There are two primary types of drainage systems.

1) Gravity drain to atmosphere with no back pressure on steam trap.
2) Closed loop system using Automatic Pump Trap.

1) **Gravity drain to atmospheric (0PSIG) condensate return with no elevation after the steam trap.**

This gravity drainage system must assure that there is never pressure above atmospheric in the condensate return. **CAUTION,** failed open steam traps and other leaks from the steam piping to the condensate return piping will pressurize the condensate return enough to cause steam stall.
Flash steam. High temperature/pressure condensate will flash back into steam immediately downstream of the steam traps and cause back pressure on the steam traps draining the coil causing steam stall.
Condensate return lines designed for atmospheric pressure must be adequately sized to allow for the flash steam and condensate. They must be pitched toward the condensate receiver which is vented to atmosphere. The vent line off of the atmospheric receiver must be sufficient size to vent all flash steam without building up a back pressure in receiver.

Gravity return is not easily achievable. Also, over time as the system ages, the condensate return line which was designed for atmospheric pressure can begin to experience pressures above 0 psig due to failed steam traps tied into the common condensate header**.**

The steam trap must handle lots of air and drain condensate at saturated steam temperature continuously while the load and pressure are changing and thus a Float-Thermostatic type is recommended for all gravity drain steam air heating coils. The trap is mounted below the condensate outlet from the coil with a vertical drop giving enough hydraulic head to enable a suitable size to be selected. A 14” head should be the minimum and represents about ½ psi, a 28” head about 1 psi, and to reduce possibility of freeze-up, a drop of 3 ft. to the trap is recommended.

Trap each coil separately. If two or more coils are tied to one steam trap, only one coil will drain properly. **Each coil must have its own steam trap, air vent and vacuum breaker.**

Utilize vacuum breakers on each coil. Steam traps require a positive pressure differential to force the condensate through the valve seat. If the coil's pressure drops below atmospheric, the pressure differential across the valve will be negative and the condensate will not drain. This condition can lead to serious damage or failure of the coil due to freezing, water hammer and corrosion. The vacuum breaker should be located just ahead of the coil steam inlet connection between the control valve and the coil steam inlet.

Provide an air vent for each coil at its highest location. Luvata provides a 0.5" threaded vent connection on the return manifold as a standard on all steam coils. Non-condensable gasses present in the steam will collect in a coil and reduce its capacity. Therefore, it is necessary to provide a means for the removal of these gasses. Also, these gasses can diffuse into the condensate forming byproducts, which can lead to severe corrosion.

The condensate return piping leading from the coil to the steam trap should be the same size as the coil outlet connection. Do not bush down in the vertical leg to the trap. You may reduce in the horizontal run to the trap to match steam trap connection. See page 3 of this IMO manual for Steam Coil Piping Diagram when using gravity drainage to atmospheric pressure and no back pressure on steam traps.

Makeup air heating coils and other heat exchange equipment where the steam supply pressure is modulated to hold a desired outflow temperature must always be kept drained of condensate. Fitting a vacuum breaker and steam trap, no matter what the size, does not always result in trouble-free operation and problems with noisy, hammering, corroded and especially frozen coils are well documented. These problems are the result of coil flooding at some point when either:
a. Incoming makeup air increases above minimum design temperature, or
b. Flow rate through an exchanger decreases below the maximum equipment output. In a steam system, temperature regulation actually means controlling the pressure. Under partial load conditions, the steam controller, whether self-acting, pneumatic or any other type, reduces the pressure until the necessary trap differential is eliminated, the system "**stalls,**" and steam coils become water-filled coils.

Steam Stall

Saturated steam temperature is directly related to its pressure and for any load requirement, the control valve output is determined by the basic heat transfer equation, Q = UA x ΔT. With "UA" for a steam-filled coil a constant, the amount of heat supplied, "Q", is regulated by the "ΔT, the log mean temperature difference (LMTD) between the heated air or liquid and saturated steam temperature at the pressure delivered by the valve. Thus, the steam pressure available to operate the trap is not constant but varies with the demand for heat from almost line pressure down through sub-atmospheric, to complete shutdown when no heat is required. Actual differential across the trap is further reduced when the heating surface is oversized or the trap must discharge against a back pressure. Knowing these conditions, the system must be designed accordingly.

Draining Equipment Under "Stall" Conditions

"System stall" is lack of positive differential across the steam trap and temperature controlled equipment will always be subject to this problem when the trap must operate against back pressure. **Under these conditions, a vacuum breaker is ineffective because "stall" always occurs above atmospheric pressure.** Even when steam is supplied at a constant pressure or flow to "batch" type equipment, stall can occur for some period of time on startup when the steam condenses quickly and the pressure drops below the required differential. What happens when the system stalls is that the effective coil area ("UA" in the formula) drops as the steam chamber floods and heat transfer is reduced until the control valve responds to deliver an excessive supply of steam to the coil. This results in a "hunting system" with fluctuating temperatures and hammering coils as the relatively cooler condensate alternately backs up, then at least some portion is forced through the trap. This hunting occurs on the milder temperature days because the coil is sized for the lowest possible air temperature. The coil cannot change surface area, so the steam pressure/temperature control valve takes over to accommodate the change in load. The solution to all system stall problems is to make condensate drain by gravity under all conditions including vacuum. Atmospheric systems tend to operate more predictably and are generally easier to control but major heating equipment is usually not drained into an atmospheric return because of the large amount of energy that is lost from the vent. In many hospitals and process plants, venting vapors of any type is discouraged and a "closed loop" system is not only required but is less subject to oxygen corrosion problems.

Solve steam stall with "closed loop drainage system utilizing Spirax Sarco APT (automatic pump trap)" Sized and matched to your Luvata Heatcraft Coil.

2) Closed Loop Drainage Systems

To make equipment drain by gravity against back pressure, **the steam trap must be replaced by an Automatic Pump Trap (APT).**

In this arrangement, the equipment does not have a vacuum breaker

but is pressure equalized to drain by gravity to the APT, then the equalizing line is isolated while condensate is pumped from the system.

This arrangement will drain the coil free of condensate at all times (even under a vacuum).

The system can be under a constant stall but it will still drain free of condensate because the pressure in the Automatic Pump Trap is always equal to the pressure inside the coil.

Vacuum is just pressure below atmospheric and water seeks its own level whether under vacuum, atmospheric or higher pressures. Gravity pulls with the same force on water (condensate) no matter what the pressure is.

If there is sufficient differential pressure to move the condensate through the APT then it functions as a normal steam trap. Then when needed it functions as a pump, using steam as a motive force to move the condensate to the condensate system.

The APT is simply connected to the outlet of the coil. No need for vacuum breakers.

- The APT will drain condensate under all load conditions.
- Giving exceptional temperature control at the heat exchange interface.
- Reduce tube corrosion.
- Eliminate noise and water-hammer.
- Extend coil life.

The APT is a simple and efficient solution to a difficult problem. Without the need for high Net Positive Suction Head NPSH, the APT will operate with only 8” installation head from the base of the pump, and remove condensate from a coil under vacuum, atmospheric or higher pressures, discharging it to either high or low level condensate return lines.

The following is an example of how to size and install the APT (Automatic Pump Trap)

Install conditions (such as elevation of the coil outlet from the APT), height elevation of condensate return line and back pressure in the condensate system will alter the capacity of the APT. All must be taken into consideration when sizing the APT for a steam coil.
These conditions effect the capacity of the APT.
See the bulletin “**Steam Coil with Automatic Pump Trap for drainage under all conditions” Consult your Luvata Heatcraft agent for help in sizing and selection of both the coil and the APT.**