Element D Services

Heating, Ventilating, and Air Conditioning

D3025 Steam Boilers and Associated Equipment

PART 1 - GENERAL

1.1 OVERVIEW

- A. This section includes criteria for the design of building heat generating systems including all isolation valves and steam piping and fittings, steam specialties, control valves, steam pressure pumps and shell and tube heat exchangers.
- B. Refer to Design Guideline Element D3044 for waterside distribution requirements.
- C. Where applicable for satellite locations, HVAC heating water and domestic hot water shall be produced using high efficiency (condensing style, long life, cast iron, etc.) natural gas fired heaters/boilers.
- D. Where steam generation is required/chosen due to existing systems, process needs, or district distribution, pursue high efficiency heat recovery systems (i.e., 2-stage flue gas recovery) for steam generating equipment to achieve high efficiency condensing operation. Intent is to limit inefficient steam generation where possible by using highly efficient steam generating systems.
- E. Consideration of facility operations with respect to dual-fuel and emergency operation is required when using condensing style boilers/heaters. Refer to Design Guideline Element D3026 for water heating and distribution requirements.

PART 2 - DESIGN CRITERIA

2.1 GENERAL

- A. Boiler fuel selection and system design will be in accordance with the ASHRAE Handbooks and NFPA Standards.
- B. Boiler steam will be used as a heating medium for the following applications:
 - 1. Heating Hot Water
 - 2. Food Service (non-contract, as applicable)
 - 3. Domestic Hot Water
 - 4. Humidification (Clean) Steam (using an unfired boiler)
 - 5. Autoclaves and sterilizers (verify quality of steam and whether plant or clean steam is required).
- C. Coordinate with the plumbing engineer to provide gas and oil meters for the boiler installation.

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- 1. Coordinate with the plumbing engineer to provide a gas meter at the building(s). Install oil meters in both the supply line and the return line of each storage tank.
- 2. Each boiler, or set of identical boilers, must be equipped with a natural gas totalizer for each boiler, or each set of identical boilers, in accordance with 30 TAC 117.340(a) and 30 TAC 117.2035(a).
- 3. If the boilers to be installed have a maximum capacity less than 40 MMBTUs/hr, then it is acceptable by TCEQ to design one flow meter for a set of identical boilers. MDACC requires one flow meter totalize per boiler.
- D. Safety relief vent piping shall be extended above the roof and shall be independent of the other steam vent piping. To avoid long safety relief valve discharge piping, safety relief valves may be located close to the terminal point if there is no shut-off valve between the PRV and the safety relief valve.
- E. Steam relief vent piping located downstream of safety relief valves shall be designed per ASME standards.
- F. Steam service from a local boiler or from a central plant boiler shall be reduced to the proper working pressures at the individual heat exchangers, prior to the control valve. Provide two-stage pressure reducing valve station when reducing high pressure steam to low pressure steam service.
- G. Steam condensate will be collected at the receivers and pumped back to the deaerator and boiler.
- H. Each steam pressure reducing station will have a minimum of two air loaded steam pressurereducing valves. One steam pressure-reducing valve will be sized to provide 1/3 of the required steam capacity and the second steam pressure-reducing valve will be sized to provide 2/3 of the required steam system capacity.
- I. The number of condensate pumping systems and deaerator provided will be determined based on condensate loads. Redundant pressure reducing valves will not be provided, but each pressure reducing station will have a manual normally closed bypass valve. Each pressure reducing station shall have a manual normally open isolation valve located at upstream of each strainer and downstream of each pressure regulator.
- J. Heating hot water shall be produced by steam to hot water heat exchangers. The A/E shall allow for a minimum of two steam to hot water shell and tube heat exchangers to handle the heating hot water load. Each exchanger shall be capable of heating the hot water from 120 degrees F to 150 degrees F, at the required flow rate (gpm) to heat the building.
- K. Select equipment such that one heat exchanger provides 100 percent redundant capacity based on peak design load.
- L. Steam pipe sizing shall not exceed 80 feet per second.

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- M. Steam relief vents shall be extended to the highest building roof where possible. In all cases, terminate vents in locations where the discharge will not create a hazard.
- N. Design steam distribution system for minimum ³/₄ inch pipe size. Design steam and condensate piping with loops, bends, and offsets to allow for thermal expansion and keep stresses within allowable limits of the piping material.
- O. Humidification steam is produced by an unfired steam boiler.
- P. Avoid using expansion joints or ball joints if possible.
- Q. Steam traps shall be readily available for ease of maintenance. For renovation project, the A/E shall confirm with Owner to determine if the existing steam condensate system is utilizing (Steam Eye) a monitoring system that detects and identifies failed steam traps.
- R. Depending on the size of the installation and the pressure at which steam is generated, use boiler accessories such as feedwater heaters to increase the steam generation cycle efficiency where applicable.
- S. Use blowdown separator/recovery units where possible to preheat make-up water to boiler system/deaerator where possible. Size blowdown separator/recovery unit to reduce blowdown water temperature below 140F prior to discharge of water to sanitary drainage system.
- T. Use flue gas recovery heat exchangers to preheat boiler feed water (and/or serve other heating loads where applicable). Use two-stage flue gas recovery (condensing) where possible to further increase boiler efficiency. Where recovery systems result in condensing of flue gases, design the boiler system with appropriate venting materials, proper sloping, and sufficient removal of condensate. Second stage of heat recovery may be associated with lower temperature heat requirements (e.g., HVAC heating hot water, domestic hot water, desiccant reactivation, etc.).
- U. Consider the application of vent condensers as another means to recover waste heat. A deaerator vent is a typical application for a vent condenser.
- V. The blowers on large capacity steam boilers often produce excess pressure at part load conditions. While blowers have increased in size due to reduced emissions requirements, there may be an opportunity to acquire some energy savings by using variable-frequency drives. Consider application of VFDs on boilers that have long operating hours at part-load, particularly when loads are at or below 50 percent fire.
- W. Meter all building steam supply, hot water supply, condensate return, and hot water return lines if steam is being supplied by a central plant steam system.
- X. Fuel oil storage tanks are to meet all EPA and applicable State, city codes and technical standards.

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PART 3 - SPECIAL CONTRACT DOCUMENT REQUIREMENTS

3.1 GENERAL

- A. The A/E shall include a schematic of the steam boilers and associated equipment, in the Contract Documents. The boiler(s) and steam distribution system including controls shall be shown on a control diagram. The control diagram shall be complete with, but not limited to, the following:
 - 1. Isolation valves
 - 2. Control valves
 - 3. Pressure and temperature gauges
 - 4. Boiler blowdown cooler and piping
 - 5. Flash tank
 - 6. All steam piping specialties
 - 7. Make up water treatment system (for boilers)
 - 8. Chemical feeder
 - 9. Make up or feedwater controls (interface with boiler)
 - 10. Pressure reducing stations
 - 11. Condensate receivers
 - 12. Deaerator
 - 13. Condensate tank
 - 14. Feed water pumps
 - 15. Flow control and measuring devices
 - 16. Flue gas monitoring system and controls (interface with boiler)
 - 17. Variable frequency drives (if used)
 - 18. Heat exchangers with water side temperature controls.
- B. Boilers that serve Vivarium space heating, cagewash hot water, and steam for autoclaves shall be on emergency power. Refer also to Section D3000 for additional emergency power requirements.

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- C. Texas Commission on Environmental Quality Nitrogen Oxide Emission Compliance Requirements:
 - Emissions standards for any new boiler with a maximum rated capacity equal to or greater than 100 MMBtu/hr: i. 0.020 lb Nitrogen Oxides (NO x) per MMBtu; and ii. 400 ppmv carbon monoxide (CO), at 3.0 percent O2 dry basis. Reference: 30 TAC 117.310(a)(1)(A) and 30 TAC 117.310(c)(1).
 - 2. Emissions standards for any new boiler with a maximum rated capacity equal to or greater than 40 MMBtu/hr, but less than 100 MMBtu/hr: i. 0.030 lb NO x per MMBtu; and
 - ii. 400 ppmv carbon monoxide (CO), at 3.0 percent O2 dry basis. Reference: 30 TAC 117.310(a)(1)(B) and 30 TAC 117.310(c)(1).
 - Emissions standards any new boiler with a maximum rated capacity less than 40 MMBtu/hr but greater than 2.0 MMBtu/hr: i. 0.036 lb NOx per MMBtu (or alternatively, 30 ppmv NOx, at 3.0 percent O2 dry basis); and ii. 400 ppmv carbon monoxide (CO), at 3.0 percent O2 dry basis. Reference: 30 TAC 117.310 (a)(1)(C), 30 TAC 117.310(c)(1), 30 TAC 117.2010(c)(1)(A) and, 30 TAC 117.2010(i)(1).
 - 4. A/E must inform the Owner's Project Manager to contact the Owner's EH&S department, if a unit of the above sizes will be installed. A unit of this size may trigger some additional federal requirements under Title 40 of the Code of Federal Regulations (40 CFR) as well as state and federal permitting requirements under 30 TAC 116 or 122.
 - Emissions standards any new boiler with a maximum rated capacity greater than 400,000 Btu/hr, but less than or equal to 2.0 MMBtu/hr: i. 30 ppmv NOx at 3.0 percent O2 dry basis; or ii. 0.037 lbs NOx per MMBtu of heat input. Reference: 30 TAC 117.3205(a)(4).
 - Emissions standards any new boiler with a maximum rated capacity greater than 75,000 Btu/hr, but less than or equal to 400,000 Btu/hr: i. 40 ng NOx per J of heat output; or ii. 55 ppmv NOx at 3.0 percent O2 dry basis. Reference: 30 TAC 117.3205(a)(3).
 - Emissions standards any new boiler with a maximum rated capacity less than or equal to 75,000 Btu/hr: i. 10 nanograms (ng) NOx per Joule(J) of heat output; or ii.15 ppmv NOx at 3.0 percent O2, dry basis. Reference: 30 TAC 117.3205(a)(2).
- D. The boiler must be able to achieve the applicable low Nox emission standards, as indicated above, 100 percent of the time. Flue gas recirculation or any other technology that will not obtain low Nox emissions 100 percent of the time is not acceptable.

PART 4 - PRODUCTS

4.1 GENERAL

A. Refer to Owner's Master Construction Specifications. These are available on the Owner's

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Design Guidelines website: http://www2.mdanderson.org/depts/cpm/standards/specs.html

- B. Fire tube boilers are preferred for large scale building projects that have a large demand requirement for medium pressure steam. The fire tube boiler would provide steam to autoclaves, unfired boilers for sterilizers, converters for building hot water, and to steam hot water heaters for domestic hot water.
- C. Specify condensing boilers for smaller scale buildings that utilize hot water re-heat. Design Guideline Element D3044 Hot Water Distribution, provides additional information that applies to the use of this type of boiler.

PART 5 - DOCUMENT REVISION HISTORY

| Issue | Date | Revision Description | Reviser |
|--------|----------|----------------------|---------|
| | 20190301 | Original Issuance | |
| Rev. 1 | | | |

END OF ELEMENT D3025