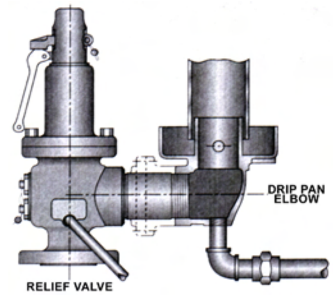
TECH TIP #32

STEAM TABLE - PROPERTIES OF SATURATED STEAM

Gauge Pressure PSIG	Temperature °F	Heat in Btu/lb. Sensible	Latent	Total	Specific Volume Cu. ft. per lb.	Gauge Pressure PSIG	Temperature °F	Heat in Btu/lb. Sensible	Latent	Total	Specific Volume Cu. ft. per lb.
IN VAC. **25**	**134**	**102**	**1017**	**1119**	**142**	185	382	355	843	1198	2.29
20	162	129	1001	1130	73.9	190	384	358	841	1199	2.24
15	179	147	990	1137	51.3	195	386	360	839	1199	2.19
10	192	160	982	1142	39.4	**200**	**388**	**362**	**837**	**1199**	**2.14**
5	203	171	976	1147	31.8	205	390	364	836	1200	2.09
0	**212**	**180**	**970**	**1150**	**26.8**	210	392	366	834	1200	2.05
1	215	183	968	1151	25.2	215	394	368	832	1200	2.00
2	219	187	966	1153	23.5	220	396	370	830	1200	1.96
3	222	190	964	1154	22.3	**225**	**397**	**372**	**828**	**1200**	**1.92**
4	224	192	962	1154	21.4	230	399	374	827	1201	1.89
5	**227**	**195**	**960**	**1155**	**20.1**	235	401	376	825	1201	1.85
6	230	198	959	1157	19.4	240	403	378	823	1201	1.81
7	232	200	957	1157	18.7	245	404	380	822	1202	1.78
8	233	201	956	1157	18.4	**250**	**406**	**382**	**820**	**1202**	**1.75**
9	237	205	954	1159	17.1	255	408	383	819	1202	1.72
10	**239**	**207**	**953**	**1160**	**16.5**	260	409	385	817	1202	1.69
12	244	212	949	1161	15.3	265	411	387	815	1202	1.66
14	248	216	947	1163	14.3	270	413	389	814	1203	1.63
16	252	220	944	1164	13.4	**275**	**414**	**391**	**812**	**1203**	**1.60**
18	256	224	941	1165	12.6	280	416	392	811	1203	1.57
20	**259**	**227**	**939**	**1166**	**11.9**	285	417	394	809	1203	1.55
22	262	230	937	1167	11.3	290	418	395	808	1203	1.53
24	265	233	934	1167	10.8	295	420	397	806	1203	1.49
26	268	236	933	1169	10.3	**300**	**421**	**398**	**805**	**1203**	**1.47**
28	271	239	930	1169	9.85	305	423	400	803	1203	1.45
30	**274**	**243**	**929**	**1172**	**9.46**	310	425	402	802	1204	1.43
32	277	246	927	1173	9.10	315	426	404	800	1204	1.41
34	279	248	925	1173	8.75	320	427	405	799	1204	1.38
36	282	251	923	1174	8.42	**325**	**429**	**407**	**797**	**1204**	**1.36**
38	284	253	922	1175	8.08	330	430	408	796	1204	1.34
40	**286**	**256**	**920**	**1176**	**7.82**	335	432	410	794	1204	1.33
42	289	258	918	1176	7.57	340	433	411	793	1204	1.31
44	291	260	917	1177	7.31	345	434	413	791	1204	1.29
46	293	262	915	1177	7.14	**350**	**435**	**414**	**790**	**1204**	**1.28**
48	295	264	914	1178	6.94	355	437	416	789	1205	1.26
50	**298**	**267**	**912**	**1179**	**6.68**	360	438	417	788	1205	1.24
55	300	271	909	1180	6.27	365	440	419	786	1205	1.22
60	307	277	906	1183	5.84	370	441	420	785	1205	1.20
65	312	282	901	1183	5.49	**375**	**442**	**421**	**784**	**1205**	**1.19**
70	316	286	898	1184	5.18	380	443	422	783	1205	1.18
75	**320**	**290**	**895**	**1185**	**4.91**	385	445	424	781	1205	1.16
80	324	294	891	1185	4.67	390	446	425	780	1205	1.14
85	328	298	889	1187	4.44	395	447	427	778	1205	1.13
90	331	302	886	1188	4.24	**400**	**448**	**428**	**777**	**1205**	**1.12**
95	335	305	883	1188	4.05	450	460	439	766	1205	1.00
100	**338**	**309**	**880**	**1189**	**3.89**	500	470	453	751	1204	.89
105	341	312	878	1190	3.74	550	479	464	740	1204	.82
110	344	316	875	1191	3.59	600	489	473	730	1203	.75
115	347	319	873	1192	3.46	**650**	**497**	**483**	**719**	**1202**	**.69**
120	350	322	871	1193	3.34	700	505	491	710	1201	.64
125	**353**	**325**	**868**	**1193**	**3.23**	750	513	504	696	1200	.60
130	356	328	866	1194	3.12	800	520	512	686	1198	.56
135	358	330	864	1194	3.02	900	534	529	666	1195	.49
140	361	333	861	1194	2.92	**1000**	**546**	**544**	**647**	**1191**	**.44**
145	363	336	859	1195	2.84	1250	574	580	600	1180	.34
150	**366**	**339**	**857**	**1196**	**2.74**	1500	597	610	557	1167	.23
155	368	341	855	1196	2.68	1750	618	642	509	1151	.22
160	371	344	853	1197	2.60	2000	636	672	462	1134	.19
165	373	346	851	1197	2.54	**2250**	**654**	**701**	**413**	**1114**	**.16**
170	375	348	849	1197	2.47	2500	669	733	358	1091	.13
175	**377**	**351**	**847**	**1198**	**2.41**	2750	683	764	295	1059	.11
180	380	353	845	1198	2.34	3000	696	804	213	1017	.08

TECH TIP #33



SAFETY VALVE INSTALLATION AND OPERATION INSTRUCTIONS

Pre-installation Handling

Pressure relief valves are designed to protect equipment from over pressure. The valve should be handled with care, not subject to heavy shock loads, and protected to prevent dirt from getting inside. It should be installed correctly. Failure to do so could result in property damage or serious injury to personnel.

Installation

1. Mount the valve in a vertical position so the valve body is self-draining. If a body drain port is provided, make sure it is open when required by the ASME code. Do not plug any bonnet vent openings. The inlet piping should be as short as possible, with no elbows, and equal to or greater than the size of the pressure relief valve inlet connection. This will help to limit the inlet pressure drop to 3% or less when the valve is relieving.

2. When discharge piping is connected to valve outlet, make sure it is self-draining when a body drain port is not used. The valve should not be connected to any discharge pipe that contains pressure before the valve opens, or to any pipe where the pressure build-up is greater than 10% of the set pressure when the valve is open and relieving.

   Discharge piping, other than a short tailpipe, must be supported by something other than the valve. For steam service, a drip pan elbow or flexible connection between the valve and the pipe should be used to prevent excessive pipe stress, due to thermal expansion, from being imposed on the valve body.

3. For threaded valves, apply a small amount of pipe thread sealing compound to external threads only. Do not put any sealing compound on the first thread or any internal threads. To do so may cause the sealing compound to enter the valve and cause seat leakage.

   Use wrench flats provided to tighten the valve to the connecting pipe. Do not use the valve body or bonnet, and do not over-tighten. To do so may cause valve leakage.

4. For flanged valves, use new gaskets and tighten the mounting studs evenly.

Operation

1. Maintain a system operating pressure at least 5 psig, or 10% below the set pressure of the valve, whichever is greater. Operating too close to the valve set pressure will cause seat leakage and will shorten the time between valve maintenance.

2. Do not use the safety valve as a control valve to regulate system operating pressure. Excessive operation will cause the seat to leak, and will require more frequent valve maintenance.

3. ASME Section I and VIII valves equipped with lift levers are designed to be operated only when the system pressure is 75% of the set pressure or greater. ASME Section IV valves may be operated at any system pressure. When hand operating the valve, hold it open long enough to purge any foreign matter from the seat area. If a cable or wire is attached to the lift lever for remote actuation, make sure the direction of pull is the same as it would be if the lever were pulled directly by hand.

Maintenance

Maintenance should be performed on a regular basis. An initial inspection interval of 12 months is recommended. Depending on the service conditions and the condition of the valve, the inspection interval may be decreased or increased.

TECH TIP #34

STEAM TRAP SELECTION GUIDE

The chart below lists various steam trapping applications and enables the correct choice of trap to be made.

A – First Choice B = Alternate Choice

Application	Spirax Sarco FT Range (Float/ Thermostatic)	Spirax Sarco FT/TV/SLR (Float/Thermo-static with Steam Lock Release)	Spirax Sarco FT/SLR (Float/Steam Lock Release)	Spirax Sarco TD Range (Thermo-dynamic)	Spirax Sarco BPT (Balanced Pressure Thermostatic)	Spirax Sarco SM (Bimetallic)	Spirax Sarco Thermoton (Liquid Expansion)	Spirax Sarco IB Range (Inverted Bucket)
CANTEEN EQUIPMENT								
Boiling Pans – Fixed	A	B	B[1]	B[1]	B			
Boiling Pans – Tilting		A	B		B			
Boiling Pans – Pedestal	B	B	B[1]		A[2]			
Steaming Ovens					A[2]			
Hot Plates	B	B	B[1]		A[2]			
FUEL OIL HEATING								
Bulk Oil Storage Tanks				A				B[1]
Line Heaters	A							B[1]
Outflow Heaters	A							B[1]
Tracer Lines & Jacketed Pipes				B	A[3]	B	B	
HOSPITAL EQUIPMENT								
Autoclaves and Sterilizers	B	B	B[1]		A			B
INDUSTRIAL DRYERS								
Drying Coils (continuous)	A				B	B		B
Drying Coils (grid)					B	A		B[1]
Drying Cylinders	B	A	B[1]					B[1]
Multi Bank Pipe Dryers	A				B			B[1]
Multi Cylinder Sizing Machines	B	A	B[1]					B[1]
LAUNDRY EQUIPMENT								
Garment Presses	B			A				B
Ironers and Calenders	B	A	B[1]	B[1]	B			B[1]
Solvent Recovery Units	A			B				B
Tumbler Dryers	A	B	B[1]					B[1]
PRESSES								
Multi Platen Presses (parellel connections)	B			A				B
Multi Platen Presses (series connections)				A[1]				B[1]
Tire Molds	B			A	B			B
PROCESS EQUIPMENT								
Boiling Pans – Fixed	A	B	B[1]	B[1]	B			
Boiling Pans – Tilting		A	B					
Brewing Coppers	A	B	B[1]					B[1]
Digesters	A			B[1]				B[1]
Evaporators	A	B	B[1]					B[1]
Hot Tables				B	A			
Retorts	A							B[1]
Bulk Storage Tanks				A[1]				B[1]
Vulcanizers	B			A				B[1]
SPACE HEATING EQUIPMENT								
Shell & Tube Heat Exchangers	A	B	B[1]					B[1]
Heating Coils & Unit Heaters	A	B	B[1]					B[1]
Radiant Panels & Strips	A	B	B[1]	B[1]				B[1]
Radiators & Convection Cabinet Heaters	B				A	B		
Overhead Pipe Coils	B				A			B[1]
STEAM MAINS								
Horizontal Runs	B			A	B[2]			B
Separators	A			B	B[2]			B
Terminal Ends	B			A[1]	B[2]			B[1]
Shut Down Drain (Frost Protection)					B[3]		A	
TANKS AND VATS								
Process Vats (Rising Discharge Pipe)	B			A	B			B
Process Vats (Discharge Pipe at Base)	A			B	B			B
Small Coil Heated Tanks (quick boiling)	A				B			B
Small Coil Heated Tanks (slow boiling)							A	

1. With air vent in parallel 2. At end cooling leg Minimum length 3 ft *(1m)* 3. Use special tracing traps which offer fixed temperature discharge option.

Courtesy of Spirax-Sarco

TECH TIP #34 (Cont.)

A QUICK GUIDE TO THE SIZING OF STEAM TRAPS

Need To Know:

1. The steam pressure at the trap—after any pressure drop through control valves or equipment.
2. THE LIFT, if any, after the trap.

   Rule of thumb: 2 ft. = 1 psi back pressure, approximately.
3. Any other possible sources of BACK PRESSURE in the condensate return system.

   e.g. A) Condensate taken to a pressurized DA. tank.
   B) Local back pressure due to discharges of numerous traps close together into small sized return.
4. QUANTITY of condensate to be handled. Obtained from A) Measurement, B) Calculation of heat load (see page 24), and C) Manufacturer's Data
5. SAFETY FACTOR—These factors depend upon particular applications, typical examples being as follows:

	General	With Temp. Control
Mains Drainage	x2	—
Storage Heaters	x2	—
Space Unit Heaters	x2	x3
Air Heating Coils	x2	x4
Submerged Coils (low level drain)	x2	—
Submerged Coils (siphon drain)	x3	—
Rotating Cylinders	x3	—
Tracing Lines	x2	—
Platen Presses	x2	—

Rule of thumb: Use factor of 2 on everything except Temperature Controlled Air Heater Coils and Converters, and Siphon applications.

How To Use

The difference between the steam pressure at the trap, and the total back pressure, including that due to any lift after the trap, is the DIFFERENTIAL PRESSURE. The quantity of condensate should be multiplied by the appropriate factor, to produce SIZING LOAD. The trap may now be selected using the DIFFERENTIAL PRESSURE and the SIZING LOAD.

Example

A trap is required to drain 22 lb/hr of condensate from a 4″ insulated steam main, which is supplying steam at 100 PSIG. There will be a lift after the trap of 20 ft.

Supply Pressure	= 100 PSIG
Lift	= 20 ft = 10 PSI approx.
Therefore Differential Pressure	= 100 − 10 = 90 PSI
Quantity	= 22 lb/hr
Mains Drainage Factor	= 2
Therefore sizing load	= 44 lb/hr

The ½″ TD42L will easily handle the 44 lb/hr sizing load at a differential pressure of 90 PSI.

7

TECH TIP #35

STEAM TRAP TESTING

Steam Trap Testing Methods

There is virtually no point in spending the time and money in creating a highly efficient steam system and then failing to maintain it at this same level. However, all too often leaking joints and valve stems are accepted as a normal operating condition of both steam and condensate systems.

Even a 1/8" diameter hole can discharge as much as 65 lb/hr of steam at 150 PSIG which represents a waste of approximately 30 tons of coal, 4,800 gallons of fuel oil or 7,500 therms of natural gas in a year (8400 hours).

Elimination of the visible leaks already mentioned is obviously reasonably straight forward. It is the invisible steam leaks through faulty steam traps that present a far more taxing problem. We know that the basic function of a steam trap is to discharge condensate and non-condensable gases in our systems and prevent live steam from escaping. Steam trap testing has brought about four different methods of testing. Let's look at all four methods and see what each will tell us about the condition of the steam trap.

Visual Testing

The first point that has to be understood when visually testing a steam trap is that it will be a very rare occasion where the only matter coming out of a steam trap will be water!! Almost always, there will be varying mixtures of flash steam and water and in some cases the visual discharge will be all flash steam. So the first thing to remember is that we do not want to look for water only, nor do we want to attempt to decide if we are seeing the appropriate amount of flash steam and water mixture.

Visual testing of steam traps works best on two types of trap operation due to the trap's inherent discharge characteristics. Those two traps are the Inverted Bucket (Density) and Thermodynamic (Kinetic Energy). These two traps operate in a cyclical manner being fully open, discharging, or fully closed. The open/closed operation is the key to correct visual testing and what the tester should be looking for to indicate a properly operating steam trap.

If there is installed in the piping ahead of the steam trap a wye ("Y") strainer with a blowdown valve, opening the blowdown valve and diverting all of the condensate away from the steam trap allows only steam into the trap.

Any steam trap type should close positively when it senses only steam. This additional step, diverting the condensate away from the trap's inlet, allows the tester to test any type of trap operation and receive 100% positive answers to the trap's condition.

Ultrasonic Trap Testing

Ultrasonic trap testing began with a screwdriver and has progressed to electronic sensing devices which amplify vibrations of flow. Flow of water and steam set up vibrations which are what we are looking for with ultrasonic testing. This form of testing works very well on traps that have cyclical discharge characteristics, like the kinetic energy Thermodynamic and the density operated Inverted Bucket. The open/closed operation provides a very positive answer to the trap's operation.

When testing other traps, like Float & Thermostatic and Thermostatic types which provide continuous modulating discharge, the tester again has to open the strainer blowdown valve and divert condensate away from the trap inlet so that the trap sees only steam. Again, if it is a properly operating trap, it will shut off completely. The ultrasonic testing device must be calibrated to eliminate external piping noises or other steam traps' discharge. When testing traps that are in close proximity, all traps except the one being tested must be isolated to remove any false signals from the other traps.

The ultrasonic testing method can provide very positive answers to a trap's operating condition as long as the operator doing the test has been trained, has developed some experience with the testing instrument and is able to identify the type of trap operation by visual inspection.

Temperature Testing

Temperature testing of traps involves measuring the temperature at, or close to, the inlet and outlet of the steam trap. Pyrometers, temperature sensitive crayons, paint, band-aids and thermocouples all have their advocates. Unfortunately, these methods are of limited use since the temperatures of condensate and flash steam on the downstream side of a correctly working steam trap are controlled by the pressure in the condensate return system. A very large percentage of steam traps in the USA are thought to discharge into "0" PSIG, atmospheric gravity returns, which means that the maximum temperature that could be expected is 212°F, regardless of the trap's operating condition.

TECH TIP #35 (Cont.)

STEAM TRAP TESTING

It does not necessarily mean that a trap has failed when an elevated temperature above 212°F is recorded downstream of a steam trap. More likely it means that the condensate return line is under a positive pressure, which means that the pressure/temperature relationship of steam must exist.

Thus if we were to record a temperature of 227°F on the outlet side of a trap, this tells the tester that the return system is at 5 PSIG saturated steam conditions, even though it was thought to be a "0" PSIG return system. There could be a failed open steam trap in the system that is causing this pressure or it could be purely the fact that the condensate return line was sized for water only and is not able to accommodate the flash steam volume without becoming pressurized. Temperature testing will identify a "failed closed" steam trap due to very low temperatures at the inlet of the steam trap. Temperature testing of traps to find failed open traps is by far the least accurate of all the testing methods available to users.

Conductivity Testing

A more recent development in trap testing uses the electrical conductivity of condensate. This involves the installation of a chamber (Fig. 33) containing an inverted weir upstream of the steam trap shown as follows.

With the trap working normally, condensate flows under this weir and out through the trap. There is a small hole at the top of the weir that equalizes the pressure on each side. A sensor is inserted in the chamber on the upstream side which detects the presence of condensate by completing an electrical circuit with the condensate. A portable indicator is plugged into the sensor and the indicator provides the ability to read a completed circuit on the sensor. If the trap becomes defective and begins blowing steam, equilibrium on either side of the weir becomes disturbed and the steam pressure on the inlet side of the chamber displaces the condensate below the sensor. The sensor is no longer surrounded by the conductive condensate and the electrical circuit is broken, providing a failed signal on the indicator.

A major advantage to this method is the very positive signal which can be interpreted without resorting to experience or personal judgment. It is possible to wire a number of sensor chambers to one remote testing point for ease of quickly testing larger numbers of traps. The latest designs of conductivity testing equipment have added a temperature sensor in the same chamber that will provide the ability to determine a failed closed trap.

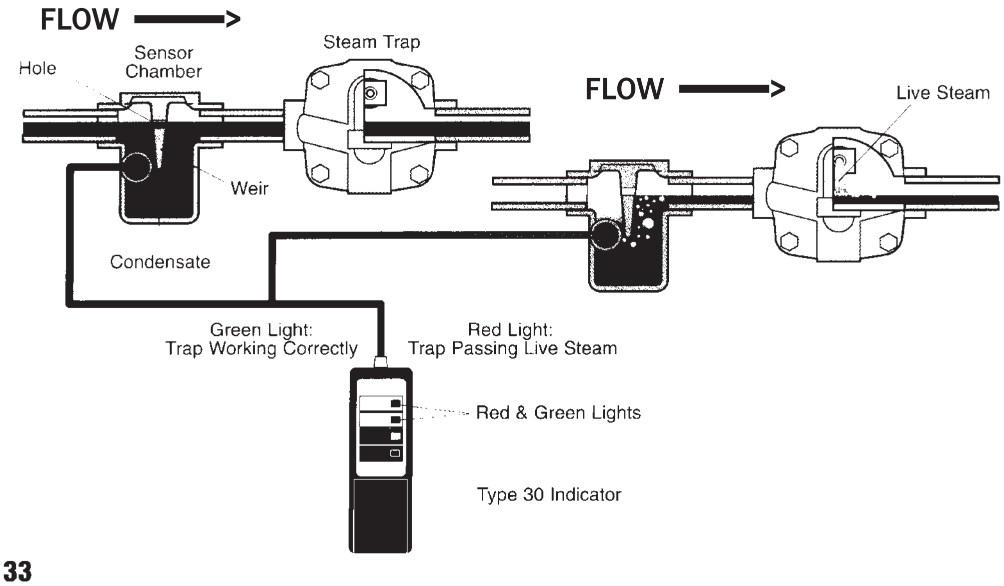


Figure 33
Conductivity Trap Testing System

7