Steam Trap Presentation for IDEA Distribution Workshop

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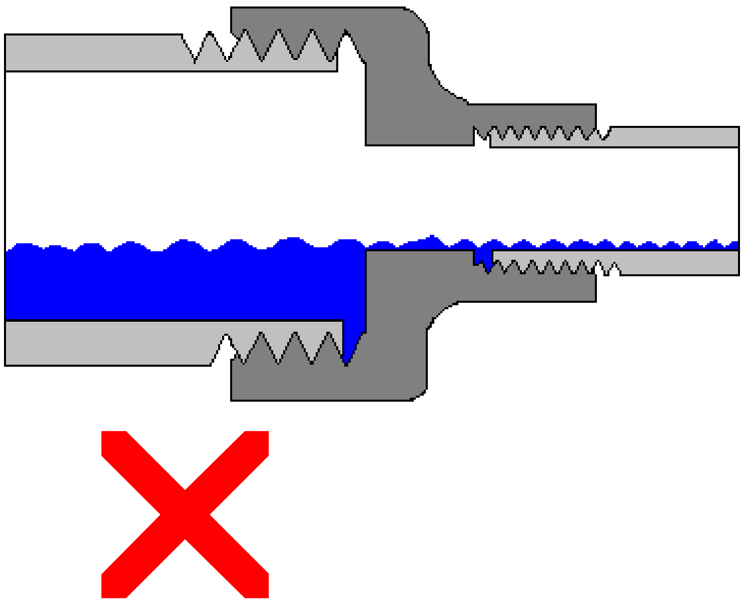
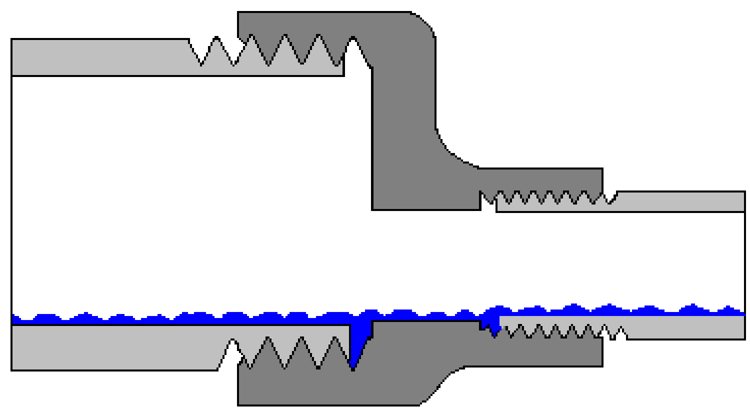
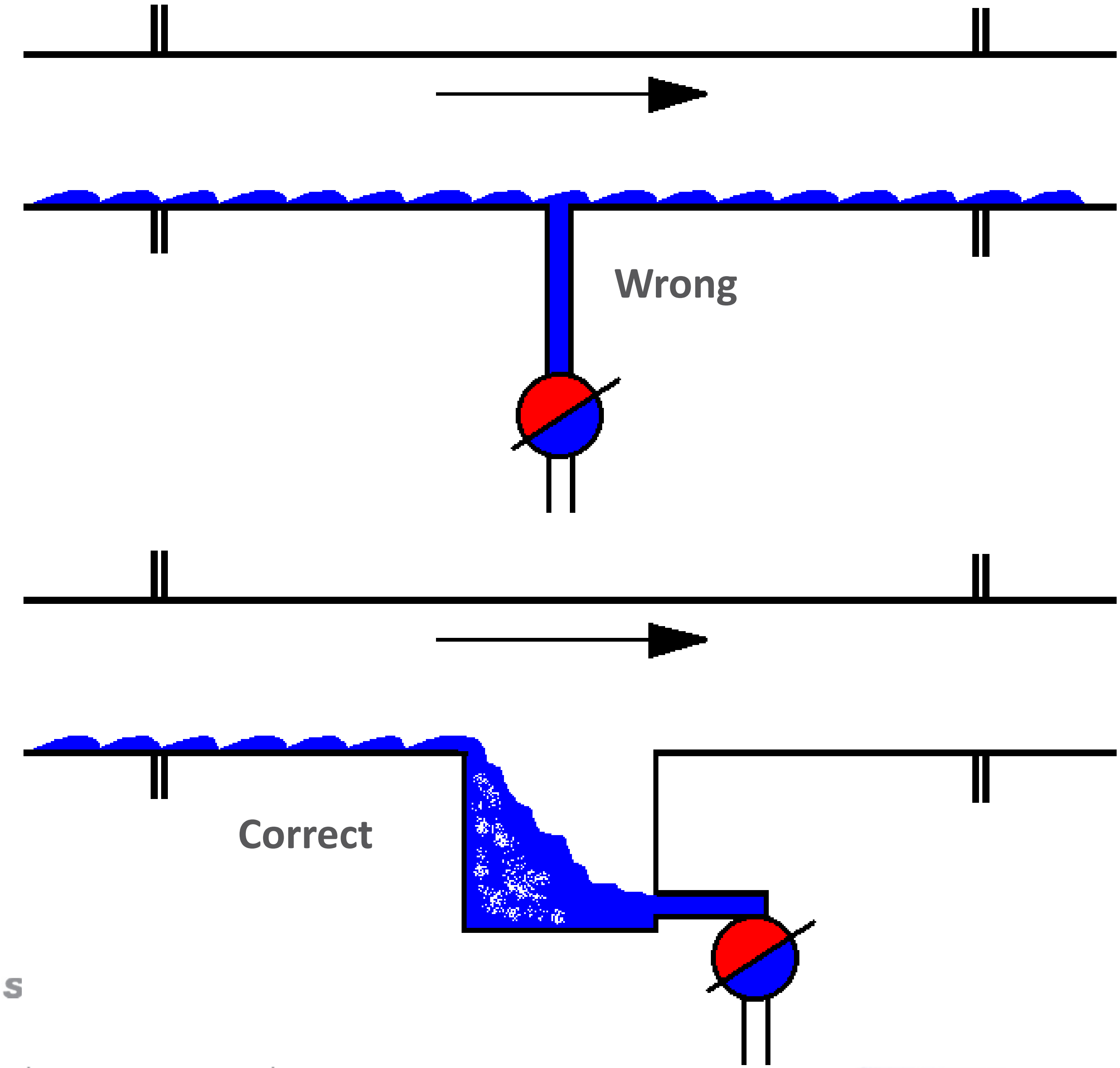
Proper Piping when Reducing Pipe Size

Concentric reducer

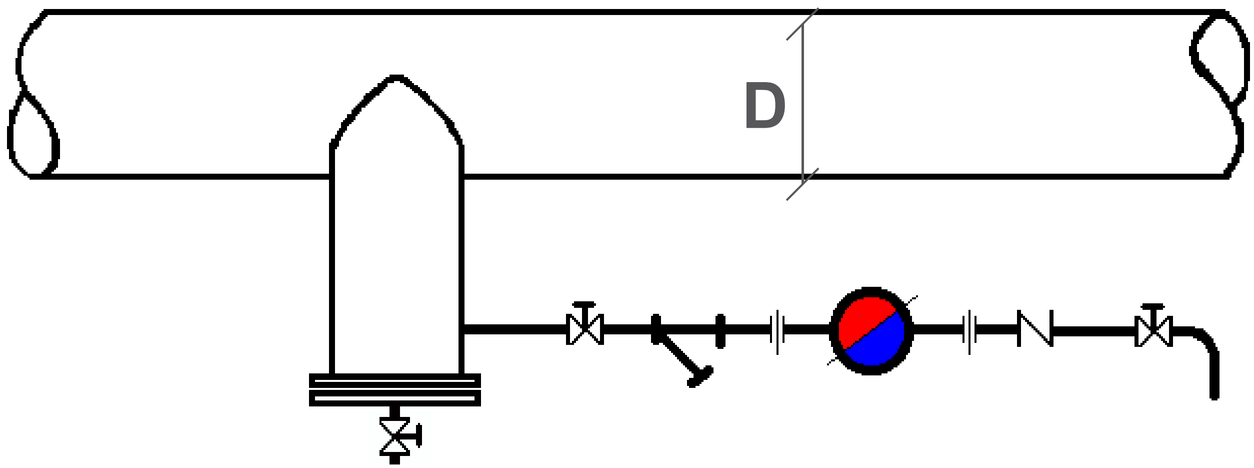


Eccentric reducer



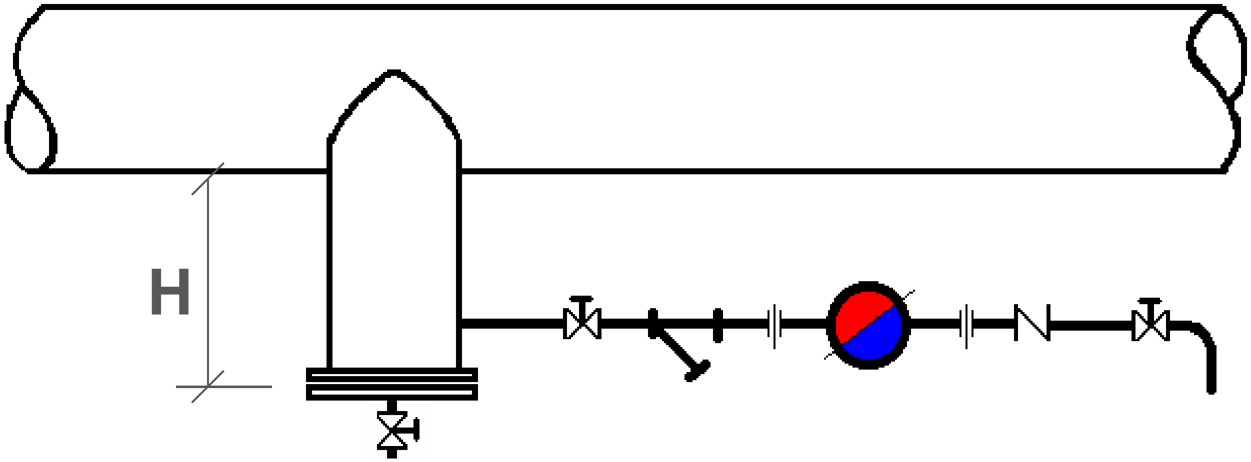

Wrong
Correct

Typical Steam Main Drip Station



Size of Main 'D'	Collection Leg Diameter
1/2" to 4"	Same dia. as main 'D'
5" & larger	½ Steam Main Size, but Never Smaller than 4"

Typical Steam Main Drip Station



Length of Collection Leg 'H'

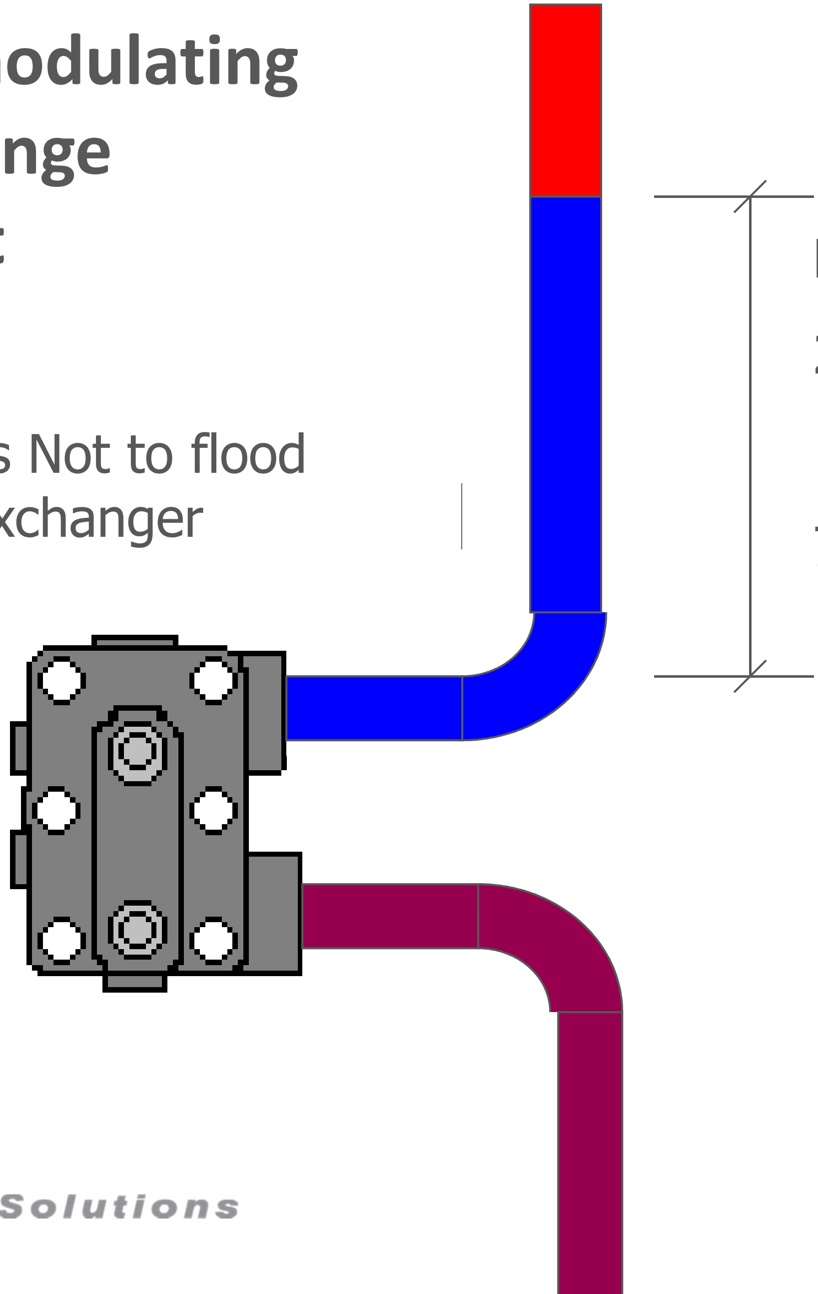
Automatic Start up: 'H' to be 28" or More

Supervised Start up: Length to be1-1/2 times steam Main Diameter,

but never shorter than 8"

Draining modulating heat exchange equipment

The Goal is Not to flood the heat exchanger



Height = Pressure

28″ = 1 psi

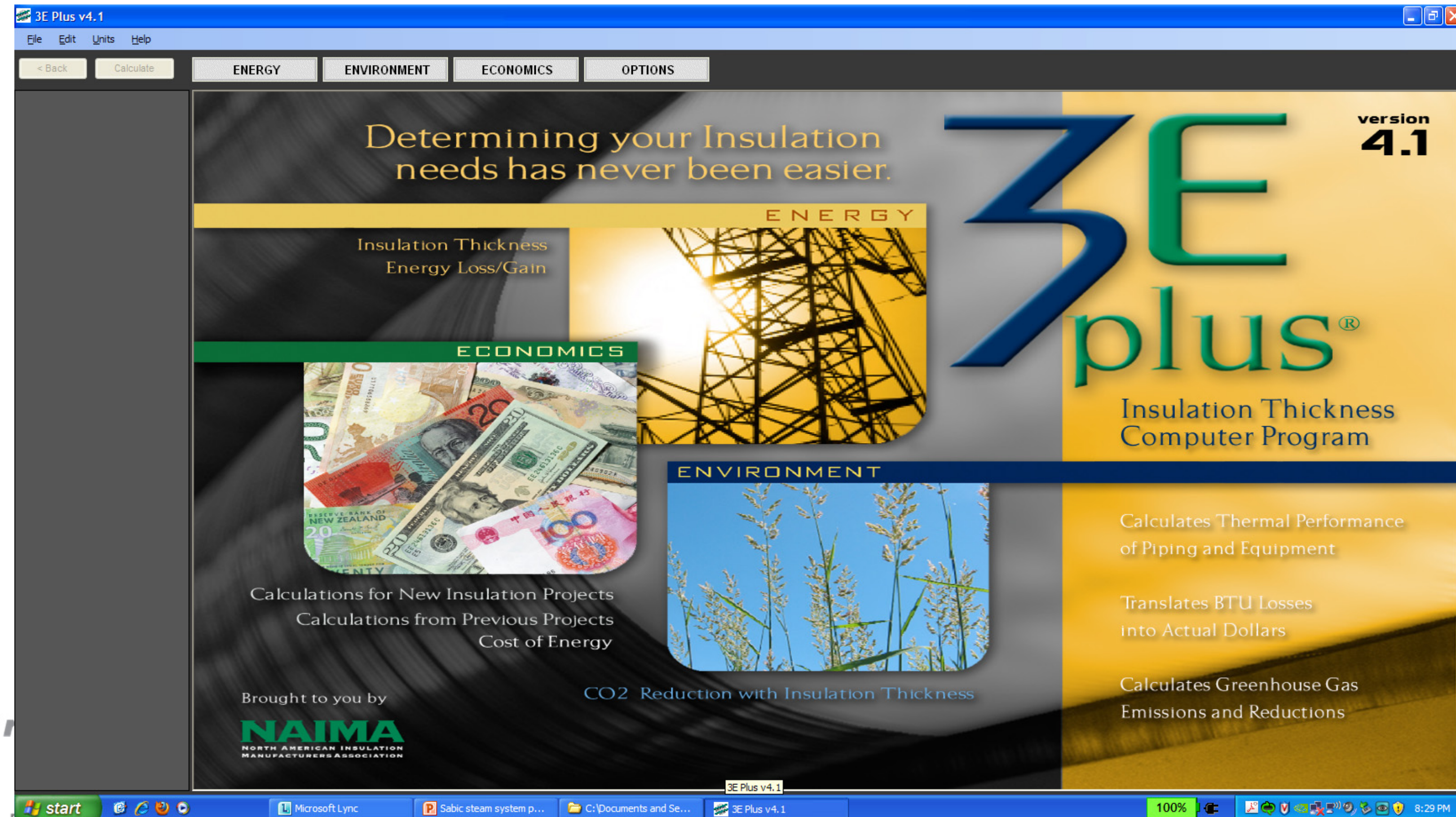
14″ = ½ psi

7″ = ¼ psi

Pressure at trap available at full modulation

Determining Condensate loads for steam mains

The best method today for determining heat loss from insulated piping is a free program given out by the DOE. The program was written by the insulation industry



System Application = Pipe - Horizontal

Dimensional Standard = ASTM C 585 Rigid

Calculation Type = Heat Loss Per Hour Report

Process Temperature = 421

Ambient Temperature = .0

Wind Speed = 20.0

Nominal Pipe Size = 12

Bare Metal = Steel

Bare Surface Emittance = 0.8

Insulation Layer 1 = 850F Mineral Fiber PIPE, Type I, C547-11

Outer Jacket Material = All Service Jacket

Outer Surface Emittance = 0.9

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft)	Efficiency (%)
Bare	418.4	8561.00	
0.5	39.9	807.20	90.57
1.0	21.7	462.50	94.60
1.5	14.7	330.40	96.14
2.0	11.1	260.40	96.96
2.5	8.8	217.10	97.46
3.0	7.3	187.60	97.81
3.5	6.2	166.10	98.06
4.0	5.4	149.80	98.25
4.5	4.7	137.00	98.40
5.0	4.2	126.60	98.52

STEAM TRAPS

Basic Designs and Operating Principles

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Steam Trap definition

An **Automatic Valve** designed to stop the flow of steam so that energy can be transferred.

It also discharges condensate, within its sizing range, and air (including Non - Condensable gases) as required.

The Need For Steam Traps?

- Air Venting
- Condensate Removal
- Thermal Efficiency
- Reliability
- Safety

Type of functional steam trap discharges

- Saturation discharge: The steam trap discharges condensate as soon as it forms with no back up
- Sub-cooled discharge : The steam trap holds the condensate until it cools off to a pre-determined temperature before releasing the condensate. The amount of back up is controlled by the temperature at which the trap discharges and the condensate load. Adequate cooling leg must be designed into system to prevent flooding in certain applications

Effect of sub-cooling condensate

When we sub-cool condensate we need to rely on the heat loss from the piping upstream of the trap to reduce the temperature down to the set point of the steam trap's operating temperature.

- Heat loss formula is U x A x △T
- U = heat transfer coefficient BTU/hr/sqft
- A= Surface area in sqft
- △T= difference between internal pipe temperature and ambient temperature.

Example: 10” steam main, 175 psig, 200 ft between drip stations, drip leg 6” @ 3 ft long 20°F sub-cool at trap, Insulation 850F mineral fiber pipe, Type 1 C547-03, 100 % insulation coverage of steam main. Condensate discharged to grade. Drip leg insulated.

Steam main insulation thickness	Ambient temperature °F	Wind speed MPH	Steam main BTU loss 200 ft	Steam main condensate load #/hr.	Back up in drip leg ft	Energy saving #/hr.
1”	0	10	72,020	85	flooded	n/a
1.5”	0	10	46,980	55	flooded	n/a
2”	0	10	37,380	44	flooded	n/a
3”	0	10	27,260	32	2.45	.62
1”	30	0	59,560	70	flooded	n/a
1.5”	30	0	40,600	48	flooded	n/a
2”	30	0	32,900	39	flooded	n/a
3”	30	0	24,480	29	flooded	n/a
1”	70	0	53,740	63	flooded	n/a
1.5”	70	0	36,880	44	flooded	n/a
2	70	0	29,960	35	flooded	n/a
3	70	0	22,380	26	flooded	n/a

Basic Steam Trap Applications

- Steam main drip
- Steam tracing
- Process heating
- Turbine and motive drives

Steam main drip

- The steam trap must always remove the condensate to prevent the liquid from rising too high in the drip leg
- Trap must discharge close to saturation only minimal sub-cooling will be allowed
- Liquid should never get above 3” below the steam line in the drip leg to prevent liquid from being pulled from the pocket into the steam main by the steam velocity.

Steam tracing

- Critical tracing where maximum heat is required sub-cooling of the condensate has to be minimized
- Non-critical tracing some sub-cooling of condensate can occur and the sensible heat of the hot water can be used in the tracer
- Tracer loads are small and generally low capacity type trap is used

Process heating

- Heat exchangers, air handling coils, re-boilers, kettles, sterilizers, autoclaves
- Steam trap should always discharge at saturation
- Any sub-cooling of condensate will quickly flood into the heating process
- Flooding into process will reduce heat output cause temperature swings and possible water hammer.

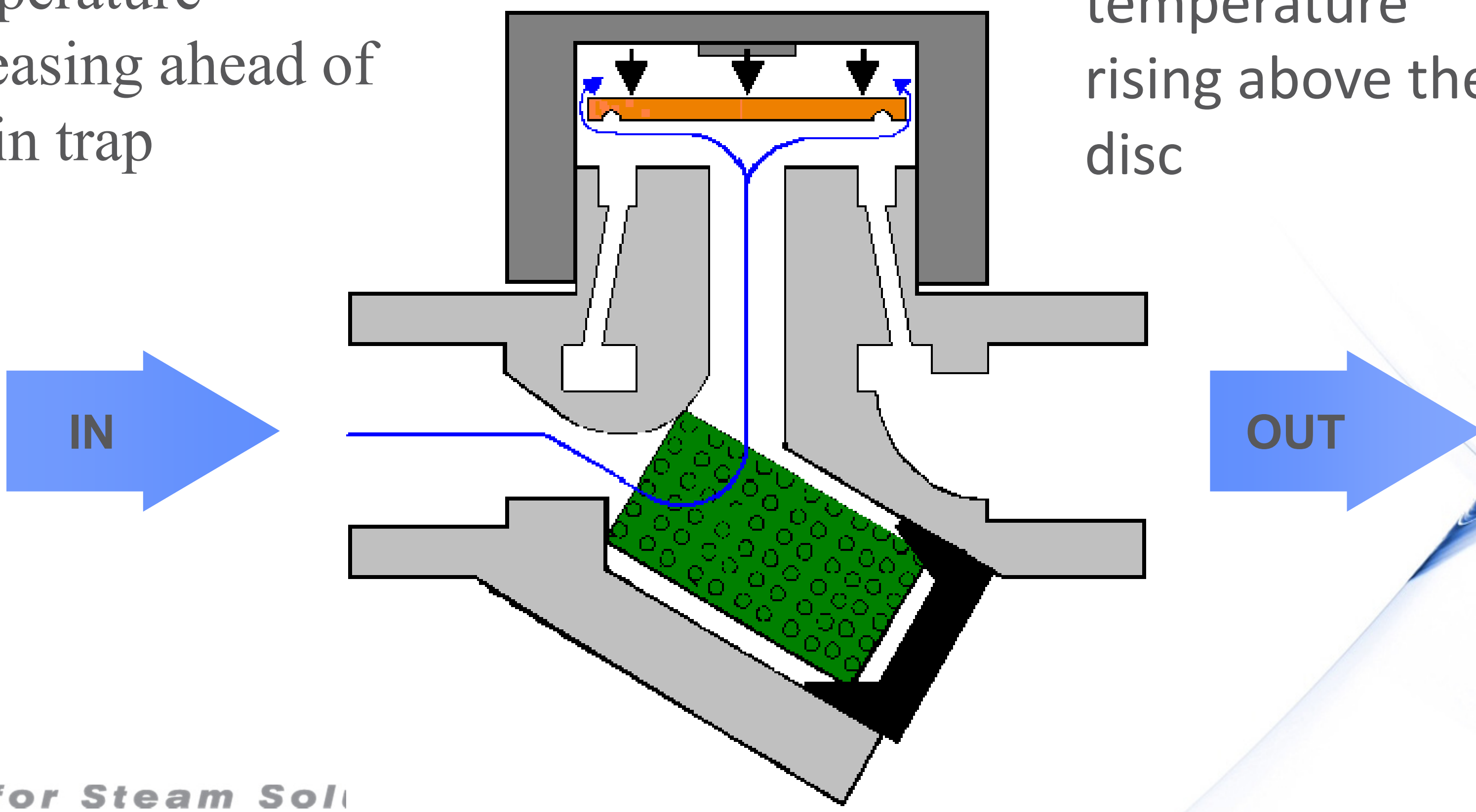
Types of Steam Traps

		Subcooling Range	Air Venting
A)	Kinetic Energy		
	Thermodynamic Disc	2 – 8°F	Limited
B)	Density		
	Float & Thermostatic	None	Excellent
	Inverted Bucket	None	Limited
C)	Thermostatic		
	1) Balanced Pressure	10 – 20 °F	Good
	2) Bimetallic	50 °F, 100 °F	Good
	3)Liquid Expansion	High/Variable	Good

Thermodynamic Steam Trap: Flowing Condition

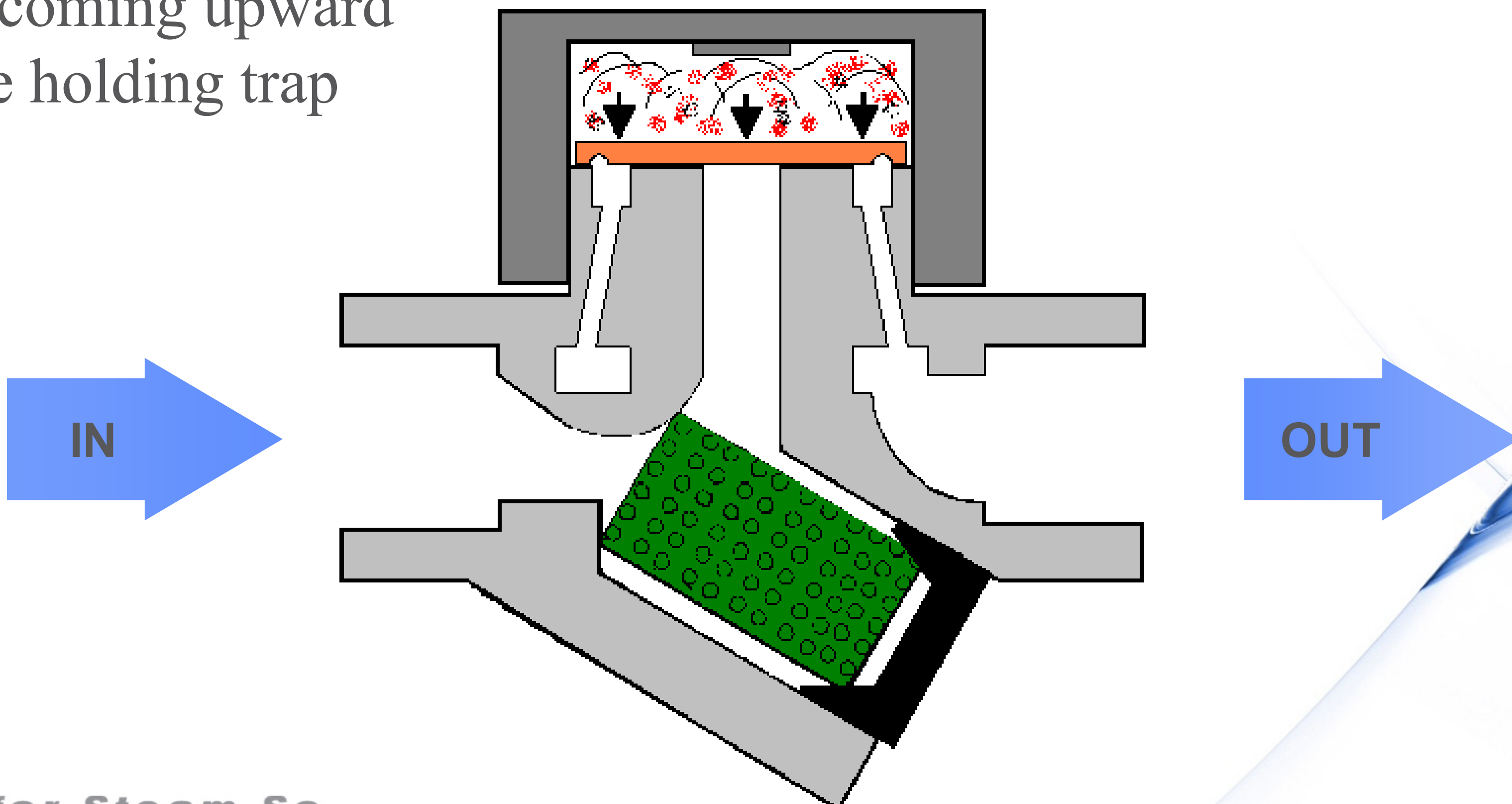
Trap open: disc up. Temperature increasing ahead of and in trap

Pressure and temperature rising above the disc



Thermodynamic Steam Trap: Closed Position

Pressure above the disc times disc area overcoming upward force holding trap shut



Thermodynamic Trap operation

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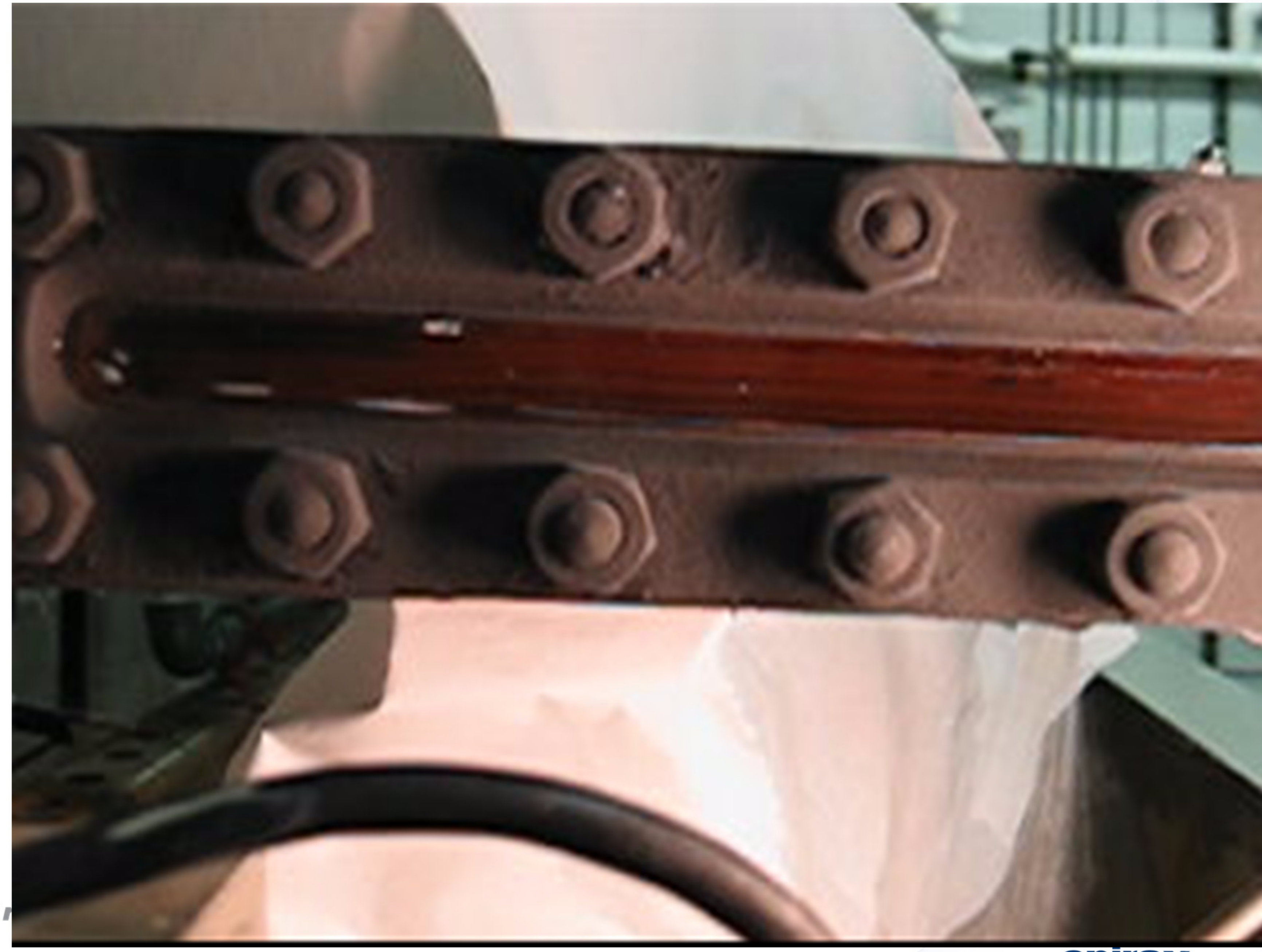

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Typical applications for TD traps

- Steam mains drips > 30 psig < 2500 psig
- Steam tracing
- Constant pressure constant load applications

Pro's and Con's of Thermodynamic steam traps

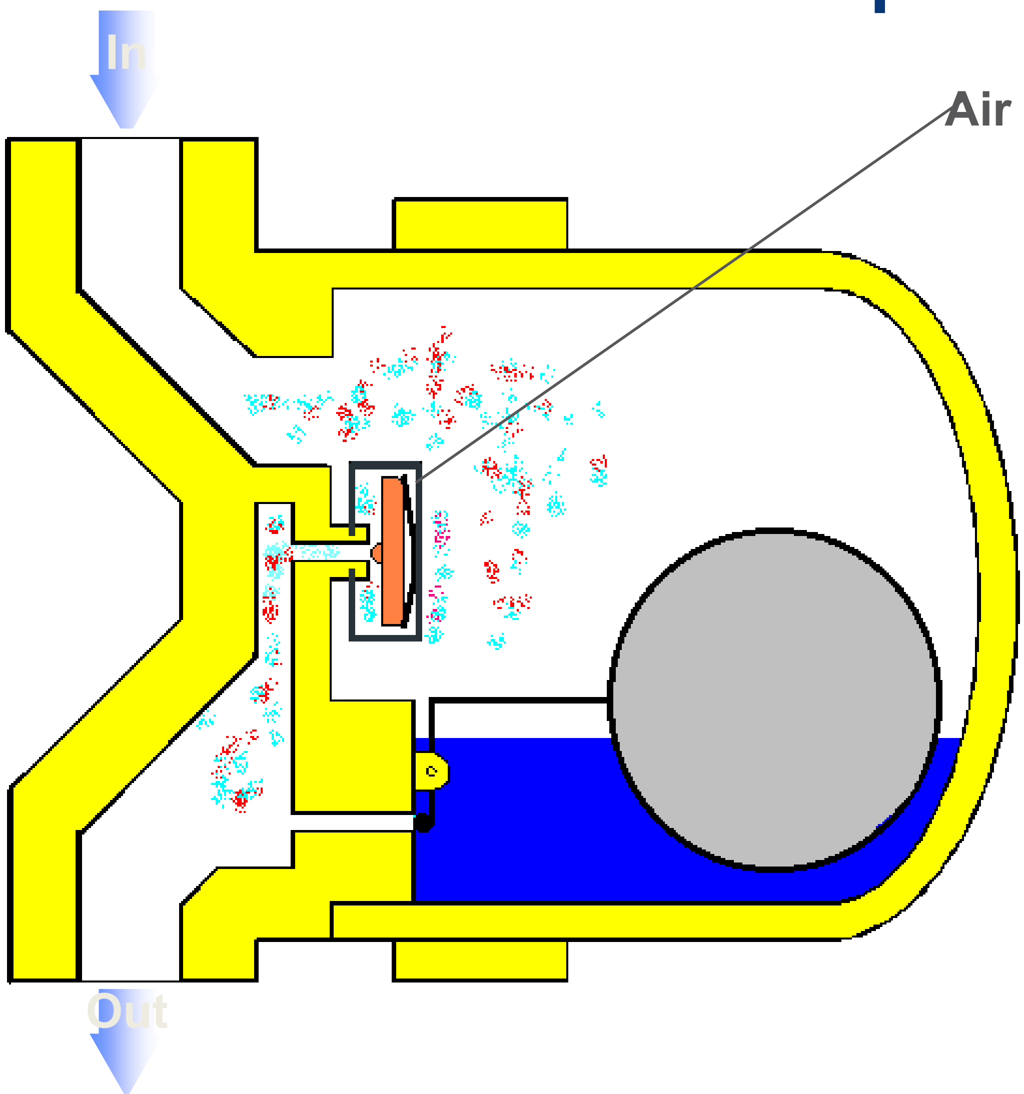
PRO's

- Very wide operating range
- Zero steam loss closes on saturated liquid
- Small size
- On-off discharge easy to test visually or by sound
- Very rugged resistant to water hammer

Con's

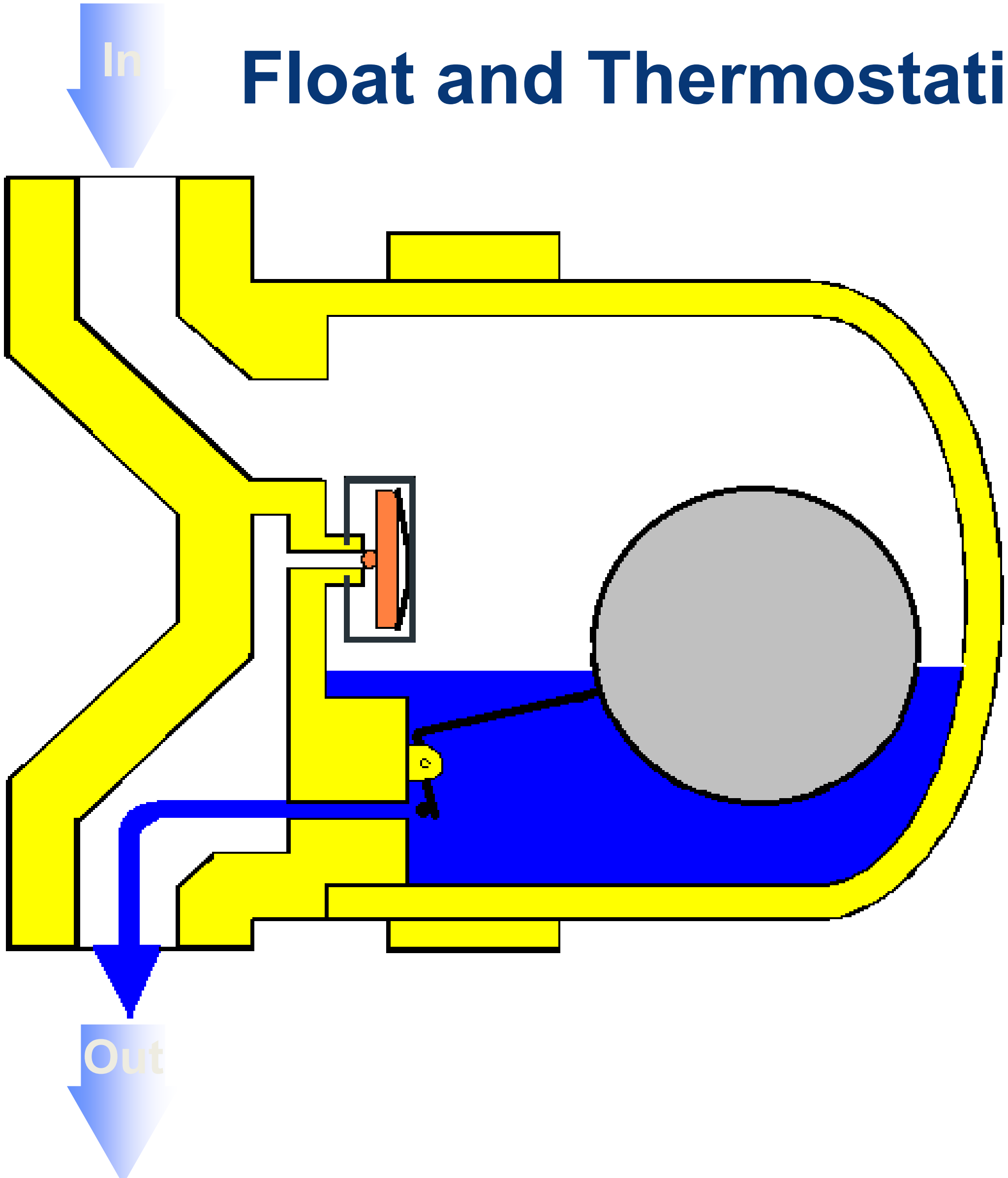
- Minimum operating pressure 3-1/2 psig
- Limited air venting capability
- Back pressure tolerance 80% of inlet pressure

Float & Thermostatic trap: Initial Start-up mode



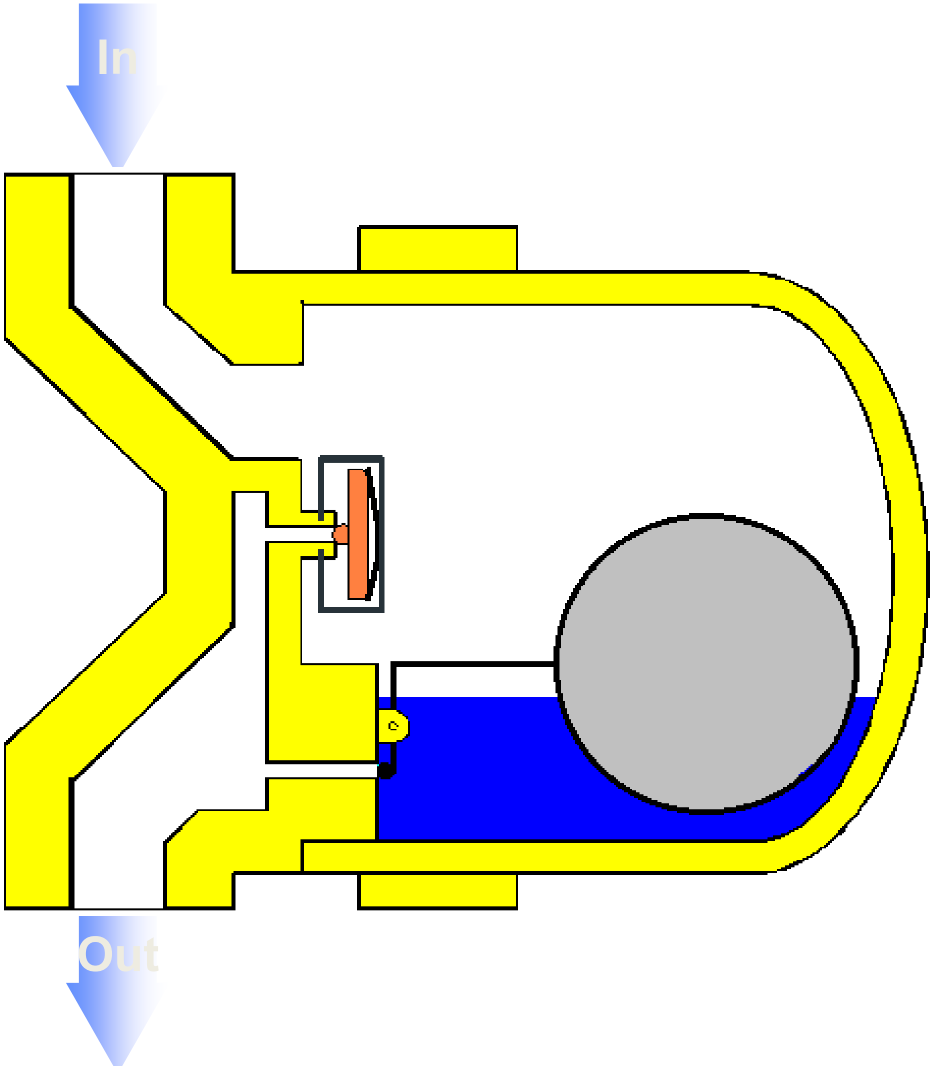
Free flow of air until temperature rises to 10 deg f below saturation. Air vent and Float valve can and will be open simultaneously during startup phase

Float and Thermostatic Trap functioning



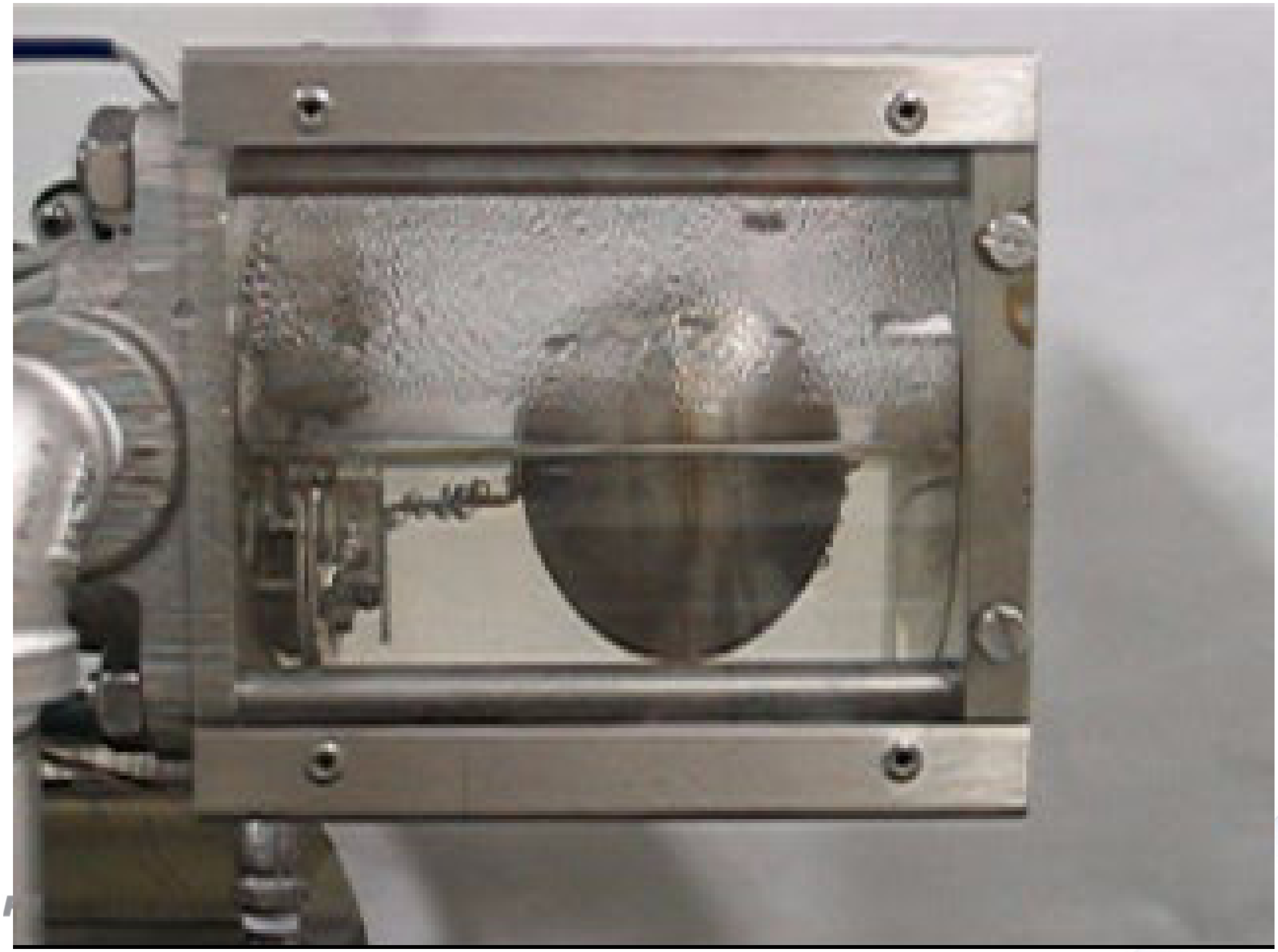
Condensate Level Increases, the Float Rises and the Valve Opens, the thermostatic air vent is closed as steam temperature is at saturation

Float & Thermostatic Trap Closed Position



Air vent hot and closed, condensate level not high enough to open main valve

Float & Thermostatic operation



F&T Typical Applications

- Heat Exchangers (shell and tube, plate and frame)
- Air handling coils
- Cooking kettles
- Unit heaters
- Reboilers
- Steam main drip
- Sterilizers
- Pressurized Flash tanks

Pro's and Con's of Float and Thermostatic Steam Traps

PRO's

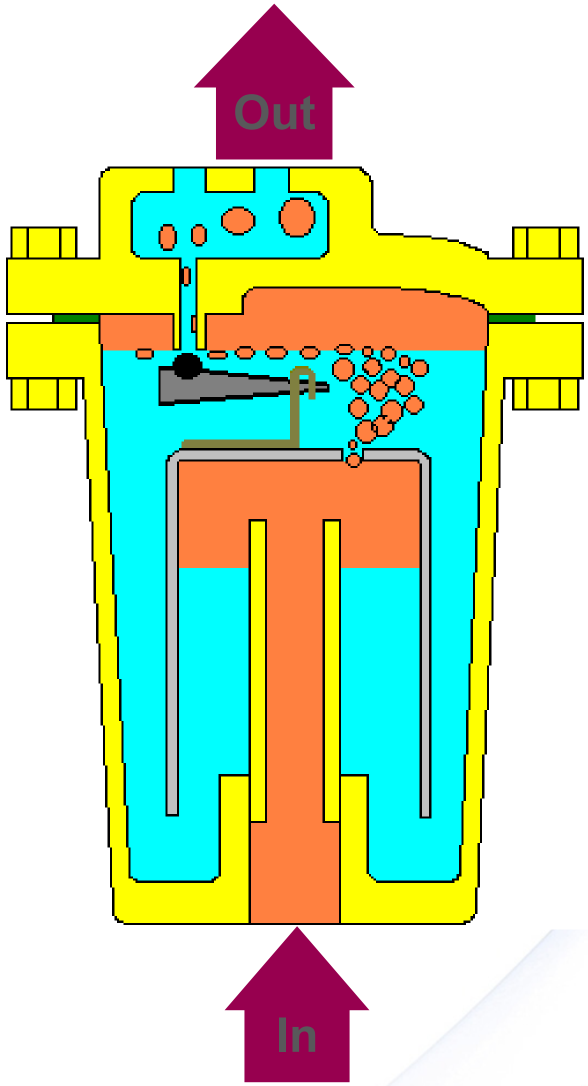
- 100 % turndown ratio on flow
- 100% turndown ratio on pressure
- Discharges at saturation
- Modulating discharge
- High air venting capability
- Large capacity range
- Available in multiple body materials

Cons's

- Float can be damaged by water hammer
- Harder to test by visual or ultrasonic methods
- Body can be large and bulky
- Multiple mechanisms required for different pressure ranges

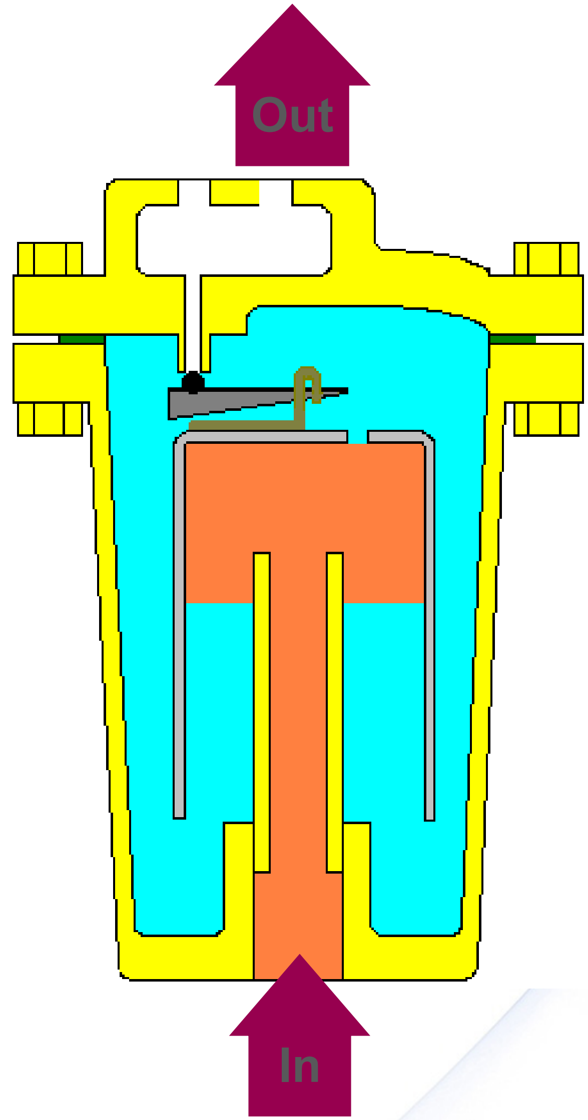
Inverted Bucket Trap: Start-up and Discharging Condensate

Trap discharging condensate and a few bubbles of steam through the vent hole in bucket . Hole in bucket allows air to flow on start-up and allows small amounts of steam to pass during normal operation.



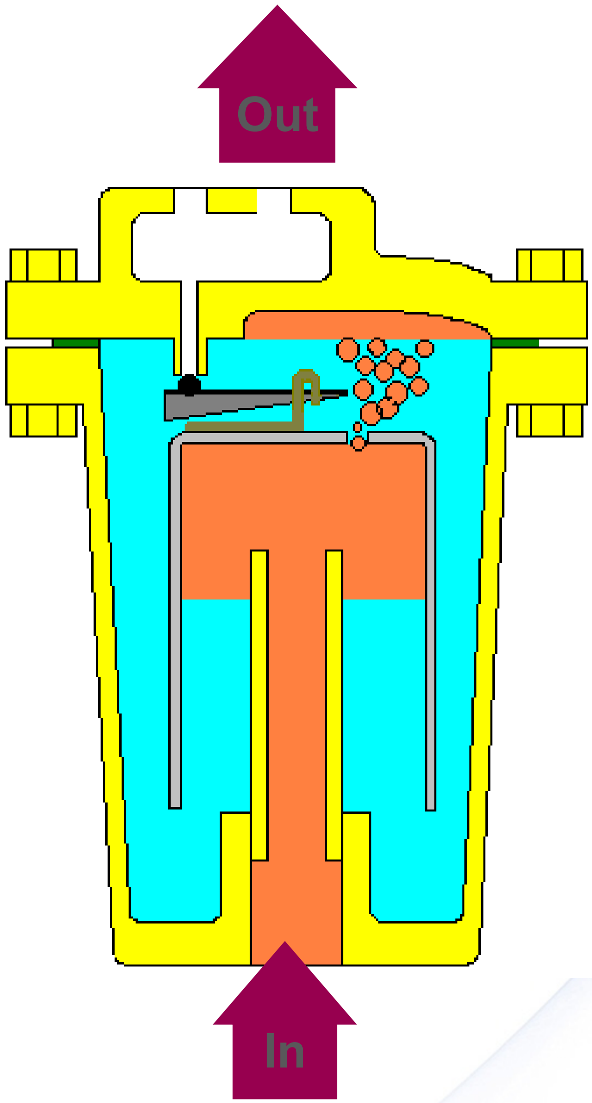
Inverted Bucket Trap: Closing

Inverted bucket fills with steam as condensate has all discharged from trap and replaced by steam.



Inverted Bucket Trap: Closed Position

Trap has adequate steam volume inside the bucket to keep it closed. As the steam condenses and condensate replaces the steam the bucket will sink opening the valve.



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Inverted Bucket function

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Typical Applications for Inverted Bucket Traps

- Steam main drips
- Heat exchangers
- Air handling coils
- Cooking kettles
- Unit heaters
- Reboilers

Pro's and Con's of Inverted Bucket Traps

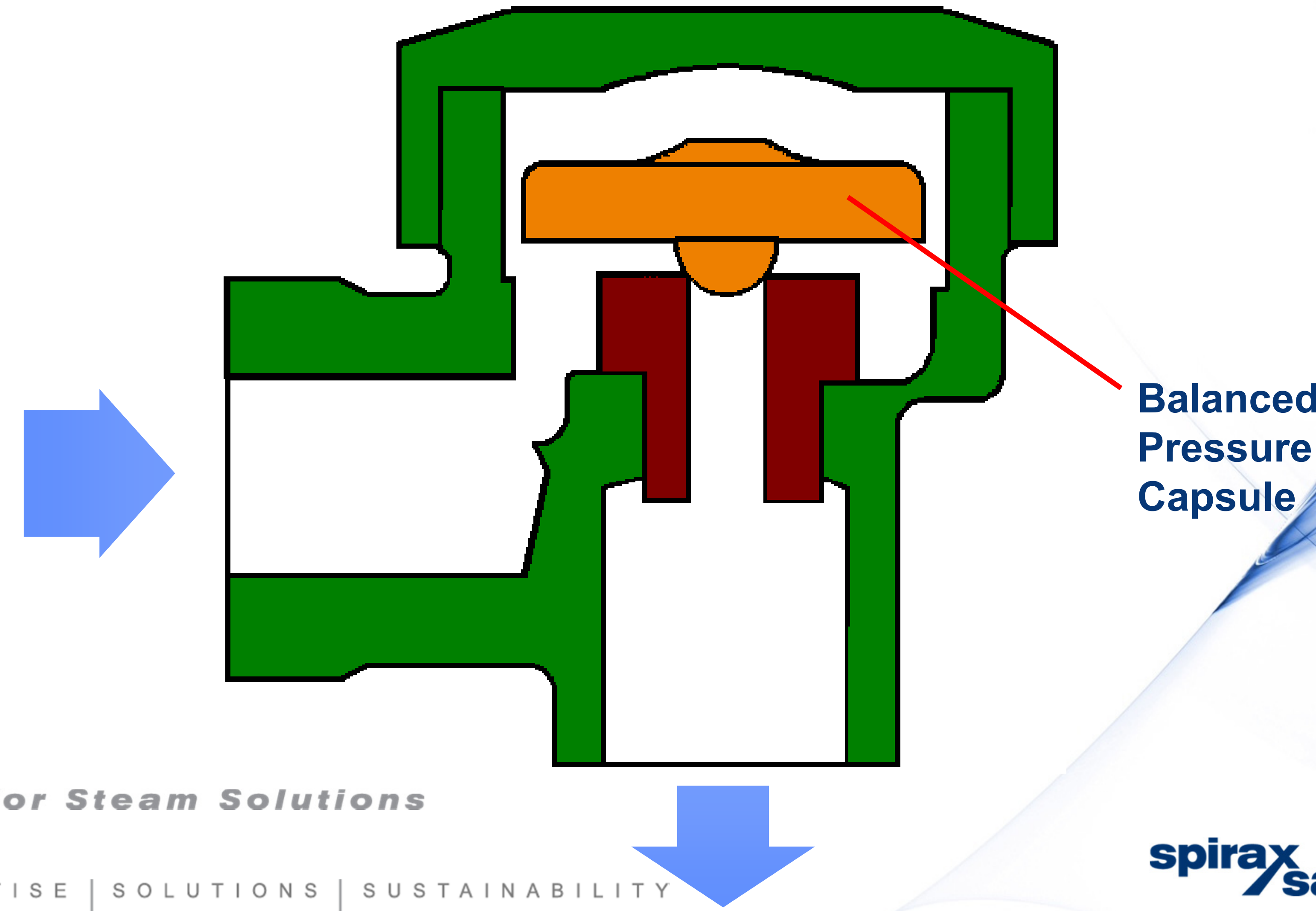
Pro's

- Discharges condensate at saturated steam temperature
- On-off discharge easy to test visually and by sound
- Multiple material options
- Large range of operating pressure models
- Higher pressure process flow then F & T traps

Con's

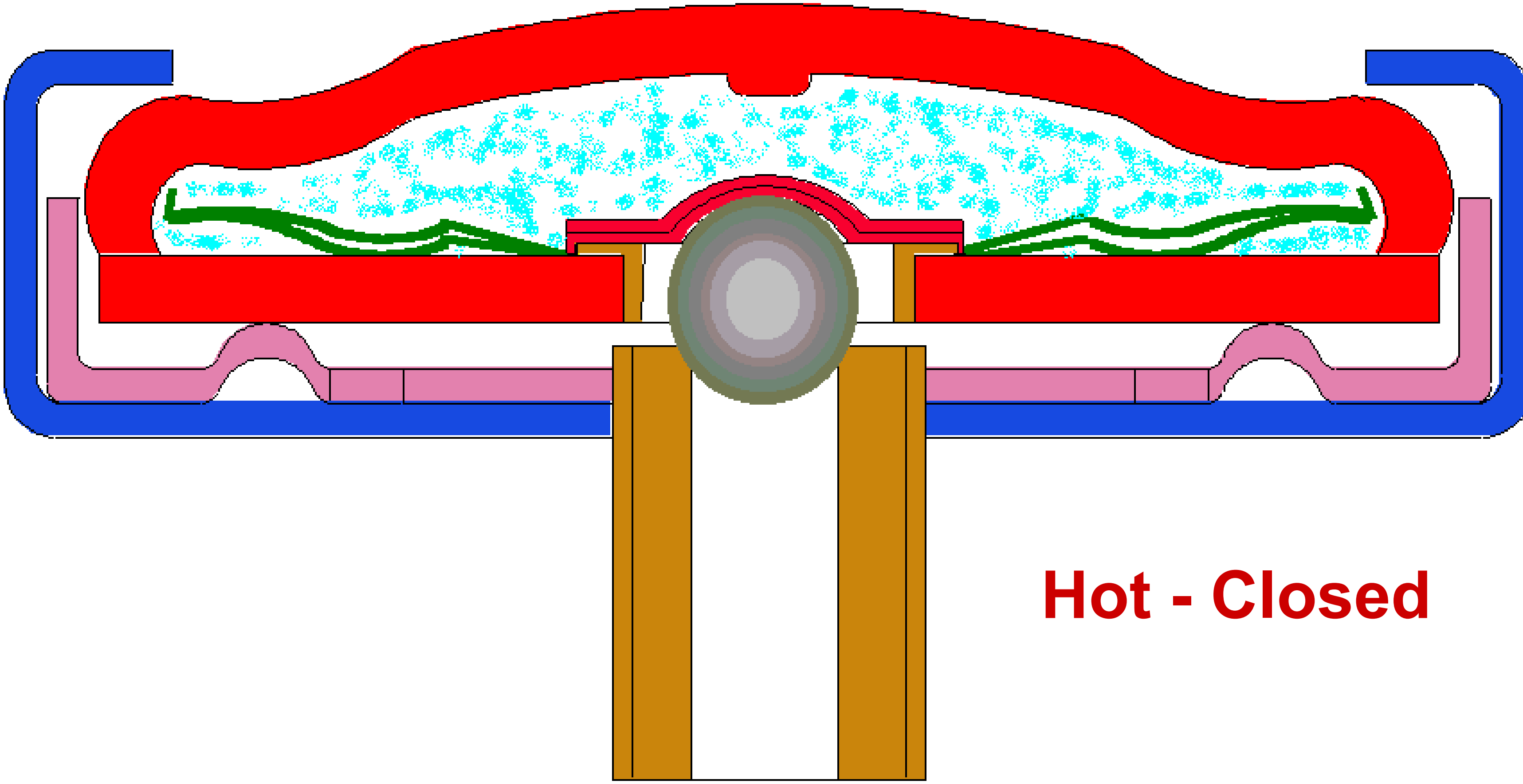
- Limited turndown ratio on pressure
- Limited turndown ratio on flow
- Can lose water seal and blow open if grossly oversized
- Limited air vent capability
- Multiple mechanisms for different pressure ranges.
- Larger traps need to be water primed before use

Modern Balanced Pressure Trap



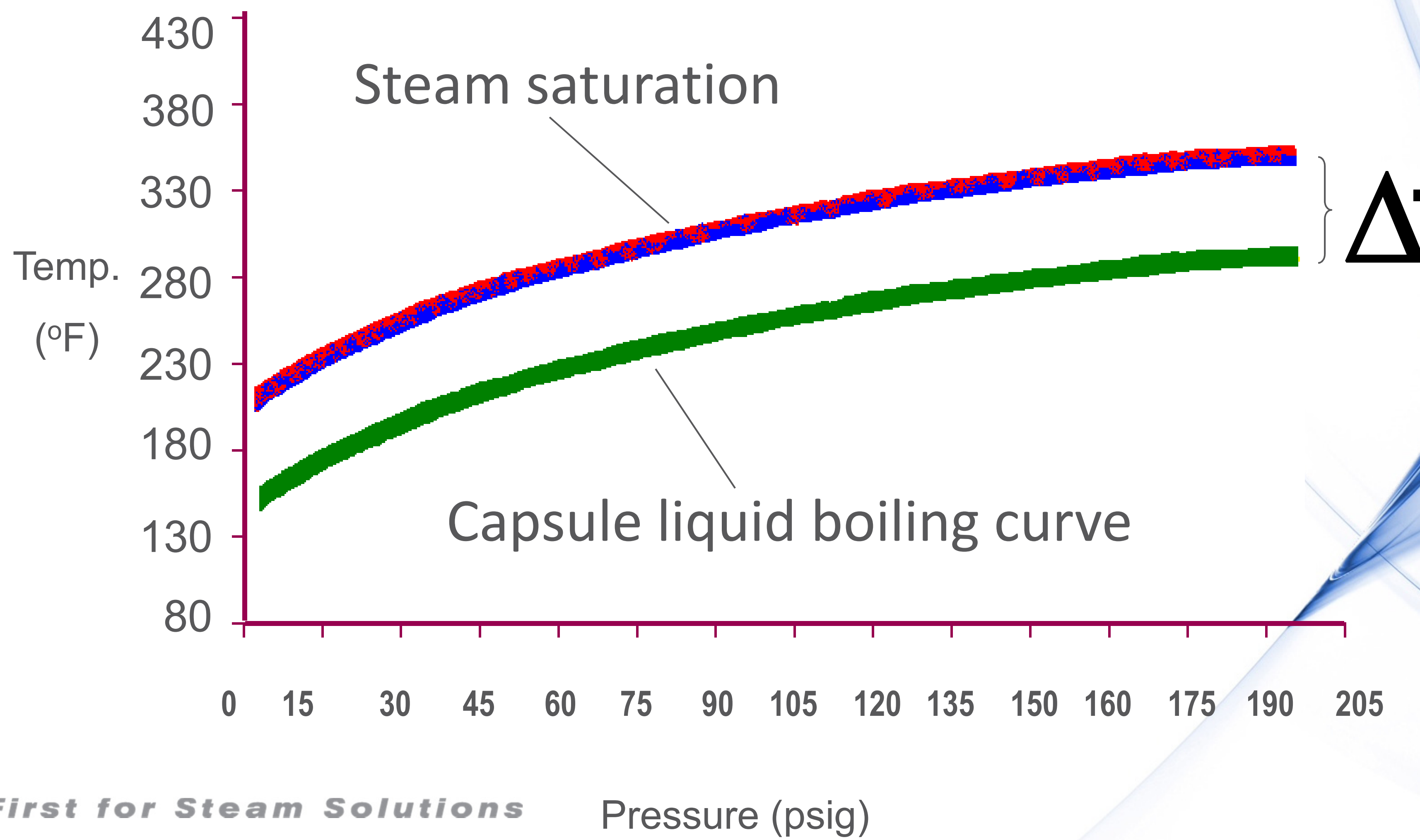
Balanced Pressure Capsule

Liquid vaporizes to pressurize capsule



Hot - Closed

Response of Balanced Pressure Trap



Thermostatic Trap operation

Typical Applications for balanced pressure thermostatic steam traps

- Steam radiators
- Steam tracing
- Steam main drips
- Air vents

Pro’s and Con’s of Balanced Pressure Thermostatic Traps

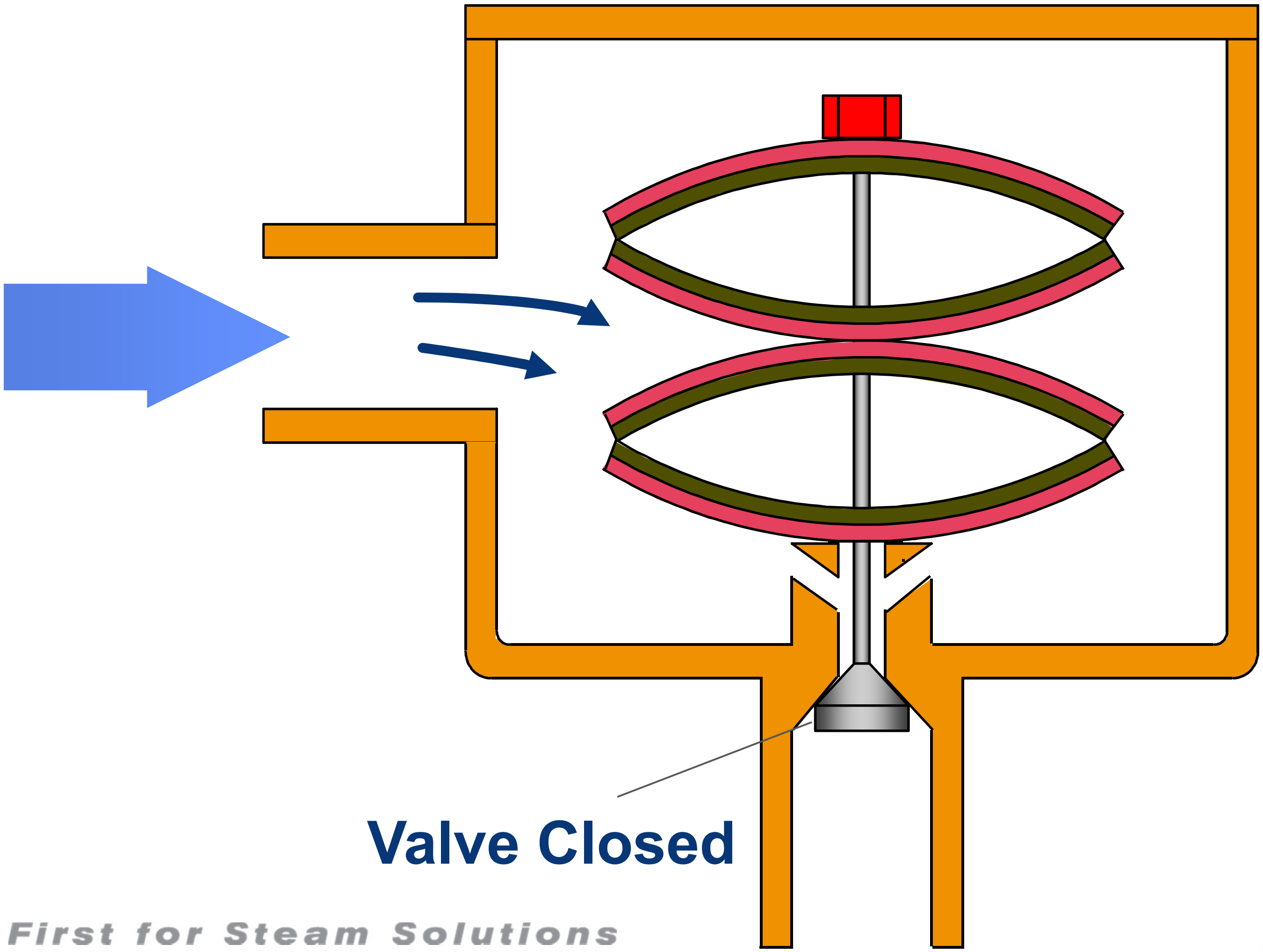
Pro’s

- Zero steam loss sub-cools condensate before discharging.
- Different temperature discharge fills available
- Small physical size
- Multiple body materials
- Large air venting capability

Con’s

- Sub-cooled condensate can cause excessive back up
- Thermostat can be damage by water hammer

Bimetallic Trap With Valve Head Out Board



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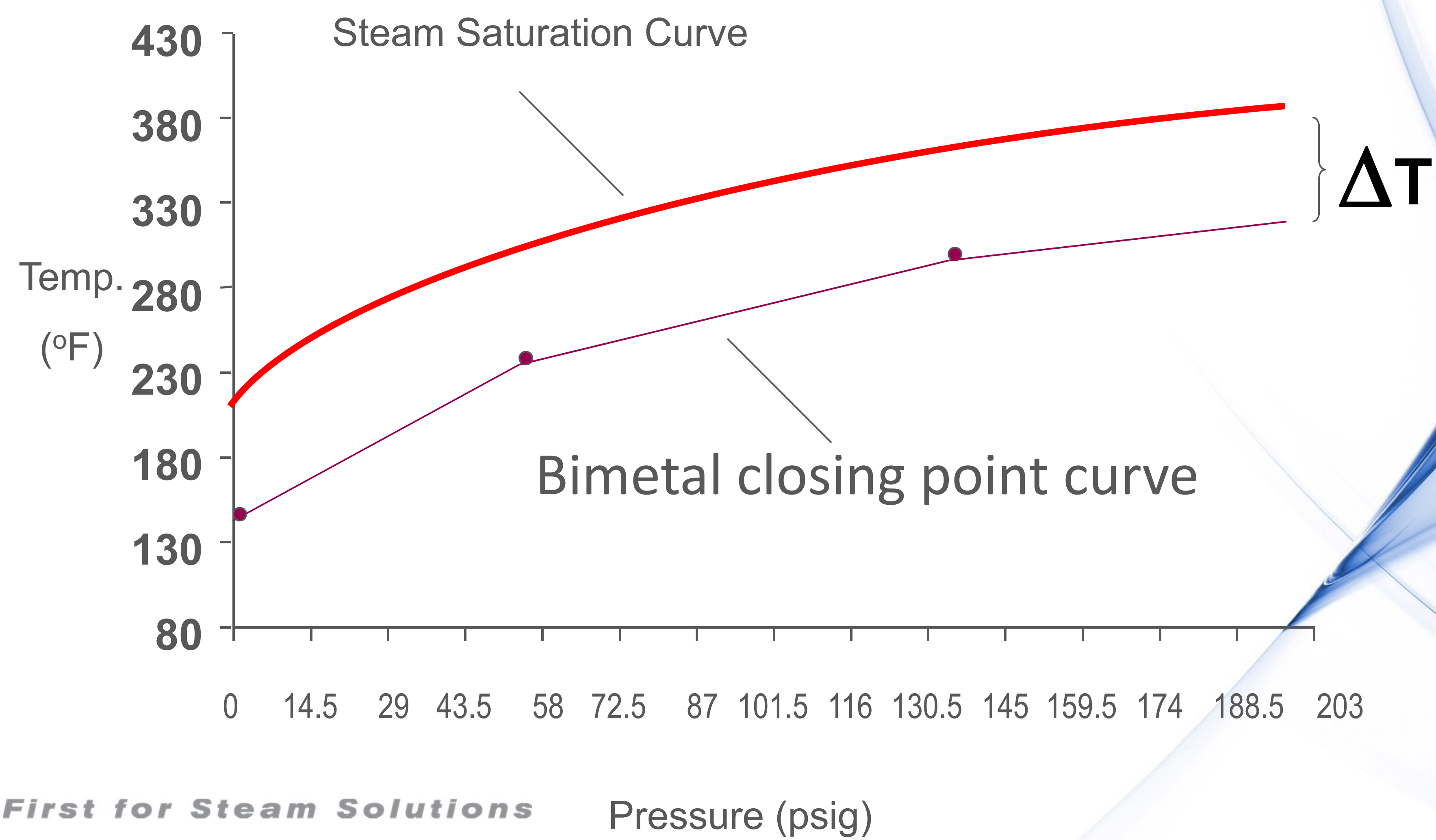
Response of Bimetallic Trap



Bimetallic Trap Operation

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Typical Applications for Bimetal Steam Traps

- Soot blower drip trap
- Non critical tracing
- Saturated steam drip trap for applications with very long cooling legs
- Drip for superheated steam applications
- Air vent on superheated steam applications

Pro's and Con's of Bimetal Steam Traps

Pro's

- Zero steam loss sub-cools condensate before discharging.
- Very high pressure ranges available
- Large air venting capability
- Water hammer resistant

Con's

- High degrees of sub-cooled condensate can cause excessive back up
- Limited applications
- Wiredrawing can occur due to oversizing

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Steam traps

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 affect the trap other than long term wear.

There are several test methods, but they are not all equally based on the results that they give.

- Visual
- Sound
- Temperature
- Conductivity

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.

SOUND TESTING

- Sound testing includes ultrasonic leak detectors, mechanics stethoscopes, and screwdriver or metal rod with a human ear against it.
- 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. By diverting condensate flow ahead of the trap or shutting off a secondary flow, the noise level will drop to zero or a very low level if the trap is operating correctly.

TESTING VISUAL AND SOUND METHODS

When utilizing the visual or sound methods, the technician performing the test should have 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.

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.**

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

Float and Thermostatic traps **have a discharge pattern that is a continuous modulating flow. We must first determine the type of application, process or light load condition. If the condensate load were 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.**

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

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.**

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

- 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.**
- Orifice drain devices **give a constant flow and never shut off. If condensate is diverted ahead of the device, 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 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.**

TEMPERATURE TESTING

Temperature testing includes infrared guns, surface pyrometers, temperature tapes, and temperature crayons.

Temperature tapes and crayons are used to gauge the discharge temperature on the outlet side of the trap.

Surface pyrometers, infrared guns or permanently fixed thermocouples can measure on both sides of the trap.

Both the infrared and surface pyrometers required bare pipe and a clean surface to achieve a reasonable reading.

Infrared guns and surface pyrometers can easily detect blocked or turned off traps, as they will show low or cold temperatures.

Combination of Sound and Temperature

Some newer testing devices combine both ultrasonic and temperature together and with built in algorithms take the human out of the determining factor of trap function in a portable device.

These type of devices are used by profession trap testing companies who will perform the testing for the customer.

CONDUCTIVITY TESTING (Spiratec)

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.

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.