TESTING STEAM TRAPS TO KEEP YOUR SYSTEM OPERATING EFFECTIVELY AND EFFICIENTLY

A steam trap, which is a fully automated condensate drainage device, generally does not require routine maintenance. Steam traps, which are sized and selected properly, should give a long trouble-free life when the proper trap for the application is in place. External forces from the steam are the only things that can adversely effect the trap other than long term wear. Three conditions which can effect the trap are:-

1. Dirt, the most common cause of premature failure, is by far the leading cause of trap failure in either a leaking position or blocked closed.
2. Pressure surges due to sudden steam valve openings, improper piping or misapplied trap causing waterhammer damaging internal components.
3. Oversized traps losing their prime, rapid cycling or wire drawing.

To keep the steam system operating efficiently, the traps in the system must be tested periodically. A trained, qualified technician should do this periodic test when utilizing most test methods. Testing would typically be performed on an annual basis, although very critical applications may be done more often. Before testing can be done, all traps should be located, and identified with a metal stamped tag. Once tagged, a log should be developed with pertinent information. The minimum data on the log at a minimum is location, trap model, trap size, steam pressure, application, trap test function and date of test. The more information that is obtained the better and more effective your program for maintaining maximum system output and efficiency. Several companies offer computerized databases for steam trap surveys.

Figure 1 shows a typical data input sheet from a steam trap survey computer program.

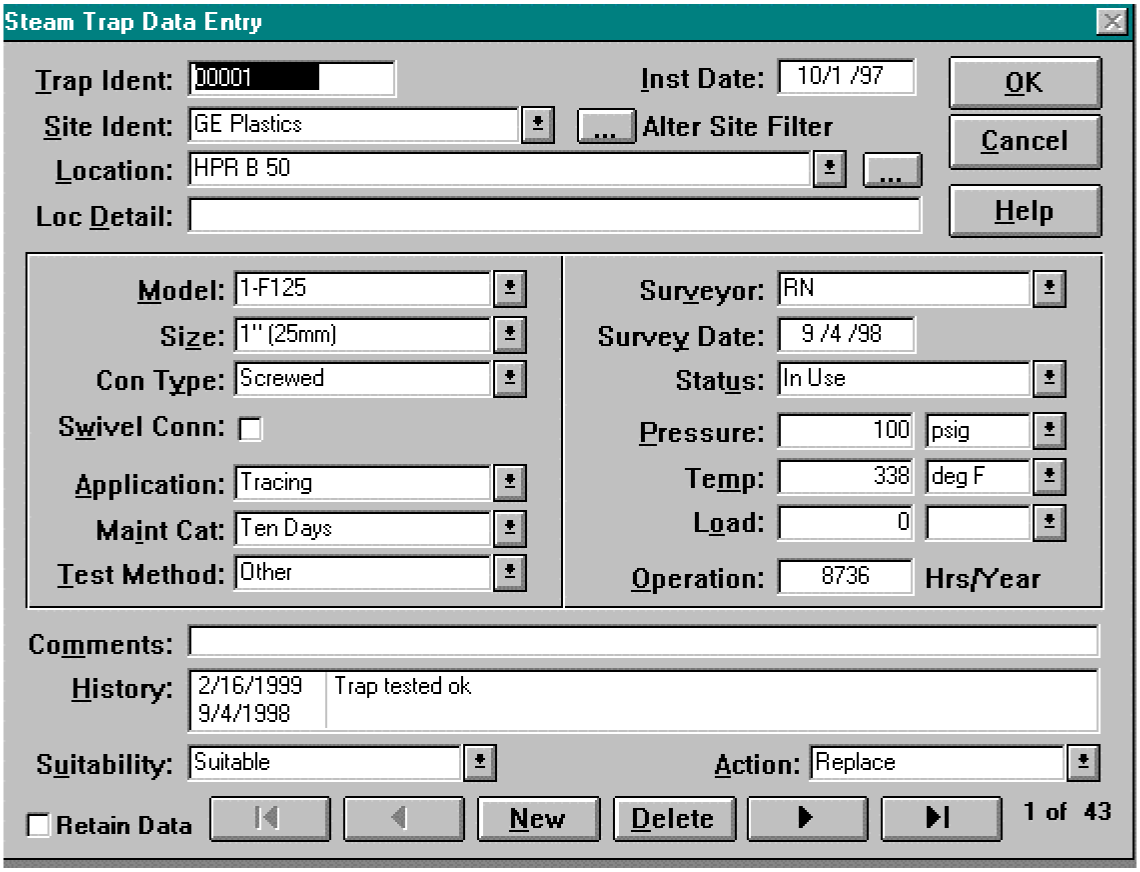
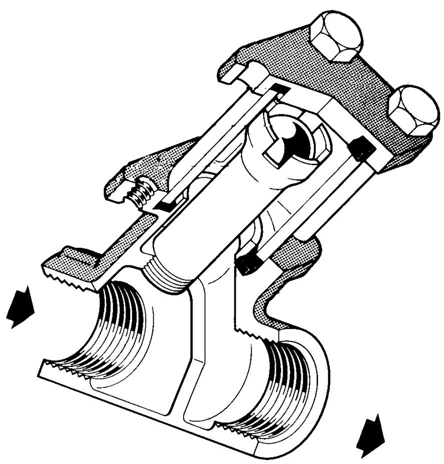


Figure 1

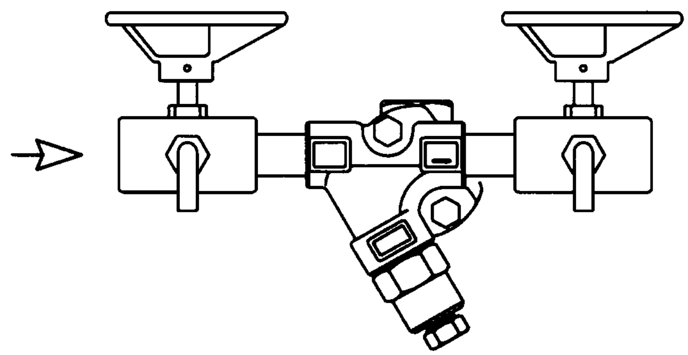
There are several test methods which can be used to inspect trap operation, but they are not all equal based on the results that they give. We will look at each type, equipment required, and the plus and minus of each of the methods.

VISUAL TESTING

Visual testing includes traps with open discharge, sight glasses, sight checks, test tees and three way test valves. In every case, you observe the flow or variation of flow visually. This method works well with traps that cycle on/off, or dribble on light load. On high flow or process, due to the volume of water and flash steam, this method becomes less viable. If condensate can be diverted ahead of the trap or a secondary flow can be turned off, the load on the trap will drop to zero or a very minimal amount so the visual test will allow you to determine leakage. For example, an air handling coil generally would be producing a high amount of condensate. If the blower was turned off cutting the secondary flow, the condensate rate would drop to almost nothing and the trap would throttle down to a dribble if it were working properly. Most systems today have closed piping and many do not have sight glasses, test tees or three way test valves installed so visual testing has limited applications. Test tees and three way test valves can only be used where condensate can be dumped on the floor or ground. It is not recommended to blowdown into a bucket due to splashing and possible scalding of personnel.



Sight Check



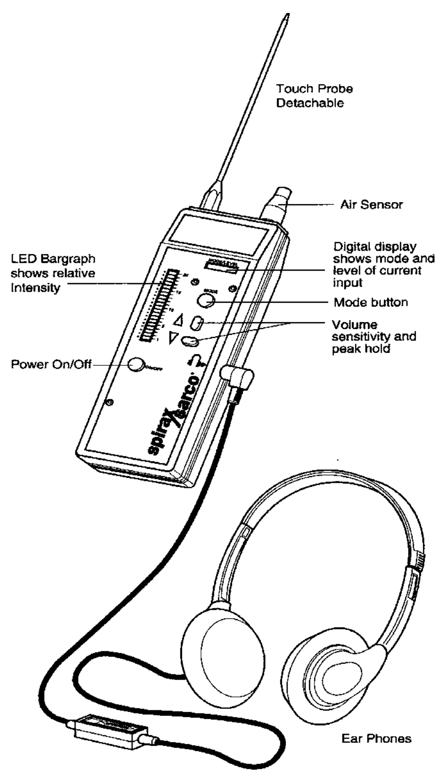
Trap Station with 3-way Test Valves

SOUND TESTING

Sound testing includes ultrasonic leak detectors, mechanics stethoscopes, screwdriver or metal rod with a human ear against it. All these use the sound created by flow to determine the trap function like the visual method. This method works best with traps that cycle on/off or dribble on light load. Traps which have modulating type discharge patterns are hard to check on high flows. (examples are processes , heat exchangers, air handling coils, etc). Again by diverting condensate flow ahead of the trap or shutting off a secondary flow as mentioned under visual testing, the noise level will drop to zero or a very low level if the trap is operating correctly. If the trap continues to flow heavily after diversion it would be leaking or blowing through.

The ultrasonic leak detector is the easiest to use, most flexible and accurate of the sound testing methods. The ultrasonic gun or any sound measuring device cannot tell if a trap is cold or blocked. It will read no flow, but that could also indicate a good trap with no or very light load. When no reading is shown, a check of the trap temperature should be done. Most ultrasonic units give you an audible and visual readout. The better units allow for independent sensitivity, volume control and use digital controls and displays. The ultrasonic leak detectors are the most widely used devices for trap testing used in large facilities today because of the ease of use, accuracy and portability.

Typical Leak Detector



TEMPERATUE TESTING

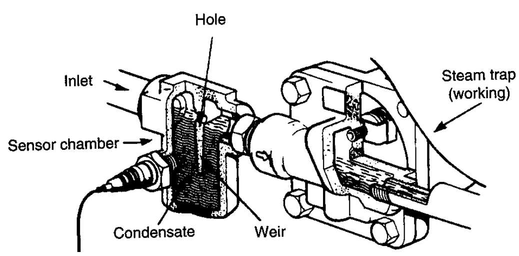
Temperature testing includes infrared guns, surface pyrometers, temperature tapes, and temperature crayons. Typically they are used to gauge the discharge temperature on the outlet side of the trap. In the case of temperature tapes or crayon, they are set for a predetermined temperature and they indicate when temperature exceeds that level. Infrared guns and surface pyrometer can detect temperatures on both sides of the trap. Both the infrared and surface pyrometers required bare pipe and a clean surface to achieve a reasonable reading. The temperature reading will typically be lower than actual internal pipe temperature due to the fact that steel does have some heat flow resistance. Scale on the inside of the pipe can also effect the heat transfer. Some of the more expensive infrared guns can compensate for wall thickness and material differences. Blocked or turned off traps can easily be detected by infrared guns and surface pyrometers, as they will show low or cold temperatures. They could also pick up traps which may be undersized or backing up large amounts of condensate by detecting low temperature readings.

When a trap leaks through, the temperature on the discharge side of the trap is always related to the pressure in the return system. For example, if one trap only discharges to a vented receiver, the return line pressure would be virtually zero and the related temperature 212°F. If the trap failed open and the pressure went up in the return line (only if return friction loss or receiver vent friction allowed a rise due to volume restrictions), the temperature would follow, due to the laws of physics. The temperature method would work in this case if pressure actually went up, which depends on piping capacity and amount of trap leakage.

Typically in the real world, several traps feed into a common return. The problem that arises is that a few traps may fail and pressurize the return, but since all the traps are tied together, the pressure equalizes throughout the return system. The temperature will also equalize. All traps now read the same temperature on the discharge and we cannot pinpoint the exact trap that has failed. For this reason, we find that temperature testing of steam traps for leakage can be inaccurate or false.

CONDUCTIVITY TESTING

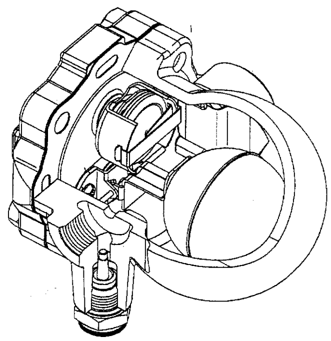
The newest technology in steam trap testing is conductivity. Since water is a conductive material and steam is not very conductive, we can sense the presence or absence of water by taking a resistance reading. The sensor is mounted into the chamber that is designed with a weir which is full of condensate under normal trap operation. When the trap leaks or blows through, the condensate level drops exposing the sensor. The sensor chamber is designed with a wall that runs about two thirds down the chamber with a small hole at top of the wall in direct line with the pipe flow. This hole allows a small amount of steam to flow through without affecting the liquid level to compensate for heat loss from the trap and piping and also to prevent the unit from being to sensitive. When a steam leak occurs, the pressure drop across the small orifice creates a manometer effect allowing the liquid level to drop exposing the sensor to steam. The electrical signal from the measuring device is broken and the failure is shown. Sensor chambers must be permanently placed into piping before the trap. This system works on any type of trap from any manufacturer.



Trap with Conductivity Sensor Chamber

These designs can sense steam loss and/or low temperatures depending on the sensor type and can be connected to a building management system through the measuring device. Newer designs of the sensor can incorporate a temperature probe integral with the conductivity sensor to show traps which are failed closed or cold.

Latest designs incorporate the sensor directly into the trap body and are currently available in thermodynamic, inverted bucket and thermostatic traps. The first float and thermostatic trap with in-built sensor has just come onto the market as shown.



Float and Thermostatic Steam Trap with In-Trap Sensing

Once properly installed, there is no operator training required with the conductivity system as it gives an automatic reading of good or bad.

TESTING VISUAL AND SOUND METHODS

When utilizing the visual or sound methods, the technician performing the test should know some knowledge of the application and trap type being used. The chart below gives trap discharge modes under difference conditions for various trap styles.

Table 16: Steam Trap Discharge Modes

	Mode of Operation				
Trap Type	**No Load**	**Light Load**	**Normal Load**	**Full or Overload**	**Usual Failure Mode**
Float & Thermosatic	No Action	Usually continuous but may cycle at high pressure		Continuous	Closed, A.V. Open
Inverted Bucket	Small Dribble	Intermittent	Intermittent	Continuous	Open
Balanced Pressure Thermostatic	No Action	May Dribble	Intermittent	Continuous	Variable
Bimetallic Thermostatic	No Action	Usually Dribble Action	May blast at high pressures	Continuous	Open
Impulse	Small Dribble	Usually continuous with blast at high loads		Continuous	Open
Disc Thermo-Dynamic	No Action	Intermittent	Intermittent	Continuous	Open

Both visual and sound require the technician to understand differences between the different trap styles.

1. **Thermodynamic traps** have a blast discharge and cycles on/off. An ultrasonic tester typically will give 0-100% reading. A properly operating and sized trap will cycle 10 times per minute or less. A trap cycling more than ten cycles per minute or continuous discharge means the trap is either severely worn, is subject to high back pressure, or dirt is preventing the disc from closing off.
2. **Inverted Bucket traps** have a discharge pattern that is usually semi-cyclical. On medium to heavy loads, the trap will have a definite on/off cycle. The ultrasonic tester reading will be a sweeping motion, back and forth. Light loads will change the discharge pattern to a modulating low flow and the ultrasonic tester will give a low continuous reading. When the trap is malfunctioning, the sonic readout will be a full 100% reading for blow-through and an erratic on/off type operation for lost prime failure.
3. **Float and Thermostatic traps** have a discharge patten that is a continuous modulating flow. We must first determine the type of application, process or light load condition. If the condensate load is light, such as found on steam main drips and tracers, sound levels would be normally low and would give a low level continuous readout. A high readout would mean that some part of the trap has failed. When testing, be aware that this type of trap has two orifices; the main orifice located below the normal condensate level, and the thermostatic air vent at the top in the steam space.

   In normal operation on process equipment such as heat exchangers and air handlers, the flow will be continuous and at a high sound level. For the ultrasonic test to be accurate, the load must be removed or lightened to allow the trap to shut or throttle back considerably.

   Readings should be compared at high and low loads. To reduce the load, the airflow on a coil should be shut off; on a heat exchanger, the liquid flow turned off or a blowdown valve before the trap opened to reduce the load. In any case, the trap should shut off or throttle back to a point where a good test can be made.

When the load has been reduced or cut off, the ultrasound reading should be very low or at zero level if the orifice is tightly closed.

4. **Thermostatic/Radiator Traps** are often on low pressure and the usual discharge pattern is a dribbling type action. The load on convectors and radiators is normally low and should give a very low or zero readout when the unit is on and operating. Since thermostatic traps are wide open when cold, the trap can be tested for both opening and closing by turning off the steam supply to the trap and allowing the trap to cool. When the trap is cool, open the steam valve while the sonic probe is on the trap outlet. Trap discharge should start wide open, then quickly shut. This test proves full function of the trap and should be used if normal test proves inconclusive.

5. **Thermostatic/General Purpose Traps** contain element designs and fillings that will vary, but generally this trap dribbles on light loads and modulates on heavy loads but can also cycle on/off. Main drips and tracers where loads are light should give a low readout and cycle on/off. On most process uses, the trap will tend to modulate or sometimes cycle. For testing, the same procedure given above for processes on Float and Thermostatic traps should be used. Closing the trap off and letting it cool will open the valve fully. When turning the trap back on, the trap will blast full open and then the trap should shut down within a minute's time. The ultrasonic tester will be able to indicate both full flow and shutoff conditions. This method should be used if the reading that is normally given off by the trap is unclear as to whether it is good or leaking steam.

6. **Bimetallic Traps** do not respond to load change as fast as other types and the discharge pattern is normally modulating and tends to dribble. Bimetallic traps are usually found on drips, tracers and light load applications, so discharge would normally be continuous with a low sound level. Draining condensate ahead of the trap should shut it off, and ultrasound levels should drop to zero.

7. Orifice drain devices give a constant flow and never shut off. If condensate is diverted ahead of the trap, it is possible that the noise level may change due to the volume change from a mixture of steam and water to steam only. In either case, sound or visual, it will be hard to decipher what you are hearing or seeing. There is not a good method of testing this unit because, by design, it does leak steam.

STEAM LOSS

Calculating the steam loss on failed traps can be a complicated matter. The reason being that there can be an infinite number of leak rates depending on the trap type, type of failure, pressure or condensate load. The formula 24.24 x Pa x D^2 estimates trap steam loss when the trap has failed open. Where Pa equals the pressure in psi absolute, and D equals the diameter of the trap orifice in inches.

This formula is a variant of the Napier formula. The flow rates obtained are with traps blowing open under light loading conditions and would be considered a worst case scenario. Knowing the type of failure, something about the condensate load versus trap capacity, will allow you to add a multiplying factor to reduce calculated blowing loss to a realistic number to fit your particular leakage situation. For example, a trap, which is draining a process at 50% of the trap capacity, but failed wide open, would be leaking 50% of the calculated steam loss. A trap with just a worn head and seat could reduce the loss by 90%. Noting the type of failure on the data sheet will allow you to apply a correction factor when you calculate your losses.

CONCLUSION

In conclusion, testing is an important factor in the overall operation efficiency of the system. Visual, where it is available, is still a viable way of testing and was the first method ever employed. The conductivity testing is by far the most accurate and requires no knowledge to operate, but must be planned into the system or retrofitted into existing systems. Conductivity can give continuous constant readings on trap functions with alarms that no other system can offer and is technologically the most advanced trap testing available.

The two portable systems offer the flexibility that they can be used anywhere, so one unit could be used throughout the facility. Of the two systems, the ultrasonic leak detector gives a more accurate output since it listens to the individual trap flow and if the operator is trained, provides excellent results. The best accuracy is achieved when the ultrasonic gun is used in conjunction with an infrared gun so that the trap can be tested for flow and temperature to pick up leaks, blockages, steam pressure at the trap, and back pressure in the return system.

October 10, 2000 (Joe Radle)

Joe Radle has been employeed by Spirax Sarco, Inc. for 28 years. Working in Manufacturing, Research and Development, Applications and currently as Product Manager for Steam Trap, Drainers, and Air Vents.

Reference: Spirax Sarco Design of Fluid Systems - Hook-Ups