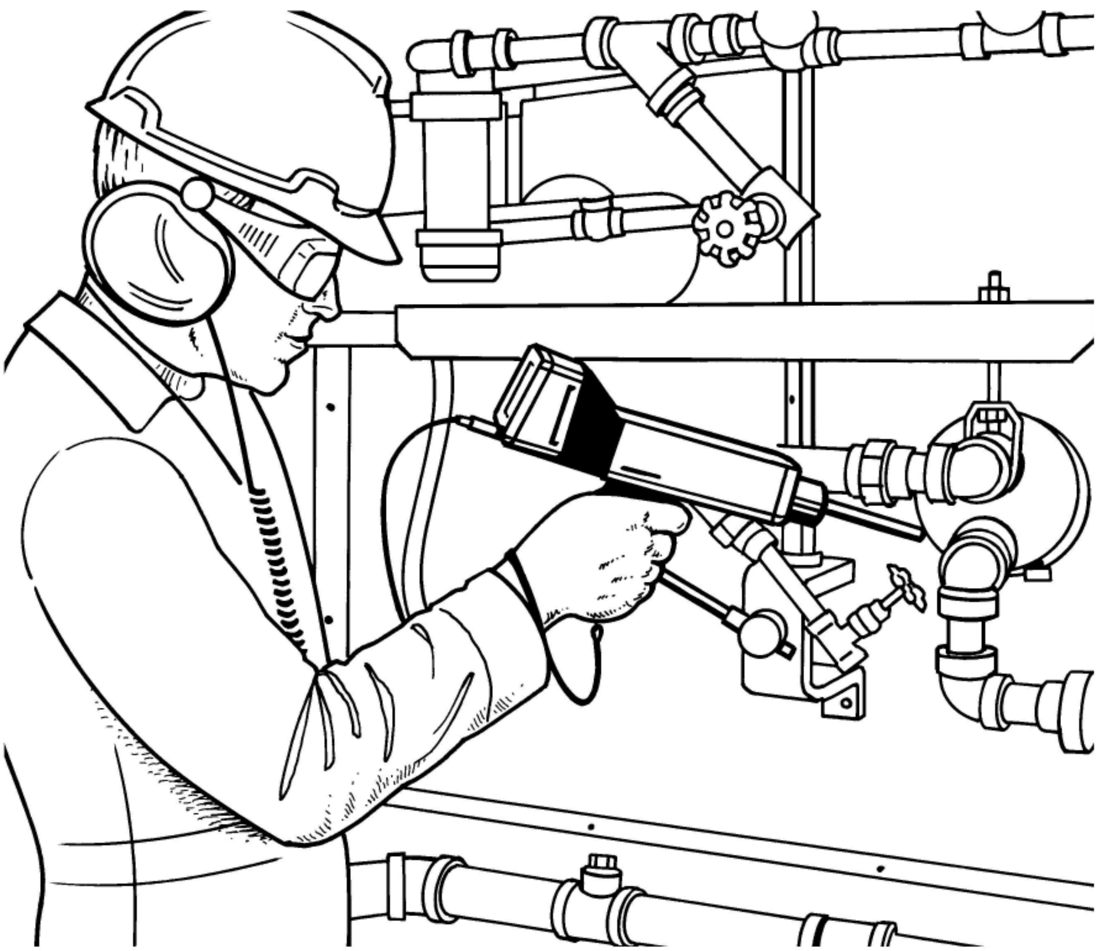
SYSTEMS INC

Steam Trap Inspection Methods
And
Steam Cost Analysis



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Steam Trap Inspection Methods

From the earliest moments of the "industrial revolution" steam has had an impact on mankind. It has moved machines, turned turbines, produced heat to aid in various manufacturing processes and provided us with warmth in the darkness of winter. Producing steam can range from the extremely simple to the vastly complex. As time has gone on, in order to optimize the utilization of the BTU's released from steam, various components have been added to a steam system. The most important development was the steam trap. This "automatic valve" allows steam to remain in a system to deliver its BTU's and then, when it has cooled sufficiently to where it is no longer useful, it discharges the cooler "condensate". Other impurities such as gases that can negatively impact on the effective transfer of heat energy from steam are also removed.

Proper steam trap maintenance is essential to a steam system. Faulty steam traps not only waste energy, they can contribute to pipe erosion due to poor water quality and contaminants allowed to pass down stream. Faulty steam traps can negatively affect product quality in various processes such as paper, food or chemicals, and even add to environmental pollution.

Steam Traps should be inspected routinely. The frequency of inspection is often determined by application. As an example, steam systems used just for facility comfort (i.e. heating) are routinely inspected annually while systems that utilize steam as part of a manufacturing process might be inspected anywhere from biannually to quarterly, depending on the impact steam has on the process.

While there are many steam trap users who routinely provide "preventive maintenance" by replacing trap elements annually, this not often practical. In fact it can prove costly and ineffective since traps can fail or leak in between these routines and many traps will work for years before the elements need to be replaced.

It is often more cost effective to establish a routine steam trap audit.

As part of any predictive maintenance routine, knowledge of the system is critical. For this reason, before inspection begins, a map or some diagram of the location of all the steam traps and valves in a facility should be available. All traps should be tagged and coded and referenced on the map/diagram. In addition, the trap inventory should include the trap type, size, manufacturer, and application.

To improve on inspection routines, it is recommended that some form of record keeping/data collection be employed to provide information about the steam system over time. This is useful in spotting potential areas of recurrent problems, possible clues about misuse of traps, data about costs and savings incurred. There is commercially available steam management software available, which can be quite useful in maintaining accurate trap records. Digital ultrasound instruments offer the ability to store trap data on board which can then be downloaded into data management software for reporting purposes. Most of the data management software accompanying digital ultrasound instruments is usually offered as "freeware".

Once the record keeping has been put in order, various methods of inspection should be considered. The most common are visual inspection, acoustic stethoscopes, temperature and ultrasonic instruments. Ultrasonic instruments translate the high frequency emissions of a trap down into the audible range where they are heard through headphones and seen as intensity increments on a display panel. In addition to intensity increments, digital instruments display intensity as decibels. Some ultrasound instruments have frequency tuning to filter out additional signals and to tune into the sounds of steam and condensate while others have on-board recording and data logging so that users can record the sounds of steam traps for sound analysis purposes and review the test data to identify faulty traps and for cost avoidance analysis.

Ultrasonic Inspection Method

While there are a variety of traps available in the market place, for purposes of inspection, there are basically two main types: continuous flow and intermittent (on/off).

"On-Off" Traps
On/off traps will have a basic hold-discharge-hold pattern. Typical of this type are:

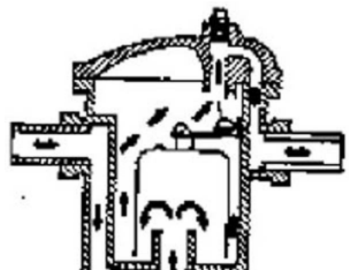
- Inverted Buckets
- Thermodynamic
- Thermostatic (Bellows)
- Bi-Metallic

Continuous Flow Traps
Continuous flow traps discharge condensate continuously. The most common are:

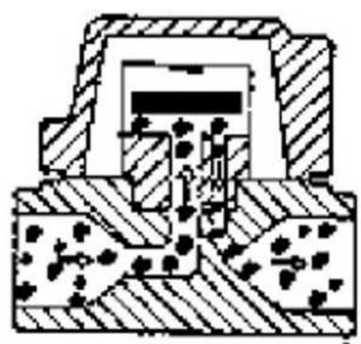
- Float and Thermostatic trap
- Fixed Orifice

Each type of trap has its' own unique pattern that is described below. It is recommended that you listen to a number of traps to determine a "normal" operation in your particular situation before you proceed with your survey. Generally, when checking a trap ultrasonically, a continuous rushing sound will often be the key indicator of live steam passing through. Sound samples of different trap types can be heard on UE Systems web site: http://uesystems.com/tech_support_gallery.asp

The most common method for testing a steam trap ultrasonically is to touch the trap in two places: on the upstream to set the instrument and on the downstream side for the actual test and data collection. First adjust the sensitivity on the ***upstream*** side to bring the instrument into range and to hear the trap sounds clearly. This is usually a setting in which the meter intensity indicator (sometimes a bar graph) of the ultrasound instrument is at a mid-line position. Do not reduce the sensitivity too low or too high. Either position, too high or too low, will make it difficult to accurately listen to the trap sounds. If frequency tuning is available on your instrument, choose 25 kHz. Once the instrument is set to perform the test accurately, move the contact probe to the ***downstream*** side of the trap, listen and record your results.

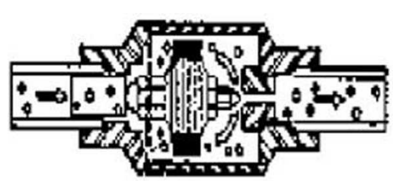


INVERTED BUCKET TRAPS (intermittent trap) normally fail in the open position because the trap loses its prime. This condition means a complete blow-through, not a partial loss. The trap will no longer operate intermittently. Aside from a continuous rushing sound, another clue for steam blow-through is the sound of the bucket clanging against the side of the trap. Leaking steam, not a total blow through, will have a continuous, but slight hissing sound. An early warning signal of potential leakage or blow-through in this type of trap will be the rattling sound of the linkage. This indicates linkage looseness that can lead to steam loss.



THERMODYNAMIC (DISC) TRAPS (intermittent trap) work on the difference in dynamic response to velocity change in flow of compressible and incompressible fluids. As steam enters, static pressure above the disc forces the disc against the valve seat. The static pressure over a large area overcomes the high inlet pressure of the steam. As the steam starts to condense, the pressure against the disc lessens and the trap cycles. A good disc trap should cycle (hold-discharge-hold) 4 – 10 times per minute. It usually fails in the open position, allowing for a continuous blow-through of steam. While a trap operating in good condition will have a distinctive shut off between discharges, a leaking trap will never shut and will produce a slight hissing sound. Should the disc become worn, a condition referred to as "motor boating" or "machine gunning" can occur. This produces a very rapid rattling sound that closely resembles the above descriptive terms. This condition allows steam to leak through and is a predictor of more severe problems to come.

THERMOSTATIC TRAPS (intermittent trap) (bellows and bimetallic) operate on a difference in temperature

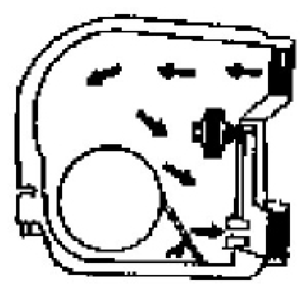


between condensate and steam. They build up condensate so that the temperature of condensate drops down to a certain level below saturation temperature in order for the trap to open. By backing up condensate, the trap will tend to modulate open or closed depending on the load. These traps will have a hold-discharge-hold pattern. They can take a long time before discharging when there is little condensate build up. At times of high condensate, such as in start up they will stay open continuously (for that period in which the condensate is present). For this reason, it is best ***not*** to test these traps during start up. When closed, these traps will be silent; a slight hissing sound will indicate leakage. Blow-through will have a high amplitude rushing sound.

Should the bellows in a bellows trap become compressed by water hammer, the trap will not function properly. The occurrence of a leak will prevent the balanced pressure action of these traps. When either condition occurs, the trap will fail in its natural position either opened or closed. If the trap fails closed, condensate will back up and no sound will be heard. If the trap fails open, continuous rushing of live steam will be heard.

Bimetallic traps have plates that, when exposed to heat from steam will set and discharge as they cool in the presence of condensate. An improper set will prevent the plates from closing completely and allows steam to pass through. This will be heard as a constant rushing sound.

FLOAT AND THERMOSTATIC TRAPS (continuous flow) contain two elements: a ball float and a thermostatic element (similar to that found in a thermostatic trap). When operating properly, the trap ball floats up and down on a bed of condensate, which keeps the discharge valve open. When listening to this condition, a modulating sound of the discharging condensate will be heard. This type of trap normally fails in the “closed” position. A pinhole leak produced in the ball float will cause the float to be weighted down or water hammer will collapse the ball float. Since the trap is totally closed, no sound will be heard and the trap will be cold. In addition, check the thermostatic element in the float and thermostatic trap. If the trap is operating correctly, this element is usually quiet. Its main function is to remove air from the steam system at start up. If a rushing sound is heard, this will indicate steam blowing through the air vent since it will be in a state that will not differentiate between either fluid. This indicates that the vent has failed in the open position and is wasting energy. Should the mechanical linkage become loose it will effect the operation of the discharge valve and can eventually lead to steam leakage. This will be heard as a clanging, rattling sound.



FIXED ORIFICE TRAPS (continuous flow)

These traps contain a narrow orifice designed to create a “venturi” effect. Basically, pressure differentials occur due to the temperature differentials between steam, hot and cold condensate. When cold condensate enters the trap, steam pressure forces condensate and air through the orifice. In theory, when hot condensate or steam reaches the trap, the pressure drop across the orifice produces flash steam that blocks the flow of live steam. As the load on the steam system falls, the condensate temperature increases and so does the amount of flash steam. The sounds of a modulating condensate flow in normal conditions will be a sign of a properly functioning trap. Contamination may cause the trap fail closed. If this does happen, there will be no sound and the trap will be cold. Should the trap blow live steam due to possible changes within the trap body, this will be heard as a high-pitched, continuous rushing sound.

THINGS TO CONSIDER

Since ultrasonic testing of steam traps is a positive test, it provides results in a "real time" basis. The main advantage to ultrasonic testing is that it isolates the area being tested by eliminating confusing background noises. A user can quickly adjust to recognizing differences among various steam traps.

While performing a steam trap survey, it is important to note specific trap condition on a chart. As mentioned above, every trap should have a tag with a corresponding identification code. During the inspection procedure, trap condition should be noted. All poorly operating traps should be documented in a non-compliance report and a follow up procedure should be planned. Include a digital photograph of the trap in your report. The follow up procedure should include such items as trap number, condition and date of repair. As part of a quality assurance procedure, all repaired traps should be scheduled for re-test. A comprehensive report is recommended to describe the results of a steam trap survey. The report should include items such as the number of traps tested, the number found in good condition and the number of faulty traps. A cost analysis should be included as well. The cost analysis should indicate the gross amount of savings, the repair costs and the net savings for the survey.

Any steam system, no matter how diligent the operation, can leak; any trap can potentially waste steam. If performed properly, a routine, planned program of steam trap inspection and repair can continually pay for itself and contribute to a company's bottom line in terms of productivity, quality, energy savings and the reduction of your facility's carbon footprint.

ENERGY SAVINGS MEANS BIG DOLLAR SAVINGS

How much energy can be saved from a steam trap survey?

A rule of thumb states that if there has been no steam trap survey or maintenance program, upwards of 50% of a system's traps can be blowing live steam. If a survey is performed annually, this figure drops to about 25%. A bi-annual survey will reduce this even further to less than 12%.

Use the guide below to estimate the amount of loss steam leaks are costing your company.

STEAM FLOW THROUGH STEAM TRAP ORIFICE TABLE

To establish the approximate dollar loss, take the lb./hr figure X 24 hours (for a year X 8760) and multiply by your cost of steam. Ex: 1/8” orifice @ 50 psi = 29.8 X 8760 = 261048. At a cost of $5.00/1000 lb.: 261048 X .005 = $1305.24

Orifice Diameter	2 psi	5 psi	10 psi	15 psi	25 psi	50 psi	75 psi
Steam Loss, lb. / hr							
1/32”	0.31	0.49	0.70	0.85	1.14	1.86	2.58
1/16”	1.25	1.97	2.80	3.40	4.60	7.40	10.3
3/32”	2.81	4.44	6.30	7.70	10.3	16.7	15.4
1/8”	4.50	7.90	11.2	13.7	18.3	29.8	41.3
5/32”	7.80	12.3	17.4	21.3	28.5	46.5	64.5
3/16”	11.2	17.7	25.1	30.7	41.4	67.0	93.0
7/32”	15.3	24.2	34.2	41.9	55.9	91.2	126
¼”	20.0	31.6	44.6	54.7	73.1	119	165
9/32	25.2	39.9	56.5	69.2	92.5	151	209
5/16”	31.2	49.3	69.7	85.4	114	186	258
11/32”	37.7	59.6	84.4	103	138	225	312
3/8”	44.9	71.0	100	123	164	268	371
13/32”	52.7	83.3	118	144	193	314	436
7/16”	61.1	96.6	137	167	224	365	506
15/32”	70.2	111	157	192	257	419	580
½”	79.8	126	179	219	292	476	660

STEAM FLOW THROUGH STEAM TRAP ORIFICE TABLE

To establish the approximate dollar loss, take the lb./hr figure X 24 hours (for a year X 8760) and multiply by your cost of steam. Ex: 1/8" orifice @ 100 psi = 52.8 X 8760 = 462528. At a cost of $5.00/1000 lb.: 462528 X .005 = $2312.64.

Orifice Diameter	100 psi	125 psi	150 psi	200 psi	250 psi	300 psi
Steam Loss, lb./hr.						
1/32"	3.30	4.02	4.74	6.17	7.67	4.05
1/16"	13.2	16.1	18.9	24.7	30.4	36.2
3/32"	29.7	36.2	42.6	55.6	68.5	81.5
1/8"	52.8	65.3	75.8	99.0	122	145
5/32"	8205	100	118	154	190	226
3/16"	119	145	170	222	274	326
7/32"	162	197	232	303	373	443
¼"	211	257	303	395	487	579
9/32	267	325	384	500	617	733
5/16"	330	402	474	617	761	905
11/32"	399	486	573	747	921	1095
3/8"	475	578	682	889	1096	1303
13/32"	557	679	800	1043	1286	1529
7/16"	674	787	928	1210	1492	1774
15/32"	742	904	1065	1389	1713	2037
½"	844	1028	1212	1580	1949	2317

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