Tech Sheet #ST113

Practical Considerations for Steam System Design & Operation Checklist

Designing and operating a safe, reliable, and efficient steam system requires careful planning and attention to a range of considerations. This checklist provides a comprehensive overview of key factors that engineers, operators, and maintenance personnel should evaluate during the design, installation, and ongoing operation of a steam system. Each element plays a role in ensuring safe, optimal steam system performance and long-term reliability.

Steam Distribution Piping:

- ☐ Process piping sized appropriately for velocity <12,000 fpm
- ☐ Heating piping sized appropriately for velocities of 4,000-6,000 fpm
- ☐ Expansion and contraction accounted for (expansion loops, expansion joints)
- ☐ Piping has appropriate negative slope (at least 1:100) in direction of steam flow (toward steam trap stations). (Example: 1 inch per 100 inches, 1 foot per 100 feet, etc.)
- ☐ Steam piping with a positive slope in the direction of flow (condensate flow is counter to the direction of steam flow): Pipe diameter increases, drip legs are spaced as close as 50 feet apart, and positive slope is at least 1:40
- ☐ Eccentric pipe reducers are utilized when reducing pipe diameters
- ☐ Steam piping sized to prevent excessive pressure drop
- ☐ Automatic air vents are installed in distribution piping at high points and ends of line
- ☐ Manual air vents installed at high points (for assisted start-up)
- ☐ Branch lines are plumbed out of the top of steam mains
- ☐ Steam lines properly labeled for contents and flow direction
- ☐ Piping anchored, supported, and guided to account for pipe movement and elimination of low points
- ☐ Steam lines insulated properly
- ☐ Subcooled temperature indication installed upstream of drip leg steam traps and isolation valves
- ☐ Drip legs sized in accordance with FCI Tech Sheet #ST104
- ☐ Drip leg steam trap stations include an appropriate steam trap style (Reference FCI Tech Sheet #ST109)
- ☐ Steam trap stations include upstream/downstream isolation valves, Y-strainer w/ blowdown valve, check valve (if required), and test valve (if appropriate). (Components can be separate or part of integral design)

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Pressure Reducing Valve Station:

- Install a moisture separator upstream of the PRV. Steam entering a PRV should be as dry as possible.
- Install a drip trap on the bottom of the separator to remove condensate.
- Install a strainer upstream of the PRV. The strainer should be installed on its side to prevent condensate from pooling and potential for water hammer.
- If pressure reduction is greater than a 15:1 turndown, a 2 stage station should be considered.
- If there is a large capacity variation between maximum and minimum load, consider using a one-third/two-third station. This is most common with winter and summer loads.
- If the PRV is supplying a critical application, then a bypass line should be installed.
- The bypass line should be the same pipe diameter as the PRV diameter.
- If using an externally piloted PRV, make sure you have adequate straight run before and after the sensing line.
- Isolation valves should be on the inlet and outlet of PRV as well as on the bypass line. The preferred type of isolation valve on the bypass is a globe style.
- Pressure gauges should be installed on the inlet and outlet of the PRV. The inlet gauge should be prior to the isolation valve and the outlet guage should be after the isolation valve.
- A safety relief valve(SRV) should be installed downstream of the PRV and sensing line(if applicable). The SRV should be sized for the maximum capacity that the PRV can pass for the system inlet pressure.
- The SRV should be installed according to ASME B31.1 Power Piping Code.

Steam Heat Exchangers:

- Automatic air vents installed at supply line high points and other points of air entrapment
- Automatic air vents installed on all steam heat exchangers
- Vacuum breakers installed on steam side of all steam heat exchangers that drain to a steam trap by gravity or if protection of the equipment is required.
- Steam heat exchanger inlet control valves: Installed at proper distance from heat exchanger inlet (>10 pipe diameters of straight pipe run)
- Steam heat exchanger control valves: Piping downstream of valve immediately expands to heat exchanger connection size
- Steam heat exchangers properly insulated (Nameplate is not to be insulated)
- Steam traps installed within 26” horizontally of condensate drainage connection (to avoid steam locking)
- Steam trap stations include upstream/downstream isolation valves, Y-strainer w/ blowdown valve, check valve (if required), and test valve (if appropriate). (Components can be separate or part of integral design)

Condensate Removal & Recovery:

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- ☐ Steam trap stations include an appropriate steam trap style for the application (Reference FCI Tech Sheet #ST109)
- ☐ Regular steam trap station monitoring and maintenance program in place (including regular steam trap surveys)
- ☐ Steam trap stations include upstream/downstream isolation valves, Y-strainer w/ blowdown valve, check valve (if required), and test valve (if appropriate). (Components can be separate or part of integral design)
- ☐ Steam traps are installed below the lowest point of the component they are trapping
- ☐ Considering sizing factor, steam traps are sized appropriately for each application (Reference ANSI/FCI 13-1, Determining Condensate Loads to Size Steam Traps)
- ☐ Modulating applications: Condensate-return piping downstream of steam traps does not rise sufficiently to cause negative pressure differential across steam traps during normal operation. Gravity-drain across the steam trap is preferred.
- ☐ If a steam trap must be installed above the condensate discharge point of the equipment, steam lock release functionality is required
- ☐ Modulating applications: Condensate flows by gravity to the steam traps and drains by gravity across the steam traps
- ☐ Non-modulating applications: Condensate flows by gravity to the steam traps. Pressure upstream of trap > condensate-return pressure plus pressure to lift condensate, if required.
- ☐ Condensate piping downstream of steam traps is plumbed into the top of condensate-return headers
- ☐ Pressure differential across mechanical steam traps < maximum differential orifice rating (Otherwise, condensate drainage will not occur.)
- ☐ Condensate is being returned to boiler feedwater treatment system
- ☐ Vented flash steam is redirected and used for other applications
- ☐ Condensate lines are sized to consider flash steam volume
- ☐ Centrifugal condensate pumps: NPSHA > NPSHR
- ☐ Pressure-powered condensate pumps: Ample fill head and receiver capacity (if needed) provided
- ☐ Condensate receiver vents sized to avoid pressurization and resulting condensate carryover and/or elevated condensate temperature (possible pump cavitation)
- ☐ Downstream of steam traps, piping sized appropriately for condensate plus flash steam
- ☐ Drips legs placed at changes of direction (up, right, or left), upstream of any valve that can close, at low points, and every 150-300 feet in straight runs of pipe
- ☐ Drip legs sized in accordance with FCI Tech Sheet #ST104
- ☐ Drip legs installed upstream of PRVs/control valves
- ☐ Everything in the condensate-removal/return system is insulated (except steam trap styles where operation could be affected)
- ☐ Condensate lines properly labeled for contents and flow direction
- ☐ Subcooled temperature indication installed upstream of drip leg steam traps
- ☐ Steam trap stations include an appropriate steam trap style for the application (Reference FCI Tech Sheet #ST109)

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Safety:

- ☐ Drip legs placed at changes of direction (up, right, or left), upstream of any valve that can close, at low points, and every 150-300 feet in straight runs of pipe
- ☐ Drip legs sized in accordance with FCI Tech Sheet #ST104 recommendations
- ☐ Drip legs installed upstream of PRVs/control valves
- ☐ Warm-up valves installed around steam isolation valves ≥ 3”
- ☐ System start-up and shutdown standard operating procedures (SOPs) in place (checklist format)
- ☐ Subcooled temperature indication installed upstream of drip leg steam traps and isolation valves
- ☐ SRVs installed according to ASME B31.1 Power Piping Code (applications >15 psig)
- ☐ Valve selection: Pressure at *the application temperature* is considered
- ☐ Valve selection: Rated PMO and TMO are appropriate for the application
- ☐ Valve selection: Rated PMA and TMA meet or exceed the maximum boiler output
- ☐ Recurring steam system safety training program in place
- ☐ Eccentric pipe reducers are utilized when reducing pipe diameters
- ☐ Piping anchored, supported, and guided to account for pipe movement and elimination of low points
- ☐ Steam trap styles are appropriate for each application
- ☐ Considering sizing factor, steam traps are sized appropriately for each application (Reference ANSI/FCI 13-1, Determining Condensate Loads to Size Steam Traps)
- ☐ Pressure differential across mechanical steam traps < maximum differential orifice rating
- ☐ Condensate lines are sized to allow steam space at top of pipe
- ☐ Everything in the steam and condensate-removal/return system located within seven feet of the floor or working platform is insulated (except inappropriate steam trap styles, regulator diaphragm housings, and heat exchanger nameplates) or properly guarded
- ☐ No steam leaks. (Program in place to identify and repair steam leaks.)
- ☐ Steam trap stations include an appropriate steam trap style for the application (Reference FCI Tech Sheet #ST109)

Proper Operation:

- ☐ Pipe size increased by one pipe diameter downstream of steam traps
- ☐ Steam piping sized to prevent excessive pressure drop
- ☐ Process piping sized appropriately for velocity <12,000 fpm
- ☐ Heating piping sized appropriately for velocities of 4,000-6,000 fpm
- ☐ Pilot-operated regulator control line installed to slope down and away from pilot
- ☐ Pilot-operated regulator control line installed in downstream piping at manufacturer’s recommended distance
- ☐ Vacuum breakers installed on all steam heat exchangers
- ☐ Threaded connections avoided (if possible) to avoid potential leaks resulting from pipe expansion and contraction)

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- ☐ Regulator diaphragm housing not insulated
- ☐ Everything in the steam and condensate-removal/return system is insulated (except inappropriate steam trap styles, regulator diaphragm housings, and heat exchanger nameplates)
- ☐ Steam heat exchanger control valves: Installed at proper distance from heat exchanger inlet (>10 pipe diameters of straight pipe run)
- ☐ Steam heat exchanger control valves: Piping downstream of valve immediately expands to heat exchanger connection size
- ☐ Steam trap test valves installed downstream of steam traps
- ☐ Steam and condensate lines properly labeled for contents and flow direction
- ☐ Recurring steam system maintenance and operations training program in place
- ☐ Steam trap stations include an appropriate steam trap style for the application (Reference FCI Tech Sheet #ST109)
- ☐ Steam trap stations include upstream/downstream isolation valves, Y-strainer w/ blowdown valve, check valve (if required), and test valve (if appropriate). (Components can be separate or part of integral design)

Reliability:

- ☐ Y-strainers installed with screen portion in the horizontal plane
- ☐ Blowdown valves installed on all Y-strainers
- ☐ Piping anchored, supported, and guided to account for pipe movement and elimination of low points
- ☐ All pressure gauges installed with siphon tubes ("pigtails")
- ☐ Pressure gauges (or gauge connections) installed throughout system (upstream/downstream of control valves, heat transfer equipment, etc.)
- ☐ Regular steam trap station maintenance program in place
- ☐ Check valves installed backwards are not used as vacuum breakers (but may be used as air ingress valves for operational purposes)
- ☐ Recurring steam system maintenance and operations training program in place
- ☐ Branch lines are plumbed out of the top of steam mains
- ☐ Subcooled temperature indication installed upstream of drip leg steam traps

Efficiency:

- ☐ Condensate not going to floor drain (unless contaminated)
- ☐ No steam leaks
- ☐ Everything in the steam and condensate-removal/return system is insulated (except inappropriate steam trap styles, regulator diaphragm housings, and heat exchanger nameplates)
- ☐ Regular steam trap station maintenance program in place
- ☐ Vented flash steam is redirected and used for other applications.
- ☐ Subcooled temperature indication installed upstream of drip leg steam traps

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