:

1.4.1 Boiler Header pressure shall be sufficient to serve the pressure requirements of the loads in an economical manner.

1.4.2 When replacing an existing boiler, header pressures shall not be changed (raised or lowered) from the existing unless a complete engineering analysis is performed on affected portions of the steam system of the facility to determine the effect of higher/lower pressures and temperatures on pipe expansion devices, steam traps, control/safety valves, equipment and other devices. Additionally, the system shall be pressure tested at 1.5 times the updated pressure to ensure all components are capable of operating at the revised pressure. The performance of equipment supplied by the steam shall also be verified through commissioning and performance testing.

1.5 Boiler Plant Heat Recovery

1.5.1 Provide heat recovery devices when they can be justified by a life cycle cost analysis. Systems may include

(1) Flue gas economizers for each boiler and
(2) Continuous blowoff heat recovery and
(3) Co-generation

2.0 GENERAL CRITERIA

2.1 Graphic Standards:

2.1.1 Central plant heating, high-pressure, low-pressure boilers, and decentralized boilers work shall only be indicated on "MP"- series drawings (see *VA Design and Construction Procedure, Topic 2, Drawings*).

2.1.2 "MP"- series drawings shall include symbols and schedules, equipment lists, schematic and isometric piping diagrams, floor plans, upper-level plan of boiler room, mezzanine and pit plans, sections, demolition plans, fuel tank plot plans, and other work as necessary.

2.1.3 Drawings must show plan and elevation views of all valves and equipment which require access and have both North and True North annotated.

2.1.4 Flow sheets with instruments and flow/capacity shall be included in the design package. Instruments and equipment shall have unique tag numbers that are correlated to an instrument and equipment index. Tag numbers shall be coordinated with the shops to ensure standard nomenclature is aligned with local facility.

2.1.5 Water treatment systems are shown on "PL" drawings.

2.1.6 Fuel Gas piping shall be shown on the MP drawings.

2.1.7 Structural drawings must show sufficient structural detail for each hanger and support location.
2.1.8 Pipe size and material of construction shall be indicated for all piping, including those referring to existing conditions.
2.1.9 Existing work which remains in service shall be identified in a way which easily distinguishes it from the new work.
2.1.10 The standard symbol for point of connection, new work to existing shall be used. A similar symbol with the circle entirely filled-in shall be used to indicate extent of demolition.
2.1.11 Dashed lines shall be used to distinguish material to be demolished.
2.1.12 Equipment shall be listed and scheduled in conformance with VA National CAD Standard details: https://www.cfm.va.gov/til/sDetail.asp#23
2.1.13 Show work on drawings using a minimum scale of 1:50 (1/4" = 1'0").
2.1.14 Steam and water piping and equipment arrangement must conform to the VA National CAD Standard.
2.1.15 Show tube pull area and door swing for fire tube boilers.
2.1.16 Show equipment rigging routes for future removal and replacement of boilers, air handlers, economizers, DA and Condensate tanks.
2.1.17 Show access routes for operation or maintenance of bottom blow down valves' removal and replacement of pumps or motors, header valves, steam stop and non-return valves at the top of the boilers, calibration and testing of transmitters.

2.2 Guidelines:

2.2.1 Heating systems requirements shall follow the HVAC Design Manual for New, Replacement, Addition and Renovation of Existing VA Facilities.
2.2.2 Design all equipment and systems to comply with this design manual, and the current editions of VA Program Guides, VA Handbooks and VA Master Specifications. The design shall also meet the provisions of all codes and regulations having jurisdiction and referenced in this document.
2.2.3 The latest edition of the VHA boiler plant safety device testing manual to ensure the appropriate arrangement and equipment are provided on the boiler and associate systems to accommodate the required testing.
2.2.4 If state or local codes are more stringent than the above requirements request clarification from the VHA authority having jurisdiction (AHJ). VHA Office of Healthcare Engineering.
2.2.5 Earthquake-resistive design shall comply with the requirements of Master Specification Section 13 05 41, Seismic Restraint Requirements for Nonstructural Components, and the latest edition of the H-18-8 Seismic Design Handbook.
2.2.6 The facility/boiler system shall comply with the latest edition of the VA Physical Security and Resiliency Design Manual (PSRDM).
2.2.7 VHA Directive 1810: If there are plans for the installation of new, or replacement of, high pressure boilers, installation of new fuel burning equipment on existing boilers, or re-tubing 30 percent or more of a single boiler, sufficient (determined by HEFP) technical and operational information must be provided for plan evaluation and approval to proceed with design development must be obtained. For approved plans,

design development documents must be submitted for review by HEFP and CFM at the 30, 60, and 100 percent design stages.

2.3 Equipment selection

Equipment selection shall be non-proprietary. When as a standard of quality, model numbers are specified, the "Basis of design" designation must be added. When specifying by model number "Basis of design", the salient characteristics of the specified item which equality would be judged must also be included.

2.4 Life Cycle cost analysis

2.4.1 The DOE requires that agencies must estimate the life-cycle costs and energy consumption of a building and compare it to the minimum criteria set forth in the applicable baseline ASHRAE or IECC standard. This measure is meant to demonstrate and record the extent to which the mandated compliance is achieved.

2.4.2 Life Cycle analysis shall include at least three unique options for the solution of the project.

2.4.3 An engineering and economic analysis shall be performed in accordance with the procedure outlined by the DOE in the latest edition of the National Institute of Standards and Technology (NIST) Handbook 135 -Life –Cycle Costing Manual for the Federal Energy Management Program. The DOE 2 program shall be utilized when performing the required BLCC analysis using the following parameters:

2.4.3.1 Life-Cycle period:

Equipment		Useful Life Expectancy (in years)
i)	Fire tube boilers and burners	30
ii)	Water tube boilers and burners	40
iii)	Hot water/condensing boilers	15
iv)	Feed water Deaerator	30
v)	Economizers	15
vi)	Burner management controls	20
vii)	Combustion controls	20
viii)	Instrumentation	20
ix)	Boiler feed and condensate pumps	20
x)	Condensate and blow-off tanks and heat recovery	40
xi)	Fuel oil pumps	40
xii)	Fuel oil tanks	40
xiii)	Valves, shut off and control	20
xiv)	Water treatment equipment	20

2.4.3.2 Discount factor as determined by DOE on Oct 1st of each year.

2.4.3.3 Include initial acquisition costs such as:

- planning, design, purchase
- construction and capital replacement costs
- operating costs, such as energy used, water used,
- operating, maintenance, and repair costs
- Taxes and insurance need not be included in the life-cycle cost analysis.

2.4.3.4 Analysis of options shall be based on the system maintained and operating as designed. If the existing system is found to be deficient in one of these areas the analysis shall estimate the cost of correction and use that as the basis of the analysis.

2.4.4 Investigate the possibility of purchasing steam from a neighboring facility if purchasing steam is feasible. An evaluation should be made as to the number and frequency of disruptions at this facility. Additionally, the need for an agreement for the supply of steam must be analyzed and included in the cost analysis addressing such items as the following:

- Rates and ability to ensure stable and agreed on escalation
- The resilience of the plant related to backup fuel and electrical
- The maintenance and upgrade program for the supplier
- The priority of the VA during load shedding.

2.4.5 Perform a life cycle cost analysis of purchased steam versus VA-generated steam including all expense factors such as boiler plant investment, fuel cost, salaries of operating personnel, maintenance costs, and electricity and water costs.

3.0 HEATING PLANT

3.1 General:

3.1.1 Heating plants can be either centralized or decentralized. The determination of what style plant a facility should install or whether a conversion is appropriate requires a detailed evaluation of many elements including installation, operation and maintenance. All new or converted plants shall analyze the following in a detailed engineering report prior to progressing to schematic engineering. The report shall be submitted to the Office of Capital Assets Management, Engineering and Support for review and comment.

3.1.2 Net present value of each option. The analysis should consider

3.1.2.1 Capital cost
3.1.2.2 Cost of replacement equipment during operational period
3.1.2.3 Operational cost
3.1.2.4 Energy as discussed in the latest edition of VA sustainable Design & Energy Reduction Manual and VA Directive 0055.
3.1.2.5 Maintenance cost
3.1.2.6 Resilience and cost impact of vulnerable areas (such as cost of vacating a building due to loss of heating equipment or cost of repairs due to loss of heating equipment)

3.1.3 The building and site adjacent to the building shall be arranged to allow for future expansion of additional boilers, chillers, or other equipment are needed.

3.1.4 Locate the heating plant in a separate building or room constructed per all applicable codes.

3.1.5 Any co-generation equipment should also be included in this building. The heating plant and the air conditioning chiller plant may be combined into an energy center

building/central utility plant. For chiller plant requirements, refer to HVAC Design Manual.

3.2 Building Requirements

3.2.1 Pipe, Breeching and Stack Supports and Anchors

3.2.1.1 Provide a structural system which permits access to overhead members for pipe and duct support and allows for future expansion.

3.2.1.2 Detail the design and locations of all roller and spring-type hangers, anchors, trapezes, seismic bracing, and special supports. Detail the anchor designs and seismic bracing designs. Detail the connections to the building structure when standard pipe hanger components cannot be used as building attachments.

3.2.1.3 Specific support, anchor and hanger information/data shall be provided on the design drawings by the engineer of record that created the drawings including but not limited to the following:

3.2.1.3.1 Types, sizes, locations, and spacing of all hangers and supports.

3.2.1.3.2 Roller or slider supports for all horizontal steam and condensate piping.

3.2.1.3.3 Special supports including anchors, guides, and braces.

3.2.1.3.4 Supports to permit removal of valves and strainers from pipelines without disturbing supports.

3.2.1.3.5 Spring hangers on all systems subject to vertical movement.

3.2.1.3.6 Roller hangers and sliding supports on all systems subject to horizontal movement.

3.2.1.3.7 Loads for all supports. On systems utilizing variable spring supports, show the loads at each support by calculating the forces and moments throughout the system. Seismic restraint calculations shall utilize the applicable shock spectra for the type of structure, type of supported system, and the locality.

3.2.1.3.8 Individual detail for each hanger, anchor and support assembly showing all components, sizes, and calculated loadings. Provide identification tags on each keyed to the layout drawings.

3.2.1.4 Design steam piping system for a minimum steam pressure of 150 psi, 370 F or the maximum boiler safety valve setting and associated temperature, whichever is higher. The condensate/return system shall also be designed for 150 psi, 250 F or pump dead head whichever is greater. Pipe stresses must not exceed allowable stresses calculated in accordance with ASME B31.1, ASME Code for Pressure Piping, Power Piping.

3.2.1.5 Vertical deflection shall not exceed 2.5 mm (0.1 inch) between supports when system is filled with fluid normally carried. Deflections due to seismic shock shall be restrained as necessary to prevent overstressing the supported system or the connected equipment. Seismic restraints shall permit movement due to thermal expansion.

3.2.1.6 If vertical angle of hanger rod exceeds four degrees, rollers or sliders are required.

3.2.1.7 Provide analysis of system stress and required expansion considerations and support/anchor requirements under all possible operational configurations shall be performed and stamped by a registered professional engineer.

3.2.1.8 Seismic Bracing for systems that experience thermal expansion shall be designed to allow the thermal expansion without overstressing any components.

3.2.2 The building design shall permit all equipment to be installed (and removed in the future) without removal of any building structural element, walls or the roof. (The exception being a designed knockout panel). This shall be clearly described and indicated on the design documents.

3.2.3 Locate the main boiler room floor above finished grade and the flood plain per PSDM to permit horizontal rigging of equipment in and out of the building.

3.2.4 Establish roof height to provide adequate clearance above all equipment and piping, for maintenance and operation. Clearance shall be a minimum of 15 feet from the top of the boilers and ancillary equipment to the roof line or the ceiling. Provide for present or future installation of economizers above the boilers.

3.2.5 Condensate storage tank, condensate transfer pumps, and fuel oil pumps should be designed to eliminate the need to be in a basement as these pieces of equipment are critical to the resilience of the plant. Installation of this equipment in pits is prohibited. If a basement is required, additional water proofing and flood protection shall be provided in the form of duplex pumping systems with redundant backup and powered with emergency power. Duplex sump pumps should be submersible to mitigate issues with potential failure due to motor flooding.

3.2.6 Locate a mezzanine above the boiler feed pump area to support and provide access to the deaerating feedwater heater. Normal mezzanine floor height above the boiler room floor is 12 feet. Design the mezzanine floor to contain/eliminate water spillage/leakage without damaging equipment below.

3.2.7 Provide overhead roll-up doors through which all equipment can be rigged. Locate a roll-up security grill inside each door so that the doors can be open for summer ventilation.

3.2.8 Boiler room shall be designed with double access (2-doors).

3.2.9 Combined Boiler and Chiller Plants (Energy Centers/Central Utility Plant)

3.2.9.1 Combining the boiler and chiller plant in one building is preferred when it can be economically justified. Each proposed energy center must be reviewed by VA Central Office.

3.2.9.2 The energy center shall house the boiler plant, chiller plant, Engineering Control Center (ECC), pumps, plumbing equipment, associated electrical switchgear and boiler plant emergency generator and co-generation equipment for the VA medical center. To the extent feasible other emergency generators and electrical substations and domestic hot water generators may be placed in the energy center.

3.2.9.3 The chiller area and the ECC shall be designed in accordance with the HVAC Design Manual.

3.2.9.4 The electrical equipment area shall be designed in accordance with Design and Construction Procedure, and VA Design Manual for Engine-Generators and Distribution.

3.2.10 The building design shall be such that the Safety Relief Valve Vent piping will exit the roof directly above the equipment for which it serves. The maximum degree of directional change after the drip ell is limited to 90 degrees. All directional changes shall be done with 45's or long radius sweeping 90's.

3.2.11 Trench type drains shall be designed and installed on both sides of the boilers and other equipment. The DA tank and Condensate tank overflow shall go to a drain rated for the temperature of the DA tank when in normal operation.

3.3 Water Treatment Area (central or hub locations):

3.3.1 Provide an area which includes bulk chemical storage tanks with containment and metering pumps. Cold water and drains must be available in the area and there must be an emergency eyewash and shower. Approximate floor space requirement for chemical storage is 100 square feet. The chemical storage area must accommodate chemicals in barrels or bulk tanks that will be furnished by the chemical supplier. The storage area must be reachable by hose from a tank truck parked outside the building. If dry chemical (water softener salt) is used there shall be access from the outside for fork truck or hand truck transport and platforms for loading into system.

3.4 Water Test Area (central or hub locations):

3.4.1 Provide laboratory type sinks in a stainless-steel countertop unit which includes cabinets below and above for storage of boiler water testing equipment. Locate boiler water sample coolers adjacent to the sink unit. The test area should be adjacent to the firing aisle. The feed water sample cooler should be located adjacent to the deaerator.

3.5 Personnel Facilities

3.5.1 An air-conditioned control room of at least 150 square feet floor area with view windows located to allow observation of boiler aisle and chillers. Where an ECC is provided additional floor-area is required (see Chapter 230 of VA Handbook 7610 for required floor area).

3.5.2 A supervisors' office of approximately 100 square feet floor area.

3.5.3 Locker facilities on the main floor of boiler plants and energy centers for employees, one or more of which will be female. Facilities shall include separate showers and locker rooms for male and female employees. Twelve lockers shall be provided including a minimum of two lockers in the female locker area.

3.5.4 Two separate toilet rooms adjacent to the locker rooms each having a water closet and lavatory plus a urinal in male toilet.

3.5.5 Water cooler.

3.5.6 Break room with sink, storage cabinets, and electric service for microwave oven and refrigerator.

3.5.7 Housekeeping closet.

3.6 Access Platforms

3.6.1 Provide a platform above each boiler to provide access to valves and manways which are located on top of the boiler. Minimum width shall be 2.5 feet, with length to suit boilers furnished.

3.6.2 A three feet x four feet steam drum manway access platform at the rear of each water tube boiler. Locate below the steam drum.

3.6.3 Provide platform for access to economizer valves and service panels.
3.6.4 Provide other platforms as necessary to allow access to equipment requiring maintenance.

3.7 Permanent ladders and stairs

3.7.1 Provide stairways to mezzanine, platform or pit levels which require frequent access, such as deaerator level. Stairways may not exceed 45 degrees incline and should be designed to minimize floor space (i.e., switchback design vs linear arrangement).
3.7.2 Provide permanent ladders for access to all platforms. The design of ladders and platforms shall conform to OSHA requirements.

3.8 Acoustical Considerations

3.8.1 Provide acoustical treatment on building surfaces which are within three meters (10 feet) of burner fans or atomizing air compressors or co-generation engines. Provide noise control in the operations room/ECC and in the office in accordance with VA Design and Construction Procedure, Noise Transmission Control.
3.8.2 Provide a block wall partition between the chiller portion of the building and other areas for noise control. Also provide the same for the co-generation engine unless other noise reduction measures are taken.

3.9 Boiler Plant Building Hazardous Gas Detection System:

3.9.1 Industrial-type system with central alarm panel and multiple sensors is required. Provide carbon monoxide sensors at breathing level near the front of each boiler and in personnel spaces where there is exhaust ventilation.
3.9.2 If natural gas is a main fuel, provide combustible gas detectors at the ceiling of the boiler room.
3.9.3 The use of propane as a main fuel or secondary fuel source requires written approval from the Office of Healthcare Engineering. Provide combustible gas sensors at the low points in the boiler plant.
3.9.4 Alarm shall be audio visual inside and outside the plant and labeled to identify the system it is protecting.

4.0 EQUIPMENT LAYOUT

4.1 In a central plant arrange boilers; co-generation equipment, emergency generator room, control panels, instrumentation panel, motor control center, and control room/ECC shall be located along the main aisle on the main floor to allow visibility of the boiler front and controls. The main aisle is considered the aisle that the boiler fronts are lined up on. Boiler and chiller spaces must be observable from the control room/ECC. Locate boiler feed pumps, water treatment area and main steam header on the main floor.

4.2 Control and instrument panels shall be visible from the main aisle, and to the maximum extent possible, visible from the control room/ECC. Instrument panels may be located in the control room/ECC.

4.3 The electrical switchgear and engine-generator(s) shall be located within the plant in a separate room adjacent to an outside wall. The engine-generator(s) shall be visible via view windows from the room that contains their paralleling and distribution equipment.

4.4 Heat Recovery Boilers: Heat recovery boilers generating high pressure steam shall be located in the boiler plant where they can be monitored by boiler plant operating personnel.

4.5 Housekeeping Pads - All floor mounted equipment shall be placed on and anchored to housekeeping pads

4.6 Tube replacement for firetube boilers generally requires a space in front of the boilers which is equal to its longest length. (See manufacturer's installation manuals for exact area required for boiler tube pulls.)

4.7 The width of the clear space between the side of a boiler and a wall shall be not less than 3 feet 6 inches.

4.8 Passage clearance between boilers >=48 inches wide and >=80inches high. For multiple boiler arrangement there shall be 48 inches of clearance between the boilers.

4.9 The clearance for the opening of boiler doors shall be not less than 12 inches from the edges of the doors in any position.

4.10 The clearance between pumps shall not be less than three feet. The clearance between pumps and walls shall not be less than two feet, preferably three feet, except where a greater clearance is required to maintain a walking aisle.

4.11 Where possible allow enough space between boilers to maneuver a forklift truck. Mandatory for new construction.

4.12 All equipment and piping devices must be accessible from the floor or from permanent platforms for operation, repair, maintenance, and replacement.

4.13 Repair, maintenance, and replacement must be possible without requiring the removal of other major items of equipment, the removal of major portions of piping, or the removal of portions of the building.

4.14 Generally, there should be at least three feet of clear floor space around all items of equipment. Boilers require a greater amount of clearance.

4.15 Where possible, valves shall be located not more than seven feet above a floor, mezzanine, or platform. Limited exceptions are permitted for valves that are rarely used, would not need to be operated in an emergency situation, and can be reached with portable ladders or chain-wheels.

4.16 Access to boiler blow down valves is critical since steam boilers are to be blown down at least once every eight hours. Clear access to these valves shall be maintained.

5.0 BOILER ROOM ENVIRONMENT

5.1 Heating Plant HVAC Requirements

5.1.1 Heating plant and energy center heating, ventilating, and air conditioning shall be provided as follows:

5.1.1.1 Combustion and ventilation air intakes through the building walls and roof. Provide combustion air make-up heating and ventilating units in colder climates. Combustion air make-up heating and ventilating units shall have a secondary means or backup system for maintaining combustion air into the boiler plant.

5.1.1.2 The maximum plant temperature shall be limited to 104 degrees F (40 degrees C).

5.1.1.3 Install roof-mounted exhaust fans to provide a minimum of 12 air changes per hour in the boiler areas (or more for to meet the maximum temperature defined).

5.1.1.4 Heat occupied rooms (ECC, office, toilets, showers, break room) to maintain temperature, humidity, outside air, etc. according to the HVAC Design Manual.

5.1.1.5 Heat (if necessary) the boiler room, chiller room and other equipment spaces to maintain 40 degrees F.

5.1.1.6 Air conditioning shall be provided in the ECC, office, toilets, showers, break room only.

5.1.1.7 Boiler room, chiller room shall be mechanically ventilated to maintain a maximum of 104 F. If either area is in excess 86 F spot coolers shall be provided at key operational areas and a portable for maintenance. Evaporative coolers such as "swamp coolers" are prohibited due to a potential of exposure to Legionella.

6.0 SYSTEMS AND EQUIPMENT

6.1 Definition of steam distribution pressure classes:

Low pressure steam (LPS)……..0 thru 15 psig
Medium pressure steam (MPS)…….Greater than 15 psig but less than 60 psig
High pressure steam (HPS)…….Greater than 60 psig

6.2 Boilers :

6.2.1 Quantity of Boilers: Minimum three units are the most cost effective and operationally practical. In some cases, two large and a smaller boiler for use in the summer load period is optimal. The selection should be based on the load profile developed by the design engineer and a life cycle cost analysis. Preferred method shall be to use the same size boilers if loads and turndown permits.

6.2.2 Boiler Design:
Boiler steam output capacity shall be based on boiler heating surface requirements as follows:

6.2.2.1 Fire Tube Packaged Gas and/or Oil Boilers:

6.2.2.1.1 Packaged fire tube units up thru 6900 kW (700 boiler hp) are acceptable. Packaged water tube units are acceptable for any capacity requirement. The choice between water tube and fire tube units must be based on life cycle costs, and available space in the boiler room, fire tube boilers are the preferred type of boilers.

6.2.2.1.2 Provide 0.019 square meter per kilowatt output (2 square feet per boiler horsepower).

6.2.2.1.3 Three or four pass boilers with smooth tubes are required.

6.2.2.2 Water Tube D- Type Packaged Gas and/or Oil Boilers: Require OHE concurrence.
Heating Surface (sq. meters) = (Output (Kg/Sec) x 60.6) + 60

Heating Surface (sq. ft.) = $\frac{\text{Output (BTU/Hr.)}}{700}$

12,500

Heating surface is defined as the flat projected area in the furnace and full circumferential area in the convection section of the boiler. Furnace heat release shall not exceed 520,000 W/cu. meter (50,000 BTU/Hr. cu. ft.).

6.2.2.3 Other Types of Boilers:
Apply conservative ratings. Utilizing other types of boilers is prohibited unless approved by CFM and VHA HEFP. One example is flex-tube boilers or other nonstandard designs. These boilers shall only be allowed if approved for non-critical loads.

6.2.3 Packaged Fire-Tube Boilers
Packaged fire-tube boilers may not be used for loads exceeding 23,400,000 BTU/hr. Packaged water tube units are acceptable for any capacity requirement.

6.2.4 Low load Operations
Water-tube boilers shall not be required to cycle on and off. Cycling of fire-tube boilers must be kept to a minimum.

6.3 Pressure control and Relief

6.3.1 Boilers shall be designed with 2 safety relief valves. Lift pressures shall be separated by 5 psi. The capacity of the safety relief valve with the lower set pressure shall be approximately 80% of the boiler capacity. The safety relief valve with the higher set pressure shall be set to the full capacity of the boiler.

6.3.2 Provide dedicated steam pressure reducing valve (PRV) station(s) for each building and for each steam pressure station

6.3.3 Do not provide two-stage PRV station to reduce high-pressure steam pressure.

6.3.4 Provide two PRV's in parallel where significant variation in the steam demand is expected. For such applications, two PRV valves, of uneven sizes should be provided. The smaller valve (1/3 capacity) set at the desired control pressure shall open first and the larger valve (2/3 capacity) set at slightly below the small valve shall open next but only when the smaller valve is unable to meet the increasing load demand and resulting higher pressure drop.

6.3.5 Install a bypass loop with globe valve sized for the flow of the largest valve in the PRV station.

6.3.6 Size safety relief valve to handle the maximum flow of the largest PRV in the station, comply with National Board of boiler and pressure vessel inspectors and ASME code requirements.

6.3.7 Provide isolation valves to accommodate maintenance of the PRVs while maintaining steam flow

6.3.8 Provide a pressure gage at the inlet and outlet of the station complete with isolation valve with a range and construction appropriate for the pressure.

6.3.9 Vent line from safety valve(s) at the PRV station shall be independent of other vent lines and shall extend a minimum of 6 feet above the roof.

6.3.10 For each steam PRV station provide a steam flow meter. Meter shall be connected to the Building Automation System (BAS) and be capable of logging instantaneous flow as well as totalized flow.

6.3.11 Shutoff Valve: For each incoming steam service, provide a shutoff valve and a 4.5-inch pressure gauge with a range appropriate for the pressure being read.

6.4 Condensate

6.4.1 To avoid flashing, the steam condensate gravity return system shall not contain connections between high pressure gravity returns or medium pressure gravity returns with the low-pressure gravity or vacuum return lines. Provide a flash tank, where all gravity returns will reduce pressure and temperature. From the flash tank, the low-pressure gravity return shall flow into the condensate receiver of the condensate return pump. Adjust the elevation of the flash tank elevation to ensure gravity flow into the condensate receiver.

6.4.2 Condensate Storage Tank shall be sized to accommodate surges without overflow. The tank shall be sized for 20 minutes minimum storage to overflow at peak plant output requirements. The A/E must review the condensate handling systems in all buildings to determine if any unusual situations will require a larger condensate storage tank in the boiler plant. Consideration should be given to sizing the tank for future loads.

6.5 Water Treatment Equipment

6.5.1 "Zero Hardness" water must be supplied for boiler makeup.

6.5.2 Water Treatment shall be provided if alkalinity in the makeup water exceeds 50 ppm. The design engineer must obtain a current analysis of the water supply and determine the type of treatment which is necessary. The design engineer must determine if the treated water will cause any substantial corrosion problems and recommend preventative methods.

6.5.3 Life cycle cost studies must be performed to evaluate which type of water treatment equipment will be applied (ion-exchange softener, dealkalizer, reverse osmosis, other systems) as proven successful with local water conditions.

6.5.4 Softeners shall be dual tower to ensure supply during regeneration. Softener size for each tower will be based on 50% condensate return at peak steam loads. Provide connection points for adding capacity through the use of rental equipment in emergency situations.

6.5.5 Bulk brine storage shall be used where possible to avoid material handling if not possible salt storage space adjacent to water softener and dealkalizer. The area should be accessible using fork truck for transport of bulk salt and a lift table provided for loading bags of salt into the tanks.

6.5.6 Boiler Plant Chemical Feed Systems

6.5.6.1 For each chemical used, provide a separate continuous feed system (metering pump) for each boiler or injection point.

6.5.6.2 System shall utilize premixed chemicals in bulk storage tanks with containment, and multiple metering pumps for injection into the system to eliminate the need for mixing and handling of the chemicals.

6.5.6.3 Provide sample coolers and sample points on feedwater, Hot water header supply and return and in the system as directed by the chemical treatment vendor.

6.6 Steam Traps:

Note: Fixed orifice steam traps with no operating mechanism are prohibited due to the small diameter orifices that become plugged with dirt and cause the trap to fail shut. This will cause build-up of condensate in the steam main and dangerous water hammer may occur.

6.6.1 Steam traps remove condensate and air from steam lines while at the same time preventing the loss of steam. A steam strainer shall be installed at the trap inlet to prevent scale or other solid particles from entering the trap.

6.6.2 Float and Thermostatic traps. Provide float and thermostatic (F & T) traps for all heating equipment having modulating loads such as heat exchangers, domestic hot water heaters, modulating control valves (where used) for preheat coils and equipment with modulating loads. Provide minimum 12 inches static head for the trap operation (18 inches where space permits). Size all F&T traps at 0.25 psig pressure drop. Capacity of a single trap shall not exceed 5,000 lbs./hr.

6.6.3 Inverted Bucket Trap. Steam traps on the steam line drip points shall be inverted bucket type, with bi-metallic thermal element for air removal. The trap pressure differential shall be 80% of the operating line pressure.

6.6.4 Drip traps shall be sized for the line radiation loss multiplied by 3 for start-up needs. (Condensate forms at a greater rate during warm up.)

6.6.5 Traps serving terminal heating equipment shall be sized for their steady state condensate load multiplied by 2.5 for startup needs.

6.7 Pumps

6.7.1 Provide one standby pump for each service except boiler feed systems where one pump is dedicated to each boiler. Pumps shall operate continuously rather than on-off. Motor kW (hp) shall be selected to be non-overloading at any point on the pump performance (head - capacity) curve with the largest available impeller. Variable frequency drives controlling discharge pressure may be applied on pumps equal to or greater than 7.5 hp.

6.7.2 Condensate Return Pumps

6.7.2.1 Provide duplex condensate pumps, complete with a receiver, to return steam condensate to the boiler plant.

6.7.2.2 Provide emergency power for the pumps and controls.

6.7.2.3 The pumps shall be of a centrifugal type and shall generally be selected to operate at 1750 rpm.

6.7.2.4 Pumps shall have a manual run mode that is not dependent on a PLC

6.7.3 Boiler Feed Pumps

6.7.3.1 Arrangement shall be one pump dedicated to each boiler, with cross connections allowing each pump to provide emergency service to one other boiler. In the largest plants it may be advantageous to provide a boiler feed header system with all pumps supplying the common header.

6.7.3.2 High efficiency multi-stage centrifugal pumps are preferred. Two-stage horizontal split case centrifugal pumps may be applied on larger plants if the life cycle cost is less than for multi-stage.

6.7.3.3 Provide emergency power to the pumps and controls

6.7.3.4 Pumps shall have a manual run mode that is not dependent on a PLC.

6.7.3.5 The pumps shall be of a centrifugal type and shall generally be selected to operate at 1750 rpm.

6.7.3.6 Allow space for a future pump.

6.8 Feedwater deaerators

6.8.1 Deaerators shall be provided to reduce corrosion. Due to enhanced turndown capabilities, tray and packed column types shall be used if there is sufficient building height available for the deaerating section which is mounted on the deaerated water storage tank. Where height is limited, spray-type units may be used.

6.8.2 The deaerated water storage tank shall be sized for 20 minutes storage from overflow level at peak plant output requirements. Consideration should be given to sizing the feedwater deaerator for future loads. Packaged boiler feed pump/deaerator units should not be applied except where there are space limitations.

6.9 Blowdown:

6.9.1 Blowdown is required to remove precipitated sediments and control the concentration of chemical additives by a valve. Continuous or intermittent manual blowdown may be used. Steam boilers shall be blown down at least once every eight hours.

6.9.2 Blowdown Tank:

6.9.2.1 The tank shall be located within the boiler plant building or room.

6.9.2.2 The blow-down tank inlet shall be at an elevation below the elevation of the blowdown header to prevent sludge from accumulating below the header. Where this is not possible provide water flushing system to clean trapped horizontal blowdown lines.

6.9.2.3 Provide a drain with manual valve on the blowdown line to allow draining of the boilers.

6.9.2.4 Blowdown tank size shall be in accordance with the recommendations contained in the Rules and Recommendations for the Design and Construction of Boiler Blowdown Systems published by the National Board of Boiler and Pressure Vessel Inspectors, Columbus Ohio.

6.9.2.5 Blowdown tank volume shall be twice the volume of water contained in a four-inch blowdown of the largest boiler.

6.9.2.6 Provide an automatic temperature control system which uses either a blowdown recovery unit (preferred) or A blowdown cooler to limit the temperature of the water going to the sewer to 140 degrees F.

6.10 Emergency Power

6.10.1 A UPS must be provided to ensure that the control system is kept functional during power outages and transition.

6.10.2 Engine-Generators: Central plant shall be equipped with a dedicated generator/ATS located in appropriate room(s)/enclosure accessible by the operator without leaving the plant.

6.10.3 Any boiler that is decentralized shall be equipped with a dedicated automatic Transfer switch and powered by the facility electrical emergency service.

6.10.4 Generators, ATS and other components which comprise the Emergency Power Supply System (EPSS) shall be installed, operated, tested and maintained in accordance with the latest edition of NFPA 110, Standard for Emergency and Standby Power Systems and with VHA Directive, Electrical Power Distribution System (latest version).

6.10.5 Sites with electric steam generators must have those generators connected to either the facility's essential electrical system (emergency power system) or a standby power

system(s) dependent on the facility's risk analysis. On-site storage of generator fuel for boiler use must be sufficient for a minimum of 96 hours of continuous operation.

7.0 FUEL

7.1 General

7.1.1 Perform an engineering economic analysis to determine the lowest life cycle cost of various fuel options. If a fuel other than fuel oil is proposed, it must be approved by CFM and VHA HEFP. A full life cycle cost analysis, narrative of the analysis and justification and a full risk analysis of the operation of the system must be submitted for review and approval.

7.1.2 When considering fuel options, determine the reliability of the supply and the feasibility of using each fuel. Where natural gas is utilized, provide a second fuel (such as fuel oil or propane), stored on the site, as a standby.

7.1.3 Analysis of fuel must consider permitting and emission limit impacts on equipment.

7.1.4 Conform to local, federal, and state emissions regulations.

7.1.5 Boiler fuel of choice is natural gas for reasons of supply security, equipment life and environmental compliance.

7.1.6 Propane shall be used for the operation of igniters (pilots) when natural gas is not available or has been interrupted. If natural gas is normally utilized, the LP gas igniter system is for emergency use only. The LP gas igniter system shall operate at 5 psig or less. The VAMC will supply replaceable propane cylinder tanks. The A/E must design the tank, piping and valve system that is located in a room on an exterior wall that has access from inside of the plant and from the outside.

7.1.7 Standby Reserve Fuel storage quantity

7.1.7.1 Facilities firing oil as fuel shall maintain a supply of fuel sufficient to meet the normal demands of continuous operation for a period of 15 January days. If the facility is equipped with a backup source of fuel such as natural gas, propane or coal, the oil supply can be reduced to 10 days. The combination of on-site primary and backup fuel supply must be sufficient for 15 days of continuous operation in January. Plants that generate less than 50 percent of their annual steam demand by natural gas for two consecutive years are considered to be oil-fired and shall meet the supply requirements for oil-fired plants.

7.1.7.2 Facilities firing natural gas as the main fuel with fuel oil or propane back-up shall maintain a sufficient supply of back-up fuel to meet the normal demands of continuous operations for a period of 10 January days. The use of propane as a back-up fuel source requires prior approval from the VHA Central Office of OHE.

7.2 Natural Gas

7.2.1 Header pressure in the boiler plant shall be as low as practical which, for water tube boilers is 70 - 100 kPa (10 - 15 psig) and, for fire tube boilers is 35 - 70 kPa (5 - 10 psig). Higher gas pressures may be required for low-NOx burners or high turndown burners. Coordinate system design with requirements of local gas supplier.

7.2.2 Provide separate gas meter for the boiler plant.

7.2.3 Provide emergency Gas shut off valve with emergency stop buttons at each exit from the plant or room. Protect buttons from accidental activation and provide signage to identify the purpose.

7.3 Fuel Tanks

7.3.1 May be located underground or aboveground. Provide secondary containment systems on tanks and piping. All steel buried tanks, piping, and secondary containment shall be coated and cathodically protected.

7.3.2 Provide electronic leak detectors located in the interstitial spaces of the tanks and in piping systems between the carrier pipes and outer casings. Provide spill and overfill prevention measures as required by pollution control authorities.

7.3.3 The use of day tanks is not preferred and should only be used when there is a situation that mandates such an arrangement.

7.3.4 Tanks shall have an automatic system for monitoring/measuring fuel level and alarming high and low levels. The system shall have both audible and visual indication and annunciation locally and at the operator station.

7.3.5 Tanks shall be equipped with recirculation filtering systems to ensure fuel quality.

7.4 Fuel pumps

7.4.1 Gear, lobe or screw style pump shall be used for boiler feed.

7.4.2 Fuel oil pumps shall be sized to accommodate the maximum flow based on the maximum design steam output with a 10% safety factor for future expansion or the known master plan expansion plan whichever is greater.

7.4.3 Fuel oil pumps shall be located above grade and protected from potential flooding due to weather or other action. There shall be a housekeeping pad for each pump or pump system.

7.4.4 Pumps arrangement shall be duplex with one operating and one standby.

7.4.5 Pump skid shall be equipped with a duplex strainer on the suction of the pumps and connections on the supply and discharge for emergency connection to the system.

7.4.6 Each pump will be equipped with a safety relief valve that relieves to the tank return complete with site glass to inspect for flow. The system shall have a backpressure control valve and associated pressure relief valves.

7.4.7 The system shall have a supply and return flow meter in the piping to the boilers system.

7.4.8 Refer to standard detail on the TIL for additional information.

7.4.9 Pumps shall be of a type suitable for the application and shall generally be selected to operate at 1750 rpm.

7.5 Fuel Oil piping

Oil piping shall be located in trenches to reduce hazard caused by leaks and air binding. Provide accessible drains in trenches for cleaning and removal of water from plant or rain. All drains serving chemical and petroleum systems shall be equipped with an oil/water separator (OWS). OWS shall be accessible for pumping by a vacuum truck.

8.0 BURNERS

8.1 Automated shutdown- When steam pressure is greater than demand sensed, the following shall occur:

8.1.1 The damper will return to low fire position
8.1.2 The operating limit control opens
8.1.3 The main fuel valve circuit is de-energized, main fuel valve closes.
8.1.4 Flame is extinguished
8.1.5 The running lights on the control panel turn off
8.1.6 The blower motor continues to force air through the boiler for the post purge period.

9.0 COMBUSTION AIR

9.1 An adequate air supply provides for clean, safe combustion and minimizes the formation of soot.

9.2 The boiler room shall have two combustion air openings to ensure adequate combustion air and proper ventilation: one within 12 inches of the ceiling and the other within 12 inches of the floor. Each opening shall have a minimum free area of 1 inch squared per 2000 BTU/hr. input rating (of all burners required to carry maximum load at full capacity). The designer shall ensure the plant is not negative with all boilers required to carry maximum load running at full load.

9.2.1 Calculations for combustion air openings must include the boilers required to carry the peak load operating at 100 percent. Note: In most cases this will be the two largest boilers at 100 percent.
9.2.2 The emergency generators must have their own fresh air intake independent of the intake calculated for the boilers
9.2.3 CO-Gen/CHP equipment shall be calculated separately and have separate fresh air intakes

9.3 Combustion air fans shall be equipped with variable frequency drives. The Fan and VFD must be sized and set at the speed required for the two largest boilers running at full capacity.

9.4 Combustion dampers shall be interlocked with the boiler firing cycle. Manually operated dampers prohibited.

9.5 Fixed open dampeners do not need to be interlocked with the burners.

9.6 Motorized dampeners and Combustion Air Fans shall be interlocked with the boilers/burners. Combustion air shall be proven prior and during operation of the burners.

9.7 Motorized dampeners and Combustion Air Fans shall have a secondary means of providing and proving combustion air to the plant with an interlock that is parallel to the primary system. For example, a garage door in the opened position.

9.8 Burners:
Provide low excess air design, with oxygen trim, on larger water tube boilers when justified by life cycle cost analysis. Provide low NOx burners (not to exceed 30 ppm) unless lower emission concentration is required by emissions authorities and local AHJ. Written confirmation of the AHJs requirements shall be obtained for the record.

9.8.1 Dual Fuel Burners: Dual burners are the required for VA Hospital applications. Burners shall be of the low pressure, air atomizing (nozzle) type. Burners feature ignition by spark-ignited gas pilot flame. With either fuel, the burner operates with full modulation. A switch permits changeover from automatic fully modulated firing to manually set firing at any desired rate between minimum and maximum. Additional safeguards

assure that the burner always returns to minimum firing position for ignition. Dual burners are designed for automatic, unattended operation except for periodic inspection and maintenance. After selecting the proper overload settings for the starter, the rest of the control panel components require little attention except for occasional cleaning. Burner fuels to be used shall be based on availability and frequency of service interruption.

9.8.1.1 The change from one fuel to another must contain hard wired switch interlocks to ensure the controls align with the fuel supply. Additionally, the changeover shall not require changes to the fuel system piping or controls by the operator. Changeover shall also be accomplished without the need for special tools or hoisting equipment and should be able to be completed within 20 minutes by one operator.

9.8.1.2 Operating Controls: The burner is supplied with a remote-control panel and with a burner mounted junction box.

9.8.1.3 The control panel contains a flame safeguard programming control, motor starters, relays, time delays and terminal strips mounted internally on a panel sub-base. Lights, switches, potentiometers, a control circuit breaker, and flame safeguard displays are mounted externally on the panel. The burner control circuit operates on 115-volt, single phase, 60 hertz (or 50 hertz when required) alternating current. The flame safeguard and burner control shall be in separate cabinets to ensure complete separation and ease of troubleshooting. The wiring shall be independent and not passed through or dual use.

9.8.2 Gas Burners:

9.8.2.1 Gas train shall be in accordance with International Risk Insurance (IRI) Standards and shall meet the requirements of NFPA 85 – Boiler and Combustion Systems Hazard Code – para 6. Single fuel burners are not recommended for Hospital applications.

9.8.2.2 The burners shall be the power type and constructed of stainless steel.

9.8.2.3 The firing shall be electronically controlled and shall continually monitor the steam pressure, modulating the burner for the most efficient operation. The controls will allow for manual/auto operation of the firing rate of the burner.

9.8.2.4 Maintain, service, inspect, and operate gas burners in accordance with the manufacturer's operation and service manual.

9.8.3 Oil Burners:

9.8.3.1 Oil burners must atomize and vaporize oil to get the oil into combustible form. Large burners usually prepare the oil for combustion by first atomizing the fuel and injecting it into the combustion space for final heating, vaporization and mixing with combustion air. Single fuel burners are not recommended for Hospital applications. Atomization is generally obtained by one of the following methods:

9.8.3.1.1 Horizontal Rotary Cup type:
In this method, a thin film of oil is spun from the rim of a cup being rotated at high speed. The oil enters a cone of high velocity

primary combustion air where atomization is obtained. This type of burner is capable of high maintenance costs and efficiencies.

9.8.3.1.2 Mechanical Pressure Atomizing type:
This method expands the oil by pressure through a small orifice thereby breaking it into a spray of very fine droplets. This burner is not adaptable to appreciable modulation as a drop in pressure results in rapid deterioration in atomization efficiency. Mechanical atomization requires the highest oil pressure and yields the poorest performance.

9.8.3.1.3 Steam Atomizing type:
In this method, oil is delivered to the nozzle at pressures ranging from 40 to 150 psig with steam pressure not less than 20 – 50 psig. In most cases, steam atomizing can produce a turn-down of up to 10:1 at high efficiency. Steam for atomization must be dry as moisture causes erosion which impairs burner performance and causes pulsations which leads to loss of ignition. If steam is wet, oil cannot be properly atomized regardless of the amount of steam utilized. In general, some superheat, possibly up to 50 degrees F, is desirable. The steam supply line should be of proper size, well insulated, and adequately drained. The first cost of a steam atomizing system is less, but it is about 1 percent less energy efficient than air atomization. The steam atomizing burner has a higher turndown rate than the air-atomizing types and is used whenever air atomization cannot obtain the same turndown ratio.

9.8.3.1.4 High-Pressure Air Atomizing type:
This method is similar to the steam-atomizing type except air under pressure is used instead of steam. High-pressure air atomizing burners utilize air pressures of 30 psig and above and can operate within the same range of oil pressures and preheat temperatures as the steam atomizing type.

9.8.3.1.5 Low Pressure Air-Atomizing type:
This system generally operates within ½ to five psig air pressure and five to 20 psig oil pressure.

9.8.3.1.6 Low-Excess Air type:
These burners are designed to operate with excess air down around 5 percent. These burners are high in first cost and require excessive supervision and maintenance. Low excess air burners are used mainly to reduce nitrogen oxide (NOx) emissions. Only provide low NOx burners if required by the emissions authorities.

9.8.3.1.7 Low-NOx type:
Low-NOx burners have a wide variety of designs. The principle of all low-NOx burners is the same; they inherently generate lower NOx emissions due to internal staging of fuel combustion. The Low NOx burners are equipped with a Flue Gas Recirculation system (FGR). The flue gases are duct to the air housing and the burner combustion air fan is used to pull flue gases from the stack. The FGR rate is controlled by damper blade linked to the modulating

motor. Top or bottom connection is used with a flanged adaptor to the damper box. Fresh air and FGR is mixed and injected in the combustion zone. All FGR duct piping should be covered with a minimum of 2-inches of insulation and supported as required. The burner is designed to operate with < 30 ppm NOx corrected @ 3-percent O2 throughout the firing range, when firing natural gas. See reference: EPA/625/5-86/020, Nitrogen Oxide Control for stationary Combustion Sources. Follow burner manufacturer's recommendations for optimum operational efficiency at low NOx burner operation.

9.8.3.2 All oil burners should have two guns, one active and one spare so that one may be removed for cleaning while the other may be available for immediate use.

9.8.4 Automated shutdown: When pressure is greater than demand sensed, the following will occur:

9.8.4.1 The damper will return to low fire position
9.8.4.2 The operating limit control opens
9.8.4.3 The main fuel valve circuit is de-energized, main fuel valve closes.
9.8.4.4 Flame is extinguished
9.8.4.5 The running lights on the control panel turn off
9.8.4.6 The blower motor continues to force air through the boiler for the post purge period.
9.8.4.7 Burner shall be manually restarted by an operator once the pressure drops.

10.0 BOILER STACK AND EMISSIONS

10.1 Boiler stack location, height, and diameter shall be determined by an engineering study conducted by a licensed professional engineer, which considers boiler/burner operational requirements, air flow around the stacks and the boiler plant and adjacent buildings, and emissions regulations. Stack gases shall not affect fresh air intakes of building ventilating or air conditioning systems. Comply with federal, state, and local emissions regulations.

10.2 Generally, individual stacks on each boiler are required. A common breeching and single stack system for all boilers may be approved if documentation is provided to support the need of the request due to specific project conditions. A request for variance shall be submitted in writing through HEFP for review and approval.

10.3 Locate diesel engine exhaust outlets so that they do not mix with building intake air.

10.4 Stacks shall be designed to provide adequate natural draft. A stack generally shall extend at least 10 feet above the highest point on the roof.

10.5 The size of the stack shall not be smaller than that recommended by the boiler manufacturer. Wherever possible, the outlet area should be sized to provide a discharge velocity at a maximum gas flow of 2000 to 3000 feet per minute.

10.6 Vents, stacks, and chimneys shall comply with NFPA 54 and NFPA 210.

10.7 Gas mains, burner headers, gas piping, etc., shall be vented according to the criteria in NFPA 85A, Prevention of Furnace Explosions in single Burner, Boiler-Furnaces and NFPA 85B, Prevention of Furnace Explosions in a Gas Multi-Burner Boiler.

10.8 Boilers shall be equipped with outlet air dampeners regardless of whether the boiler has a dedicated stack.

11.0 CONTROLS AND INSTRUMENTATION

11.1 Controls

11.1.1 Multi-loop industrial safety critical process programmable digital controllers are required for all control functions except burner management where specialized digital controllers are required.

11.1.2 Parallel-positioning combustion controls are required for boilers ranging from 100 through 900 boiler Horsepower. For smaller fire tube boilers, a single-point positioning control is more practical.

11.1.3 Controls added to existing systems shall be the same manufacture and type as existing.

11.1.4 Controllers shall be password protected at a minimum of 3 levels. Level 1 operator can only make operational limit changes or go from manual to automatic firing rates. Level 2 qualified service tech access start-up and burner tuning. Level 3 factory level for programing. The VA shall be given a means to change and control Level 1 and Level 2 password and access. A level 2 password that everyone knows and is published in the service manual is not a password nor does it control access.

11.2 Safety devices

11.2.1 Steam Boilers shall be equipped with safety devices as defined in the most current edition of the VA boiler plant safety device manual. Electric steam boilers will comply with all elements of the manual minus the fire side requirements; however, it shall be equipped with electrical safety devices as defined by the manufacture. In addition to the requirements of the manufacturer an automatic shunt trip and two remote emergency stop buttons (one in the area of the unit and one at a centrally monitored location) shall be provided on the electrical power supply.

11.2.2 Emergency fuel cut-off switches (panic buttons) shall be located at each point of egress from the plant and in the control room. The switches shall close the Natural Gas shutoff valve to the plant and de-energize all fuel oil pumps.

11.3 Automatic/Remote Starting (light off)

11.3.1 There shall be no automatic/remote restart of boilers after the occurrence of a fault. Faults shall activate a latching switch which must be manually reset at the boiler.

11.3.2 There shall be no lead lag systems with automated/remote cycling of boiler.

11.3.3 In addition to digital controls, the boilers shall come with an analog local loop control system for manual operation when the digital system is down.

11.3.4 All controls shall meet the requirements of ANSI Standard Z21.13 and NFPA 85 – Boiler and Combustion Systems Hazard Code – paragraph six for Automatically Fired Boilers. The controls include ignition safeguard, high temperature limit, operating temperature control, gas pressure regulator, redundant electric gas valve, water flow sensing, and a manual shut off valve.

11.4 In addition to the requirements of the manufacturer, an automatic shunt trip and two remote emergency stop buttons (one in the area of the unit and one at a centrally monitored location on the same campus) shall be provided on the electrical supply. Monitoring and data management:

11.4.1 BACNet or LONWORKS protocol Direct Digital Controls (DDC) shall be used for connection to the BAS.

11.4.2 Centralized Boilers and system data shall be monitored by the BAS for data collection and logging.

11.4.3 Distributed boilers shall be monitored through a building control system at a centrally monitored location. Control system shall be supervised and monitor alarm and log status, faults and safety equipment/devices. Data shall be logged for review of performance and faults.

11.4.4 Shall be by means of a Supervisory Control and Data Acquisition (SCADA) program on a computer workstation reserved for only boiler system monitoring. There shall also be annunciation of alarms, pressure switches, and other operating displays on instrument panels within easy view of the attendant/operator. Controls added to existing systems shall be the same manufacture and type as existing.

11.5 Low-Water Cutoffs: Low water cutoffs, recycle and non-recycle, shall be provided to shut off the boiler in case of low water level in a boiler. The switches shall alarm locally and at the operator station with an audio/visual indication. The reset for the recycle switch must be local to the boiler to ensure the operator verifies the cause of the situation and investigates the impact prior to resetting. The non-recycle switch shall require a manual boiler restart.

12.0 OPERATION OF BOILERS

12.1 Operational Requirements

12.1.1 Designer shall ensure that all the operational requirements defined below can be accommodated with the equipment and systems provided. In some cases, additional connections or specific equipment for testing, and calibration may be required and must be specified and designed into the system (sample taps, test equipment, etc.).

12.2 Inspections

12.2.1 A testing and commissioning plan shall be developed and approved prior to the start of construction to ensure all elements are in place to accommodate successful completion. All systems shall be designed to allow for field calibration, inspection, and testing upon completion of the boiler installation. The appropriate documentation shall be provided for the purpose of receiving an operating certificate.

12.2.2 Boilers and safety devices shall be designed and installed to accommodate testing as defined in the VHA boiler safety device test manual and in accordance with the laws of the local jurisdiction.

12.3 Cleaning

12.3.1 Boilers: New and repaired boilers will contain internal surfaces that have been coated with oil. This must be removed prior to operation to avoid corrosion. A boil out chemical compound shall be used. This process requires prior planning and coordination

therefore the manufacturer shall be consulted to develop a written plan and schedule for the process.

12.3.2 Chemical cleaning shall be used to remove any hard scale from interior surfaces. The manufacturer shall be consulted, and the process approved by HEFP prior to executing work. Any sort of deposit will reduce the effectiveness of the heat transfer process.

12.3.3 All steam, condensate, and oil piping within the plant shall be flushed and cleaned to remove all dirt, debris, oil, and scale. The flushing shall be accomplished at a minimum of 3 fps and the cleaning shall address the removal of mill scale and other contaminants in the pipe. A detergent flush shall be used to remove oils used in packaging of the piping.

13.0 FREEZE PROTECTION

13.1 Heat Tracing systems are not recommended for systems inside the building. It is not visually apparent that a heat cable has failed.

13.2 When terminal devices are in contact with freezing ambient air, steam is the preferred choice for the heat source.

13.3 The condensate created when steam is used for freeze protection may be returned to the boiler.

14.0 MODIFICATIONS TO EXISTING PLANTS

14.1 In addition to the equipment required for operation, the design shall provide a standby boiler and standby pumps during all phases of construction.

14.2 Temporary boilers and other equipment may be employed if cost effective.

15.0 CODES & STANDARDS

ASME section I Power Boilers
- ASME B31.1 – Code for Pressure Piping
- ASME B31.9 – Code for Pressure Piping, (Plants which do not generate steam over 15psig)

National Board of Boiler Inspectors Code Part 1

National Fire Protection Association
- NFPA 31 – Standard for the Installation of Oil Burning Equipment
- NFPA 70 – National Electrical Code
- NFPA 70E – Standard for Electrical Safety in the workplace
- NFPA-85 – Boiler and Combustion Systems Hazard Code
- NFPA 110 – Standard for Emergency and Standby Power Systems

VHA Directive 1028 – Electrical Power Distribution System

Comply with all federal, state and local codes, laws and regulations whichever is more stringent. Comply with federal executive orders and all nationally recognized industry standards (NFPA, ASHRAE, etc.).

16.0 REFERENCES

16.1 Design Manuals (PG-18-10); HVAC Design Manual for New, Replacement, Addition and Renovation of Existing VA Facilities: Department of Veterans Affairs, Office of Construction and Facilities Management.

16.2 Unified Facilities Criteria (UFC) Central Heating Plants UFC 3-430-08N

16.3 GSA P100 Facility Standards for Public Buildings Service

16.4 EPA/625/5-86/020, Nitrogen Oxide Control for Stationary Combustion Sources.

16.5 Heating Boiler Operators Manual, Mohammad A. Malek, 2007 McGraw-Hill

16.6 Cleaver Brooks – Boiler Room Guide

16.7 Code Requirements – International Mechanical Code latest edition

16.8 The VA Safety Device Testing Manual

16.9 VA Directive - Boiler and Boiler Plant Operations

16.10 VHA Directive 1028, Electrical Power Distribution System

16.11 VHA standard details on the TIL.

16.12 VA CFM Physical Security and Resiliency Design Manual (PSRDM), latest edition

16.13 29 CFR 1910