REPLACE STEAM BOILERS

Northern Arizona VA Health Care System

649-22-104

Design Narrative & Option Descriptions – CD Set
06/26/2025

I. Project Summary (Executive Summary)

Useful Life Expectancy:

The useful life expectancy of the existing Water Tube boilers is 40 years. The existing campus steam boilers were manufactured and installed in 1975 approaching 46 years and are past their useful life. Boilers, condensate and DA tanks completed a useful life study in September 2024 with a satisfactory condition report for continued utilization. The associated plant PRV station and its associated valves, traps and specialties are beyond their useful life expectancy. The boiler plant header isolation valves, traps and warmup bypass valves are beyond their useful life expectancy. The boiler plant has been well maintained and safety device tested per the September 15-17, 2020 Boiler Plant Safety Device Training and Testing were 87% compliant. Currently known deficiencies are:

- ESTOPS are not installed on the existing boiler plant exits.
- Combustible gas monitoring is currently installed above and near the gas trains and needs to be installed near the boiler plant roof.
- ACM in Boiler building.
- Boiler chemicals are currently added manually. Automatic chemical feed system should be installed.
- The existing boilers extended life expectancy is beyond 2025.
- No fire suppression in control room.
- No secondary means of egress from mezzanine.
- Roof membrane near end-of-life expectancy.
- Boilers lacking lockout / tagout capabilities.
- Existing communications closet does not meet VA guidelines.
- Plant piping, PRV and header.
- Deaerator, condensate and flash tanks.
- Condensate transfer pump, chemical feed pumps, water feed pumps, sump pumps and generator fuel pump.
- Gas fuel train.
- Gas and steam meters.

- Air intake louvers
- Control Room must have views for all boilers.

This project is to correct the deficiencies, replace the boilers and controls, and bump out the control room to provide line of site to each boiler's fronts and controls.

Design Conditions:

The ASHRAE 99.6% winter outdoor design temperature for Prescott Arizona per the HVAC Design Manual (2019), is 17.7 degrees F. The 0.4% summer design temperature is 94.4 degrees F. Historical hourly load data from the boiler plants calibrated flow meters is summarized in Section V. of this report were utilized to determine maximum steam loads.

Existing Conditions:

The three existing boilers are each 12,000 LBS/HR, 350 BHP, High Pressure Water Tube boilers. Manufactured by E.Keeler Co., S.W.P. 200, W.W.H.S. 255, and B.H.S. 1,475. The total N capacity with two of the three boilers in operation is 24,000 LBS/HR with the third boiler an additional +1 of 12,000 LBS/HR. Boiler #1 burner has been modified to provide a slightly reduced capacity and is utilized during summer months of low load.

BOILER NAME PLATES

The boiler plant is currently being operated to provide 70 psig high pressure steam to the plant steam header. The 70 psig header has maintained 35 psig to the distribution system. The associated plant PRV station and its associated valves, traps and specialties are beyond their useful life expectancy. The boiler plant header isolation valves, traps and warmup bypass valves are beyond their useful life expectancy.

EXISTING 1/3-2/3 PRV STATION

EXISTING STEAM HEADER

Existing chart recorders have been abandoned and replaced with electronic indication. Control panels are outdated and in need of replacement. The existing control panels shown below will be removed and replaced with new boiler controls with a BACnet reporting interface to the new plant BAS system. The existing gas monitoring system has been upgraded and can be reused and modified to relocate the existing flammable sensors. The existing stack economizers are newer than the boilers but will be replaced with new units to match the new boiler capacities.

EXISTING PLANT CENTRAL CONTROL PANEL

EXISTING GAS MONITORING

EXISTING BOILER CONTROL

EXISTING STACK ECONOMIZER

During the 35% review, it became apparent that the existing Deaerator, DA tank, and Chemical Feed Systems needed to be added to the design. These items are past or close to life expectancy and were important to include in this scope of work to minimize down time and future down time to install and update these systems. This will also reduce the VA overall construction costs to include in this project. The Deaerator, DA tank, and Chemical Feed Systems were sent out as a change order and approved to be part of the scope of work on this project.

During the 95% review, the team realized the following deficiencies for the boiler plant. No fire suppression in the control room. No secondary egress from mezzanine. Roof membrane needs to be replaced. Lockout / tagout capabilities lacking on existing valves and equipment. The Communications closet did not meet VA design guide requirements. The existing boiler blowdown tank and ventilation exhaust fans were also found to be past their useful life. The design was then updated to accommodate said deficiencies.

Fire Safety:

This project is to add a fire riser and fire suppression system to the control room for the Boiler Plant. This will tap into the existing 6 inch domestic waterline that has an existing 80 PSI. This is a small area that will not require much pressure or water flow. This fire suppression system will include flow valves, monitoring monitors, and adding monitoring into the existing fire alarm control panel for the fire suppression system.

Based on previous comments an Extra Hazard Group 2 (EH2) occupancy is the most demanding area for the project. From NFPA 13, and EH2 occupancy requires a density of 0.40 gpm/sq.ft. over 2500 sq.ft. for a water demand of 1000 gpm. Adding a safety factor (1.3) and a hose stream of 500 gpm the total anticipated demand is 1800 gpm. Using 6” PVC Class 200 at 1800 gpm and approximately 75’ length we can expect a pressure loss of 8.5 psi. The latest water flow test information provided indicates 130 psi static available near the project site. Based on this information a 6” minimum fire line should be sufficient to support the project fire suppression system.

Hazardous Material Abatement:

The current 100% design submittal identifies several feet of existing piping and all associated fittings, supports and hangars requiring demolition, removal, and disposal off site to make way for the installation of the new proposed piping, fittings, accessories, supports, instrumentation, and insulation. Additional scope to demolish steam and steam condensate return piping has been added. We have included drawings that define the scope of work and demolition required.

Any additional asbestos that may be encountered during construction would require we set aside as a contingency a sum of funds to cover the costs of this unforeseen abatement should it occur. Our design documents will require the Contractor to randomly sample specific suspect materials prior to demolition to confirm no ACBM's are present.

The VA standard for testing existing materials will be followed. We will require the general contractor to test all insulations, and/or suspicious materials before demolition begins.

Required Boiler Capacity:

From section VI below the calculated required steam load for the facility assuming a 10% growth factor is 13,970 lbs/hr or approximately N=400 BHP. During the summer months the load decreases to 6,380 lbs/hr or approximately 200 BHP.

In conclusion the existing boiler system is oversized and the boilers are beyond their life expectancy. The recommended replacement is and will be three 300 BHP boilers to meet the N+1 requirement.

Recommended Options:

To verify the best value to the government, three different concept designs were evaluated. They were evaluated on overall costs, pluses and minuses, and how well they met the project objectives. The option that was least cost and highest value was chosen.

This project will provide the VA with new safe and reliable high pressure natural gas – fuel oil steam boilers that meet the required VHA safe operating requirements and safety device testing requirements. These new boilers will be safe, reliable, and efficient at a good cost to the government.

II. Applicable Standards

The design will comply with the latest adopted edition of all applicable codes and standards including, but not limited to:

- VA Directives and Design Manuals:
  - PG-18-1 Master Construction Specifications, 2004
  - PG-18-3 Design and Construction Procedures, 2020
  - PG-18-4 Standard Details and CAD Standards, 2008

- PG-18-10:
  - 2014 Architectural Design Manual
  - 2019 Electrical Design Manual
  - 2015 Fire Protection Design Manual
  - 2017 HVAC Design Manual
  - 2020 Interior Design Manual
  - 2015 Lighting Design Manual
  - 2020 Physical Security & Resiliency Design Manual (Life Safety Protected Facilities)
  - 2018 Plumbing Design Manual
  - 2014 Structural Design Manual
- Infrastructure Standard for Telecommunications Space
- Directive 1810 – Boiler and Boiler Plant Operations
- Boiler and Associated Plant Safety Device Testing Manual, Seventh Edition
- Steam, Heating Hot Water, and Outside Distribution Systems Design Manual

- 2018 International Building Code (IBC) including International Mechanical and Plumbing Codes (Only when specifically referenced in VA Design Documents, see notes below)
- 2018 NFPA 101 Life Safety Code (see notes below)
- 2018 NFPA National Fire Codes with the exception of NFPA 5000 and NFPA 900.
- 2023 NFPA 85, Boiler and Combustion Systems Hazards Code
- Occupational, Safety and Health Administration (OSHA) Standards
- VA Seismic Design Requirements, H-18-8
- National Electrical Code (NEC)
- IEEE C2-2017 National Electrical Safety Code (NESC)
- International Plumbing Code (IPC)
- ASME Boiler and Pressure Vessel Code
- ASME Code for Pressure Piping
- 2015 Architectural Barriers Act Accessibility Standards (ABAAS) including VA Supplement, Barrier Free Design Guide (PG-18-13)
- Building Code Requirements for Reinforced Concrete, American Concrete Institute and Commentary (ACI 318)
- Manual of Steel Construction, Load and Resistance Factor Design Specifications for Structural Steel Buildings, American Institute of Steel Construction (AISC)
- Energy Policy Act of 2005 (EPAct)
- DOE Interim Final Rule: Energy Conservation Standards for New Federal, Commercial and Multi-Family High-Rise Residential Buildings and New LowRise Residential Buildings, 10 CFR Parts 433, 434 and 435.
- Federal Leadership in High Performance and Sustainable Buildings: Memorandum of Understanding (MOU)
- Executive Order 13423: Strengthening Federal Environmental, Energy, and Transportation Management
- The Provisions for Construction and Safety Signs to be stated in the General Requirements, Section 01 00 00, of the VA Construction Specifications
- Ventilation for Acceptable Indoor Air Quality – ASHRAE Standard 62.1- 2004.
- Electrical Standards – ASHRAE Standard 90.1
- IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems

- ASHRAE 55
- ASHRAE 62
- Occupational, Safety and Health Administration (OSHA) Standards
- VA Seismic Design Requirements, H-18-8 (2019)
- Building Code Requirements for Reinforced Concrete, American Concrete Institute and Commentary (ACI 318-14)
- TMS 402-16 Building code requirements & Specifications for Masonry
- Manual of Steel Construction, Load and Resistance Factor Design Specifications for Structural Steel Buildings, American Institute of Steel Construction (AISC)

NOTES:

1. NFPA 101 primarily addresses life safety and fire protection features while the IBC addresses a wide range of considerations, including, but not limited to, structural strength, seismic stability, sanitation, adequate light and ventilation, and energy conservation. VA buildings must meet the requirements of NFPA 101 and documents referenced by NFPA 101 in order to comply with the accreditation requirements of The Joint Commission. Therefore, designs shall comply with the requirements of the latest edition of NFPA 101 and documents referenced therein. Design features not addressed by NFPA 101 or documents referenced therein shall comply with the requirements of the latest edition of the IBC or as otherwise addressed above in this Program Guide. For design features that are addressed by both the IBC as well as NFPA 101 or a document referenced by NFPA 101, the requirements of NFPA 101 or the document referenced by NFPA 101 shall be used exclusively (this applies even if the IBC requirements are different). VHA PROGRAM GUIDE PG-18-3 September 2013 3 of 3
2. Conflicts between Nationally Recognized Codes and Standards and VA Requirements – Should a conflict exist between VA requirements and VA adopted nationally recognized codes and standards, the conflict shall be brought to the attention of VA. The resolution of the conflict shall be made by the authority having jurisdiction for VA to ensure a consistency system wide.

III. Design – Boilers

a. Rent two skid or trailer natural gas/ diesel 250 BHP and one 200 BHP temporary boilers. Temporary boilers to be located exterior to the boiler plant. Connect 100 PSI steam piping to plant distribution piping, condensate return, natural gas, diesel and feed water systems.

b. Install piping, drainage, and electrical for temporary skid boilers. Two 250 BHP boilers 100psig.

c. Remove all ACM for the affected work area.

d. Install new steam and condensate return piping insulation.

e. Remove and replace existing boiler plant wall, window and catwalk to allow removal of existing and installation of new boilers.

f. After the Temporary boilers are operational and during low load summer months, remove existing boilers #1, #2 and #3 and associated stack economizers, deaerator, condensate storage tank, two condensate transfer pumps, two sump pumps and three automatic chemical feeders. Keep boiler 3 in service while replacing all the piping, catwalks, and boilers 1 and 2 demolition. This is to reduce time and costs.

g. Removal of abandoned condensate vacuum pump system and associated condensate return piping from existing boiler plant.

h. Install replacement of existing boiler plant 1/3 – 2/3 PRV system. Sequence work to minimize down time.

i. Install replacement of existing boiler plant header Isolation valves.

j. Modify existing gas detection system as necessary to allow for testing from ground level while gas detectors shall remain at roof level.

k. Install new steam, feedwater, makeup and natural gas metering.

l. Replace the electrical generator sub tank with a double walled sub tank. Install new electrical MCC, panels, and all associated circuits and equipment disconnects.

m. Replace lighting fixtures with LED, high efficiency light fixture.

n. Replace doors and provide new access control on two of the doors.

o. Provide CCTV per the VA standards, campus standards.

p. Remove local and central control systems for boilers #1, #2 and #3.

q. Install three new 300 BHP high pressure steam boilers and associated stack economizers, new deaerator, new condensate storage tank, two new condensate transfer pumps, two new sump pumps and three new automatic chemical feeders.

r. Install new louvers in wall with steam radiator to heat intake air as needed. Louvers have been sized to meet VA requirements for ventilation air and combustion air.

s. Replace four existing boiler room exhaust fans to provide adequate ventilation air to boiler plant. Calculations for sizing can be found on ME601.

t. Extend existing generator flue to upper roof area.

u. Replace existing boiler blowdown tank.

v. Replace existing evaporative cooling unit in control room with split system DX heat pump unit.

w. Install new boiler controls with associated LCD MMI in local panel. Include required safety device testing requirements. Include interface to existing BAS supervision.

x. Install new operator work stations with controls software interface and graphics for all three new boilers.

y. Change the boiler door swing.

z. Install wall and door to tunnel.

aa. Install E-Stops on egress doors

bb. After new boilers are on line, provide third party certification of new plant safety devices including lockout tagout procedures.

cc. Remove rental boilers piping and electrical.

dd. Remove existing window, masonry wall, and concrete stem wall for placement of boilers. Reinstall window and rebuild masonry wall and concrete stem wall once boilers have been installed within the building.

ee. Provide temporary raised floor for boiler install, remove temporary floor after boilers are in place.

ff. Dismantle the existing catwalk steel beams columns etc. to allow for placement of new boiler and removal of old. Tag or track locations of catwalk elements for reassembly.

PLUS:

- Construction duration.
- Minimal campus steam system down time.

MINUS:

- Cost for boiler rental and piping.
- Additional boiler control systems and safety devices.

IV. Other Design Elements

a. Replace the existing roofing membrane.
b. Provide roof top fall protection. Provide non penetrating system.
c. Provide emergency new egress from mezzanine level to ground. Provide new door opening through existing window. Remove and reconfigure window opening to accept new door/window.
d. Provide steel HSS column door frame and out-of-plane window support.
e. Provide new steel stair at new egress. Provide steel channel stringers, beams, and columns.
f. Provide grating stairs tread and landing.
g. Provide guard rails and handrails for new stair.
h. Provide reinforced concrete footings. Patch and repair asphalt as needed.
i. Replace flooring throughout the mezzanine. New LVT shall be installed in the mezzanine office, and LVT shall be installed throughout the rest for the mezzanine.
j. Remove four windows in the control room and patch existing wall with brick to match existing.
k. Replace the remaining windows in the control room.
l. Remove the exterior door to the control room and replace it with a new door that swings out of the building.
m. Replace door between control room and boiler room with fully glazed door to optimize visibility.
n. Floor has been extended over a portion of the pit to facilitate an expansion of the control room to provide adequate site lines to all of the boilers.
o. Remove the existing door and adjacent portion of the wall separating the control room from the boiler space. Install new steel HSS columns and a double-angle steel header beam to support the modified opening.
p. Install new concrete topping over the new steel deck in the pit area north of the control room. Extend the control room footprint into this area. Construct new walls using metal studs with gypsum board, matching the finish of the existing control room. Relocate the existing catwalk and railing as necessary to accommodate the revised room layout.
q. Add a wall and door to the utility tunnel from the lower-level pump room.
r. Provide exterior roof access ladders to the three lower roofs.
s. Add fire suppression system to control room.
t. Add new enclosed telecommunications rack to the control room, update the power and HVAC to the space to meet the telecommunications requirements for Boiler.
u. Run new fiber lines to the building to meet ISTS requirements.
v. Update valves and disconnects to equipment that are lockable for lockout / tagout compatibility.

V. Historical Steam Load

Hourly maximum winter steam loads at the 99.6% outdoor winter design temperature for Prescott Arizona VA (17.7F), “HVAC Design Manual May 1, 2019”, for the winters of 2019 through 2021 are summarized in the following Boiler Plant Hourly Maximum tables. Boiler Plant calibrated steam meters recorded hourly steam consumption logs are utilized for the summarized data. Winter outdoor air temperatures (O.A.T.), near or below the design temperature are shown with the concurrent steam loads highlighted. Winter steam loads represent a single boiler in operation with a second boiler at idle operating at 70-75 psi header pressure.

- 1/31/2021 **12,700 lb/hr** steam.
- 2/12/2020 12,100 lb/hr steam.
- 2/20/2019 12,100 lb/hr steam.

Hourly maximum and minimum summer steam loads at the 0.4% outdoor summer design temperature for Prescott Arizona VA (94.4F), “HVAC Design Manual May 1, 2019”, for the summers of 2019 through 2021 are summarized in the following Boiler Plant Hourly Maximum/Minimum tables. Boiler Plant calibrated steam meters recorded hourly steam consumption logs are utilized for the summarized data. Summer outdoor air temperatures (O.A.T.), near or above the design temperature are shown with the concurrent steam loads highlighted. Summer steam loads represent a single boiler in operation with a second boiler at idle operating at 70-75 psi header pressure.

• 6/3/2021	**5,800 lb/hr** steam maximum.	6/29/2021	1,500 lb/hr minimum.
• 6/20/2020	5,800 lb/hr steam maximum.	8/28/2020	2,000 lb/hr minimum.
• 7/15/2019	5,000 lb/hr steam maximum.	8/15/2019	1,400 lb/hr minimum.

The 2020 hourly data included recent building additions to the campus with a maximum daily load of 254 Mlbs of steam and a maximum hourly steam load of 12.3 Mlbs/hr.

Boiler Plant Hourly Maximum 2021

Date	Outdoor 99.6% (17.7F) O.A.T. (F)	Maximum Hourly Steam Mlbs	Date	Outdoor 99.6% (17.7F) O.A.T. (F)	Maximum Hourly Steam Mlbs	Date	Outdoor 99.6% (17.7F) O.A.T. (F)	Maximum Hourly Steam Mlbs	Date	Outdoor 99.6% (17.7F) O.A.T. (F)	Maximum Hourly Steam Mlbs
1/1/2021	18.0	11.0	2/1/2021		10.5	3/1/2021	18.0	**11.7**	4/1/2021		8.7
1/2/2021		11.8	2/2/2021		10.0	3/2/2021		11.6	4/2/2021		7.0
1/3/2021		11.5	2/3/2021		9.1	3/3/2021		11.2	4/3/2021		7.9
1/4/2021		11.4	2/4/2021		10.2	3/4/2021		10.0	4/4/2021		8.2
1/5/2021		10.9	2/5/2021		10.9	3/5/2021		10.3	4/5/2021		8.3
1/6/2021		10.9	2/6/2021	25.0	**12.7**	3/6/2021		9.2	4/6/2021		7.1
1/7/2021		11.4	2/7/2021		10.6	3/7/2021		9.1	4/7/2021		8.3
1/8/2021		11.2	2/8/2021		11.6	3/8/2021		8.5	4/8/2021		8.0
1/9/2021		10.7	2/9/2021		9.6	3/9/2021		9.6	4/9/2021	31.0	**8.9**
1/10/2021	17.0	11.3	2/10/2021		9.6	3/10/2021		8.8	4/10/2021		7.6
1/11/2021	18.0	11.8	2/11/2021		9.5	3/11/2021		10.0	4/11/2021		7.6
1/12/2021	13.0	12.5	2/12/2021		9.5	3/12/2021		9.9	4/12/2021		8.3
1/13/2021		11.2	2/13/2021		9.6	3/13/2021		10.9	4/13/2021		7.3
1/14/2021		10.5	2/14/2021		9.6	3/14/2021		10.6	4/14/2021		8.0
1/15/2021		11.6	2/15/2021		11.0	3/15/2021		10.2	4/15/2021		8.2
1/16/2021		10.5	2/16/2021		10.1	3/16/2021		10.9	4/16/2021		7.5
1/17/2021		11.7	2/17/2021		11.7	3/17/2021		11.0	4/17/2021		7.9
1/18/2021		10.9	2/18/2021	18.0	11.6	3/18/2021		10.0	4/18/2021		8.0
1/19/2021		9.7	2/19/2021		11.2	3/19/2021		10.0	4/19/2021		8.0
1/20/2021		10.4	2/20/2021		10.0	3/20/2021		8.7	4/20/2021		7.2
1/21/2021		9.2	2/21/2021		10.2	3/21/2021		9.6	4/21/2021		7.3
1/22/2021		9.1	2/22/2021		11.1	3/22/2021		10.4	4/22/2021		6.9
1/23/2021		10.1	2/23/2021		10.7	3/23/2021		9.4	4/23/2021		6.8
1/24/2021		10.7	2/24/2021		8.9	3/24/2021		9.5	4/24/2021		7.8
1/25/2021		11.6	2/25/2021		10.5	3/25/2021		9.6	4/25/2021		6.9
1/26/2021		11.9	2/26/2021		11.4	3/26/2021		10.1	4/26/2021		7.2
1/27/2021	5.0	11.9	2/27/2021		9.6	3/27/2021		11.0	4/27/2021		7.8
1/28/2021	18.0	12.6	2/28/2021		10.7	3/28/2021		10.2	4/28/2021		8.3
1/29/2021		10.6				3/29/2021		9.0	4/29/2021		7.8
1/30/2021	17.0	12.0				3/30/2021		9.0	4/30/2021		7.6
1/31/2021	18.0	**12.7**				3/31/2021		10.3			
Janurary		**12.7**	**Feburary**		**12.7**	**March**		**11.7**	**April**		**8.9**

Table 1

Boiler Plant Summer Hourly Maximum/Minimum 2021

Date	Maximum Hourly Steam Mlbs	Outdoor 0.4% (94.4F) O.A.T. (F)	Minimum Hourly Steam Mlbs	Date	Maximum Hourly Steam Mlbs	Outdoor 0.4% (94.4F) O.A.T. (F)	Minimum Hourly Steam Mlbs	Date	Maximum Hourly Steam Mlbs	Outdoor 0.4% (94.4F) O.A.T. (F)	Minimum Hourly Steam Mlbs
6/1/2021	5.4		3.4	7/1/2021	5.0	90.0	**2.9**	8/1/2021	5.1		3.5
6/2/2021	4.7		3.4	7/2/2021	4.8		3.3	8/2/2021	5.2		3.6
6/3/2021	5.8	94.0	3.2	7/3/2021	4.7		3.4	8/3/2021	5.0	94.0	3.5
6/4/2021	5.7	95.0	3.4	7/4/2021	4.9		3.5	8/4/2021	4.6	98.0	3.7
6/5/2021	5.3	93.0	3.4	7/5/2021	5.3	95.0	3.0	8/5/2021	5.7	96.0	**2.2**
6/6/2021	5.7		3.5	7/6/2021	5.2	100.0	3.3	8/6/2021	4.8	93.0	3.3
6/7/2021	5.5		3.7	7/7/2021	5.8	101.0	3.0	8/7/2021	5.0	93.0	3.5
6/8/2021	5.3		3.7	7/8/2021	4.3	99.0	3.0	8/8/2021	**5.8**	93.0	3.5
6/9/2021	5.6		3.8	7/9/2021	5.2	105.0	3.3	8/9/2021	5.2	93.0	3.5
6/10/2021	5.3		3.8	7/10/2021	4.6	105.0	3.5	8/10/2021	5.0		3.9
6/11/2021	5.4		3.5	7/11/2021	4.6	103.0	3.3	8/11/2021	5.0		3.6
6/12/2021	5.5	97.0	3.5	7/12/2021	5.0	96.0	3.3	8/12/2021	5.2		3.7
6/13/2021	4.9	96.0	3.1	7/13/2021	4.9	94.0	3.2	8/13/2021			
6/14/2021	4.7	103.0	2.4	7/14/2021	4.5		3.5	8/14/2021			
6/15/2021	4.1	105.0	3.0	7/15/2021	5.1		3.5	8/15/2021			
6/16/2021	4.3	102.0	3.1	7/16/2021	4.6		3.6	8/16/2021			
6/17/2021	4.9	104.0	3.1	7/17/2021	4.7		3.5	8/17/2021			
6/18/2021	4.8	103.0	3.3	7/18/2021	4.7		3.6	8/18/2021			
6/19/2021	5.0	98.0	3.2	7/19/2021	5.0		3.5	8/19/2021			
6/20/2021	5.7	101.0	3.1	7/20/2021	4.8		3.6	8/20/2021			
6/21/2021	5.4	94.0	3.0	7/21/2021	5.2		3.6	8/21/2021			
6/22/2021	4.2	96.0	3.3	7/22/2021	5.1		3.5	8/22/2021			
6/23/2021	5.0		3.1	7/23/2021	5.4		3.4	8/23/2021			
6/24/2021	4.9		3.7	7/24/2021	**5.8**		3.8	8/24/2021			
6/25/2021	5.1		3.6	7/25/2021	4.9		3.7	8/25/2021			
6/26/2021	5.5		2.5	7/26/2021	5.3		3.8	8/26/2021			
6/27/2021	5.6	94.0	3.1	7/27/2021	5.1		3.5	8/27/2021			
6/28/2021	5.6	93.0	3.4	7/28/2021	5.3		3.4	8/28/2021			
6/29/2021	4.4	86.0	**1.5**	7/29/2021	5.0		3.3	8/29/2021			
6/30/2021	**6.3**	80.0	2.3	7/30/2021	5.0		3.8	8/30/2021			
				7/31/2021	5.2		3.9	8/31/2021			
June	**6.3**		**1.5**	**July**	**5.8**		**2.9**	**August**	**5.8**		**2.2**

Table 2

Boiler Plant Hourly Maximum 2020

Date	Outdoor 99.6% (17.7F) O.A.T. (F)	Maximum Hourly Steam Mlbs	Date	Outdoor 99.6% (17.7F) O.A.T. (F)	Maximum Hourly Steam Mlbs	Date	Outdoor 99.6% (17.7F) O.A.T. (F)	Maximum Hourly Steam Mlbs	Date	Outdoor 99.6% (17.7F) O.A.T. (F)	Maximum Hourly Steam Mlbs
1/1/2020		11.9	2/1/2020		10.0	3/1/2020		8.0	12/1/2020		11.1
1/2/2020		11.1	2/2/2020		10.1	3/2/2020		10.0	12/2/2020	19.0	11.5
1/3/2020		11.7	2/3/2020	19.0	10.1	3/3/2020		9.8	12/3/2020	19.0	10.8
1/4/2020		11.5	2/4/2020	14.0	11.9	3/4/2020		9.9	12/4/2020	16.0	12.0
1/5/2020		11.5	2/5/2020	12.0	**12.3**	3/5/2020		9.6	12/5/2020		10.8
1/6/2020		11.3	2/6/2020		12.3	3/6/2020		9.6	12/6/2020		11.1
1/7/2020		12.0	2/7/2020		10.7	3/7/2020		8.9	12/7/2020		11.4
1/8/2020		11.7	2/8/2020		9.9	3/8/2020		8.8	12/8/2020		10.5
1/9/2020		10.1	2/9/2020		9.9	3/9/2020		9.4	12/9/2020		11.0
1/10/2020	13.0	**12.0**	2/10/2020		9.3	3/10/2020		8.9	12/10/2020		10.1
1/11/2020	19.0	11.3	2/11/2020		9.7	3/11/2020		8.3	12/11/2020		10.2
1/12/2020		11.5	2/12/2020	18.0	12.1	3/12/2020		8.4	12/12/2020		10.5
1/13/2020		10.6	2/13/2020		11.1	3/13/2020		10.3	12/13/2020	13.0	11.3
1/14/2020		10.5	2/14/2020		10.8	3/14/2020		9.1	12/14/2020		10.4
1/15/2020		11.4	2/15/2020		10.5	3/15/2020		9.5	12/15/2020	18.0	11.0
1/16/2020		10.3	2/16/2020		9.7	3/16/2020		9.2	12/16/2020	18.0	11.6
1/17/2020		9.9	2/17/2020		10.6	3/17/2020		8.3	12/17/2020		11.0
1/18/2020		11.4	2/18/2020		9.9	3/18/2020		10.4	12/18/2020		11.6
1/19/2020		11.0	2/19/2020		9.6	3/19/2020		10.1	12/19/2020	18.0	11.3
1/20/2020		9.8	2/20/2020		9.7	3/20/2020		10.1	12/20/2020		10.6
1/21/2020		9.7	2/21/2020		9.4	3/21/2020		9.5	12/21/2020		10.9
1/22/2020		9.8	2/22/2020		9.1	3/22/2020		9.3	12/22/2020	25.0	**12.2**
1/23/2020		10.2	2/23/2020		9.6	3/23/2020		9.2	12/23/2020		11.1
1/24/2020		10.6	2/24/2020		9.9	3/24/2020		10.2	12/24/2020	16.0	11.7
1/25/2020		10.7	2/25/2020		10.7	3/25/2020		7.9	12/25/2020		11.2
1/26/2020		10.2	2/26/2020		10.9	3/26/2020		9.0	12/26/2020		10.4
1/27/2020		10.1	2/27/2020		10.2	3/27/2020		10.1	12/27/2020		10.7
1/28/2020		10.6	2/28/2020		9.6	3/28/2020	25.0	**10.7**	12/28/2020		10.9
1/29/2020		9.7	2/29/2020		9.5	3/29/2020		9.0	12/29/2020		11.0
1/30/2020		11.3				3/30/2020		9.4	12/30/2020	17.0	11.6
1/31/2020		10.9				3/31/2020		8.7	12/31/2020		11.9
Janurary		**12.0**	**Feburary**		**12.3**	**March**		**10.7**	**December**		**12.2**

Table 3

Boiler Plant Summer Hourly Maximum/Minimum 2020

Date	Maximum Hourly Steam Mlbs	Outdoor 0.4% (94.4F) O.A.T. (F)	Minimum Hourly Steam Mlbs	Date	Maximum Hourly Steam Mlbs	Outdoor 0.4% (94.4F) O.A.T. (F)	Minimum Hourly Steam Mlbs	Date	Maximum Hourly Steam Mlbs	Outdoor 0.4% (94.4F) O.A.T. (F)	Minimum Hourly Steam Mlbs
6/1/2020	5.8	90.0	2.9	7/1/2020	5.0		2.5	8/1/2020	4.0	98.0	2.5
6/2/2020	4.8	59.0	**2.4**	7/2/2020	4.7		2.5	8/2/2020	4.3	94.0	2.5
6/3/2020	5.0	96.0	2.8	7/3/2020	4.5		2.6	8/3/2020	4.0	96.0	2.5
6/4/2020	4.4	62.0	**2.4**	7/4/2020	5.1	94.0	2.7	8/4/2020	4.0	94.0	2.6
6/5/2020	4.9	90.0	2.7	7/5/2020	5.9	96.0	2.8	8/5/2020	4.1		2.7
6/6/2020	5.6		3.1	7/6/2020	4.5	96.0	2.7	8/6/2020	4.1		2.8
6/7/2020	7.6	78.0	3.1	7/7/2020	5.2	94.0	2.3	8/7/2020	3.9		2.6
6/8/2020	5.9		3.3	7/8/2020	4.9	94.0	2.5	8/8/2020	4.2	94.0	2.5
6/9/2020	5.5		3.1	7/9/2020	3.8	96.0	2.5	8/9/2020	3.8	95.0	2.6
6/10/2020	4.5		3.3	7/10/2020	5.2	96.0	2.4	8/10/2020	4.4	95.0	2.6
6/11/2020	5.4		2.6	7/11/2020	4.3	97.0	2.7	8/11/2020	4.4	95.0	2.5
6/12/2020	5.9		2.7	7/12/2020	3.9	102.0	2.5	8/12/2020	3.5	96.0	2.4
6/13/2020	5.1		3.3	7/13/2020	4.2	98.0	2.4	8/13/2020	3.5	100.0	2.2
6/14/2020	6.1		3.3	7/14/2020	5.3	94.0	2.5	8/14/2020	3.7	101.0	2.2
6/15/2020	4.5		2.8	7/15/2020	4.0	95.0	2.5	8/15/2020	4.0	102.0	2.3
6/16/2020	4.5		3.1	7/16/2020	4.6	93.0	2.6	8/16/2020	3.8	105.0	2.3
6/17/2020	5.3		3.0	7/17/2020	4.5	96.0	2.4	8/17/2020	4.4	100.0	2.3
6/18/2020	4.3		3.2	7/18/2020	4.0	95.0	2.5	8/18/2020	3.8	99.0	2.4
6/19/2020	5.2		2.8	7/19/2020	4.4	97.0	2.5	8/19/2020	3.7	102.0	2.3
6/20/2020	5.8	94.0	3.0	7/20/2020	4.4		2.6	8/20/2020	3.4	98.0	2.3
6/21/2020	4.7	94.0	2.7	7/21/2020	4.4		2.4	8/21/2020	3.3		2.5
6/22/2020	5.1	95.0	2.7	7/22/2020	4.2	95.0	2.4	8/22/2020	3.5	95.0	2.3
6/23/2020	5.0	98.0	2.8	7/23/2020	4.2		2.6	8/23/2020	3.7		2.5
6/24/2020	5.5	96.0	2.7	7/24/2020	5.1		2.7	8/24/2020	3.8	96.0	2.5
6/25/2020	4.7		2.8	7/25/2020	5.4		2.9	8/25/2020	3.7	94.0	2.7
6/26/2020	5.1	94.0	2.6	7/26/2020	4.9		2.7	8/26/2020	3.9	98.0	2.5
6/27/2020	4.8		3.0	7/27/2020	5.2	94.0	2.4	8/27/2020	4.0	97.0	2.1
6/28/2020	5.3	95.0	3.3	7/28/2020	4.7	99.0	2.4	8/28/2020	3.8	64.0	**2.0**
6/29/2020	5.4		2.6	7/29/2020	4.5	72.0	**2.2**	8/29/2020	4.4		2.1
6/30/2020	4.6	98.0	2.9	7/30/2020	4.5	73.0	**2.2**	8/30/2020	3.8		2.4
				7/31/2020	4.3	102.0	2.5	8/31/2020	3.9		2.5
June	**7.6**		**2.4**	**July**	**5.9**		**2.2**	**August**	**4.4**		**2.0**

Table 4

Boiler Plant Hourly Maximum 2019

Date	Outdoor 99.6% (17.7F) O.A.T. (F)	Maximum Hourly Steam Mlbs	Date	Outdoor 99.6% (17.7F) O.A.T. (F)	Maximum Hourly Steam Mlbs	Date	Outdoor 99.6% (17.7F) O.A.T. (F)	Maximum Hourly Steam Mlbs	Date	Outdoor 99.6% (17.7F) O.A.T. (F)	Maximum Hourly Steam Mlbs
1/1/2019	1.0	13.1	2/1/2019		11.3	3/1/2019		9.0	12/1/2019		10.8
1/2/2019	1.0	13.0	2/2/2019		10.2	3/2/2019		9.1	12/2/2019		10.8
1/3/2019	8.0	**13.2**	2/3/2019		9.9	3/3/2019		9.5	12/3/2019		11.0
1/4/2019		12.9	2/4/2019		10.8	3/4/2019		9.8	12/4/2019		9.5
1/5/2019		11.1	2/5/2019		10.8	3/5/2019		10.8	12/5/2019		9.9
1/6/2019		10.7	2/6/2019		11.4	3/6/2019		8.9	12/6/2019		10.0
1/7/2019		11.3	2/7/2019	16.0	12.1	3/7/2019		9.5	12/7/2019		9.6
1/8/2019		11.5	2/8/2019	16.0	**13.0**	3/8/2019		9.7	12/8/2019		8.7
1/9/2019		11.3	2/9/2019	24.0	11.5	3/9/2019		11.2	12/9/2019		9.8
1/10/2019		10.6	2/10/2019	17.0	11.8	3/10/2019		10.4	12/10/2019		10.2
1/11/2019		11.1	2/11/2019	17.0	11.5	3/11/2019		10.1	12/11/2019		10.4
1/12/2019		11.4	2/12/2019	17.0	11.6	3/12/2019		9.5	12/12/2019		10.8
1/13/2019		10.4	2/13/2019		11.1	3/13/2019		10.9	12/13/2019		10.0
1/14/2019		11.2	2/14/2019		10.3	3/14/2019	23.0	**11.4**	12/14/2019		9.3
1/15/2019		10.2	2/15/2019		10.9	3/15/2019		11.3	12/15/2019		10.4
1/16/2019		9.5	2/16/2019		10.7	3/16/2019		10.8	12/16/2019		10.7
1/17/2019		10.6	2/17/2019		11.4	3/17/2019		10.1	12/17/2019	15.0	11.8
1/18/2019		9.9	2/18/2019		11.7	3/18/2019		10.1	12/18/2019	18.0	11.7
1/19/2019		11.0	2/19/2019		12.0	3/19/2019		9.4	12/19/2019		11.7
1/20/2019		10.8	2/20/2019	17.0	12.1	3/20/2019		9.1	12/20/2019	18.0	11.3
1/21/2019		10.6	2/21/2019		11.4	3/21/2019		10.3	12/21/2019		10.7
1/22/2019		10.9	2/22/2019		11.9	3/22/2019		10.6	12/22/2019		10.8
1/23/2019	19.0	11.2	2/23/2019		11.7	3/23/2019		9.9	12/23/2019		9.7
1/24/2019		11.3	2/24/2019		11.2	3/24/2019		10.1	12/24/2019		10.4
1/25/2019		11.9	2/25/2019		12.4	3/25/2019		10.5	12/25/2019		10.0
1/26/2019		11.4	2/26/2019		12.4	3/26/2019		9.3	12/26/2019		11.5
1/27/2019		11.8	2/27/2019		10.1	3/27/2019		8.3	12/27/2019		10.5
1/28/2019		10.8	2/28/2019		10.3	3/28/2019		9.8	12/28/2019		11.7
1/29/2019		10.1				3/29/2019		9.5	12/29/2019	16.0	12.0
1/30/2019		9.4				3/30/2019		10.0	12/30/2019		11.2
1/31/2019		10.3				3/31/2019		10.1	12/31/2019	25.0	**12.2**
Janurary		**13.2**	**Feburary**		**13.0**	**March**		**11.4**	**December**		**12.2**

Table 5

Boiler Plant Summer Hourly Maximum/Minimum 2019

Date	Maximum Hourly Steam Mlbs	Outdoor 0.4% (94.4F) O.A.T. (F)	Minimum Hourly Steam Mlbs	Date	Maximum Hourly Steam Mlbs	Outdoor 0.4% (94.4F) O.A.T. (F)	Minimum Hourly Steam Mlbs	Date	Maximum Hourly Steam Mlbs	Outdoor 0.4% (94.4F) O.A.T. (F)	Minimum Hourly Steam Mlbs
6/1/2019	6.9	81.0	4.5	7/1/2019	4.5		2.1	8/1/2019	4.5		1.9
6/2/2019	6.5		4.7	7/2/2019	4.9		2.3	8/2/2019	4.6		1.8
6/3/2019	6.0		3.1	7/3/2019	4.5		2.4	8/3/2019	4.6		2.0
6/4/2019	5.4		2.8	7/4/2019	4.4		2.7	8/4/2019	4.4	94.0	2.4
6/5/2019	4.0		2.1	7/5/2019	4.5		2.1	8/5/2019	5.1	98.0	3.0
6/6/2019	4.3		2.4	7/6/2019	4.1		2.4	8/6/2019	5.2	90.0	3.1
6/7/2019	4.1		2.1	7/7/2019	4.7		2.1	8/7/2019	4.6		2.4
6/8/2019	3.2	47.0	**1.8**	7/8/2019	4.4		2.6	8/8/2019	3.7		2.3
6/9/2019	3.6	46.0	**1.8**	7/9/2019	4.9		2.8	8/9/2019	3.9		2.2
6/10/2019	4.2	51.0	**1.8**	7/10/2019	4.4		2.4	8/10/2019	4.1		2.6
6/11/2019	4.3	54.0	**1.8**	7/11/2019	4.6		2.6	8/11/2019	4.1		2.3
6/12/2019	4.8		2.0	7/12/2019	4.3		2.5	8/12/2019	3.9		2.3
6/13/2019	5.5		2.0	7/13/2019	4.3		2.3	8/13/2019	4.0	93.0	2.1
6/14/2019	5.7		2.8	7/14/2019	4.3		2.8	8/14/2019	4.6	97.0	1.9
6/15/2019	4.4		2.8	7/15/2019	5.0	96.0	1.7	8/15/2019	3.9	60.0	1.4
6/16/2019	5.0		2.8	7/16/2019	3.6		2.3	8/16/2019	4.2	94.0	2.3
6/17/2019	4.7		2.5	7/17/2019	4.3		2.3	8/17/2019	3.8		2.1
6/18/2019	5.0		2.0	7/18/2019	4.0		2.2	8/18/2019	3.9		1.9
6/19/2019	3.9		1.9	7/19/2019	4.4		2.0	8/19/2019	3.9		2.0
6/20/2019	3.6		2.1	7/20/2019	4.9		1.9	8/20/2019	4.7	97.0	2.0
6/21/2019	3.7		2.0	7/21/2019	3.7		2.0	8/21/2019	4.1	98.0	2.0
6/22/2019	3.5		1.9	7/22/2019	4.5		2.2	8/22/2019	3.9	94.0	2.0
6/23/2019	3.2		2.0	7/23/2019	4.6		2.6	8/23/2019	3.7		2.6
6/24/2019	4.4		1.9	7/24/2019	4.6		2.2	8/24/2019	4.4		2.2
6/25/2019	4.0		1.9	7/25/2019	4.2		2.0	8/25/2019	3.7		2.1
6/26/2019	4.7		2.3	7/26/2019	3.7		2.0	8/26/2019	4.1	96.0	2.4
6/27/2019	4.9		2.6	7/27/2019	3.5		1.8	8/27/2019	3.4	97.0	2.0
6/28/2019	5.0		2.5	7/28/2019	4.0		2.1	8/28/2019	4.3	95.0	2.1
6/29/2019	4.5		2.2	7/29/2019	4.0		2.1	8/29/2019	3.7	94.0	2.1
6/30/2019	4.3		2.3	7/30/2019	4.8		2.0	8/30/2019	4.2	97.0	2.4
				7/31/2019	3.8		2.1	8/31/2019	4.0	98.0	2.5
June	**6.9**		**1.8**	**July**	**5.0**		**1.7**	**August**	**5.2**		**1.4**

Table 6

VI. Calculations

From the data summary in Section V above, the Prescott VA winter steam load is 12,700 lbs/hr at the required 99.6% winter design temperature of 17.7F. With a 10% growth factor N=12,700*1.10=**13,970 lbs/hr,** approximately 400 BHP. The three existing equally sized boilers provide an oversized N=24,000 lbs/hr. The summer steam load is 5,800 lbs/hr. With a 10% growth factor N=5,800*1.10=**6,380 lbs/hr,** approximately 200 BHP. . In conclusion the existing boiler system is oversized, and the boilers are beyond their life expectancy. The recommended replacement is and will be three 300 BHP boilers to meet the N+1requirements year-round. Piping system stress analysis was performed on the steam and condensate return systems. Both systems were found to be within allowable stresses and the hanger loads calculated indicate minimal loading. The final contractor submitted hangers shall be in compliance with these calculations and industry standards.

See Attachment A: Structural Calculations
See Attachment B: Condensate Return Stress Analysis
See Attachment C: Steam Piping Stress Analysis

End of Design Option Narrative & Calculations