ENGINEERING STANDARD

FOR

PROCESS DESIGN OF STEAM TRAPS

FIRST EDITION

MAY 2014

FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS is based on internationally acceptable standards and includes selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

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GENERAL DEFINITIONS:

Throughout this Standard the following definitions shall apply.

COMPANY:

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER:

Means the “Company” where this standard is a part of direct purchaser order by the “Company”, and the “Contractor” where this Standard is a part of contract documents.

VENDOR AND SUPPLIER:

Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR:

Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR:

Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR:

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

SHALL:

Is used where a provision is mandatory.

SHOULD:

Is used where a provision is advisory only.

WILL:

Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.

MAY:

Is used where a provision is completely discretionary.

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0. INTRODUCTION

"Process Design of Piping System, Heat Tracing and Winterizing, and Steam Traps" are broad and contain variable subjects of paramount importance. Therefore, a group of process engineering standards are prepared to cover the subject.

This group includes the following Standard:

STANDARD CODE	STANDARD TITLE
IPS-E-PR-420,	"Engineering Standard for Process Design of Heat Tracing and Winterizing"
IPS-E-PR-440	"Engineering Standard for Process Design of Piping System"
IPS-E-PR-845	"Engineering Standard for Process Design of Steam Traps"

This Engineering Standard covers:

"PROCESS DESIGN OF STEAM TRAPS"

In this standard, some of the subjects are adapted from the Utility Manual, chapter 300 Steam Systems; section 380 Steam Trap, by Chevron corporation, 1996.

1. SCOPE

This Standard is intended to cover minimum requirements and guidelines for process engineers to specify proper type and prepare data sheet for steam traps. (A typical steam traps data sheet is shown in Appendix A). It contains basic reference information, data and criteria for steam trap selection as mentioned above.

Note 1:

This standard specification is reviewed and updated by the relevant technical committee on Feb. 2003. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No. 177 on Feb. 2003. These modifications are included in the present issue of IPS.

Note 2:

This is a revised version of this standard, which is issued as revision (1)-2014. Revision (0)-1996 of the said standard specification is withdrawn.

2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

ANSI (AMERICAN NATIONAL STANDARDS INSTITUTE) / FCI (FLUID CONTROLS INSTITUTE)

69-1 "Pressure Rating Standards for Steam Traps"

85-1 "Standards for Production and Performance Tests for Steam Traps"

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

ASME PTC 39 “Steam Traps, Performance Codes”

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-PR-420 "Process Design of Heat Tracing & Winterizing"

TEMA (TUBULAR EXCHANGERS MANUFACTURERS ASSOCIATION)

Section RCB-8

3. DEFINITIONS AND TERMINOLOGY

3.1 Company/Employer/Owner

One of the affiliated companies of the Ministry of Petroleum of the Islamic Republic of Iran, as National Iranian Oil Company (NIOC), National Iranian Gas Company (NIGC), National Petrochemical Company (NPC), National Iranian Oil Refining and Distributing Company (NIORDC) and or their subsidiaries.

4. SYMBOLS AND ABBREVIATIONS

BP	=	Balanced Pressure
BM	=	Bimetal
DN	=	Diameter Nominal, (mm)
FCI	=	Fluid Controls Institute
F&T	=	Float and Thermostatic
IB	=	Inverted Bucket
NPS	=	Nominal Pipe Size, in (inch)
TD	=	Thermodynamic
TS	=	Thermostatic.

5. UNITS

This standard is based on international system of units (SI), as per IPS-E-GN-100 except where otherwise specified.

6. GENERAL

6.1 Types of Traps

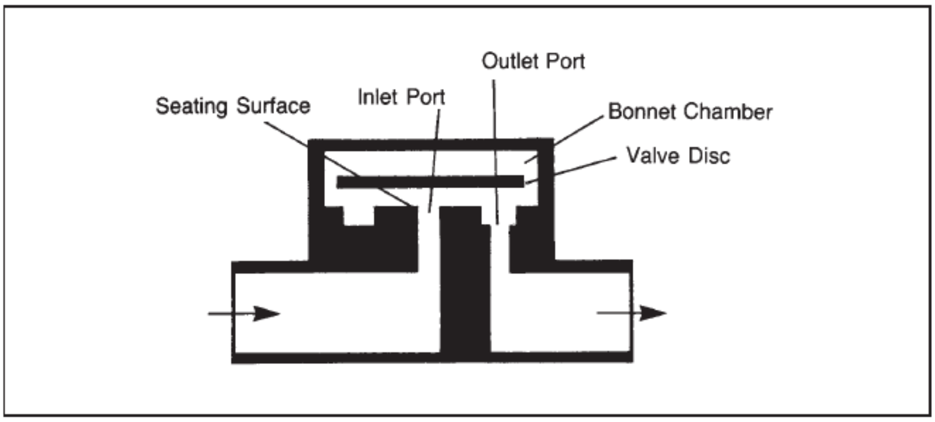
Most steam traps used in the chemical process industries fall into one of three basic categories:

- Thermodynamic
- Mechanical
- Thermostatic

6.1.1 Thermodynamics traps

Thermodynamic traps respond to the energy difference between condensate and steam. More accurately, they are activated by flashed steam. The most common types of thermodynamic traps are as follows:

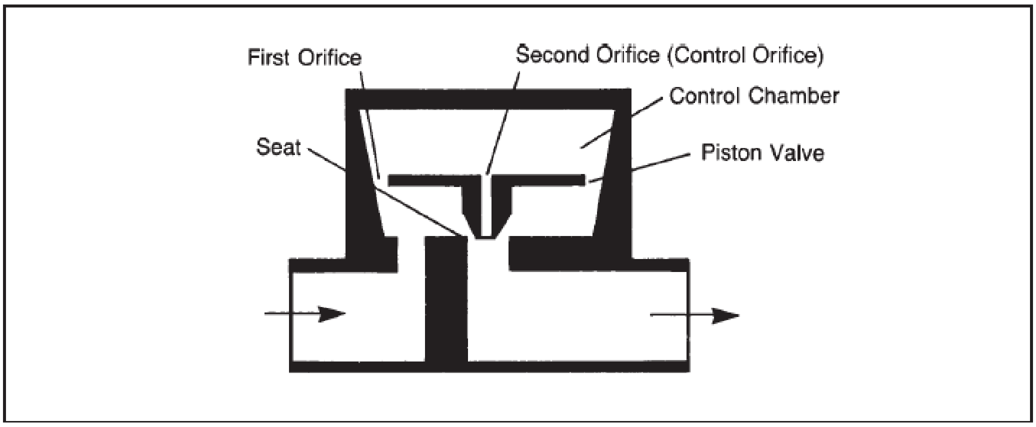
a) Thermodynamic disc traps
These traps consist of a valve disc and seat enclosed within a bonnet. Disc traps utilize the heat energy in hot condensate and the kinetic energy in steam to open and close a valve disc. They are phase detectors, sensing the difference between liquid and gas or vapor. (Fig.1)



THERMODYNAMIC DISC TRAP (COURTESY OF YARWAY CORPORATION)
Fig. 1

b) Variable-orifice (piston)

This thermodynamic trap consists of a piston valve, a seat, and control cylinder. It is a “hot” trap, providing excellent service in high pressure applications. Piston traps utilize the heat energy in hot condensate and the kinetic energy in steam to open and close a valve. Like disc traps, they are phase detectors sensing the difference between a liquid and gas or vapor. (Fig.2)

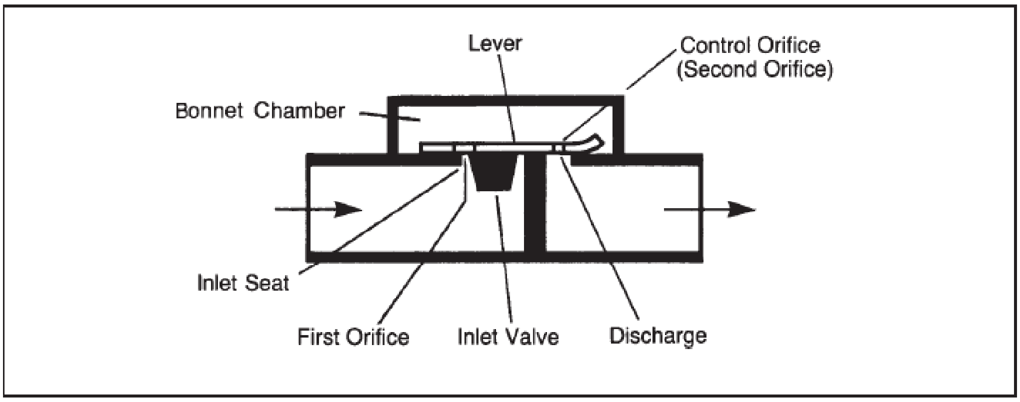


VARIABLE-ORIFICE (PISTON) TRAP (COURTESY OF YARWAY CORPORATION)

Fig. 2

Lever-valve

This thermodynamic trap consists of a lever-valve assembly and a seat, both enclosed within a bonnet. Its operation is similar to the piston trap, except it is designed for heavy condensate load applications on heat exchangers. Lever traps are a variation of the thermodynamic piston trap. They operate on the same principle as piston traps but with a lever action rather than a reciprocating piston action.(Fig.3)



LEVER-VALVE TRAP (COURTESY OF YARWAY CORPORATION)

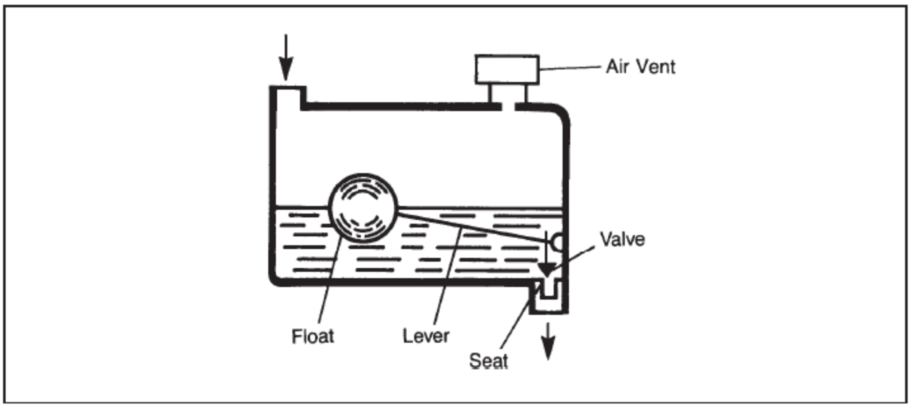
Fig. 3

6.1.2 Mechanical traps

Mechanical traps operate on the difference in density between steam (a vapor) and condensate (a liquid). They are actuated by a float, responding to changes in condensate level. Mechanical traps, like thermodynamic traps, are also phase detectors and therefore also have difficulties venting air and noncondensable gases. Mechanical traps employ either an open or a closed float to actuate a valve. The most common types of mechanical traps are as follows:

a) Float and thermostatic traps

This type of mechanical trap combines a mechanical float for condensate discharge and a temperature activated (thermostatic) valve for venting air.(Fig.4)

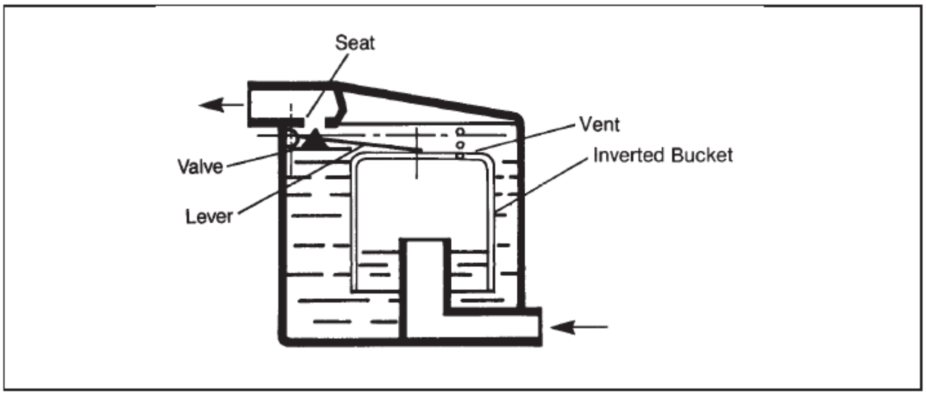


FLOAT AND THERMOSTATIC TRAP (COURTESY OF YARWAY CORPORATION)

Fig. 4

b) Inverted bucket traps

This mechanical trap uses an open "inverted bucket" as a float. The trapping principle uses the difference in density between steam and water. (Fig.5)



INVERTED BUCKET TRAP (COURTESY OF YARWAY CORPORATION)

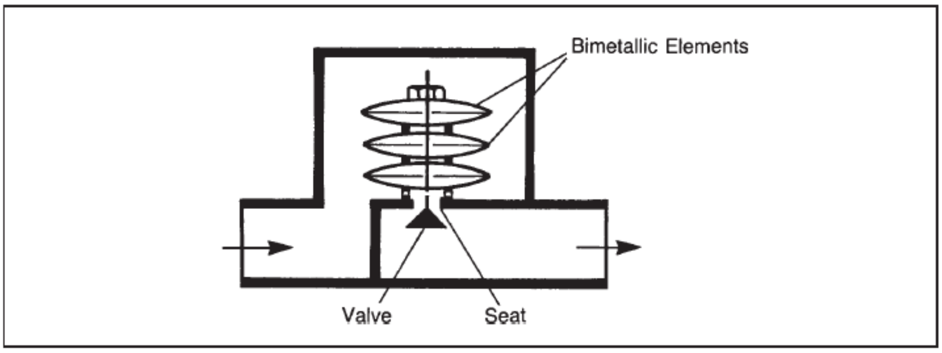
Fig. 5

6.1.3 Thermostatic traps

Thermostatic traps operate on the temperature difference between steam, at saturation temperature, and condensate, subcooled to some degree. The most common types of thermostatic traps are as follows:

a) Bimetallic traps

These traps consist of a valve and seat and a stack of bimetallic elements. Bimetallic steam traps utilize the sensible heat in the condensate in conjunction with line pressure to open and close a valve mechanism. On startup, the valve is wide open for high flow rates of air and condensate. (Fig.6)

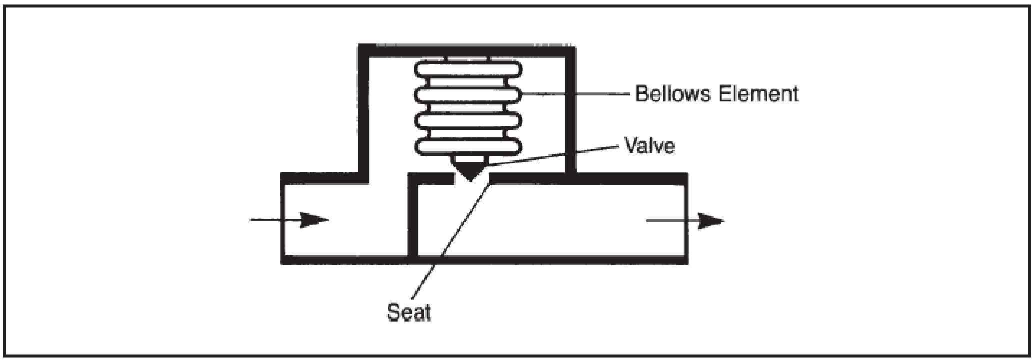


BIMETALLIC TRAP (COURTESY OF YARWAY CORPORATION)

Fig. 6

b) Bellows traps

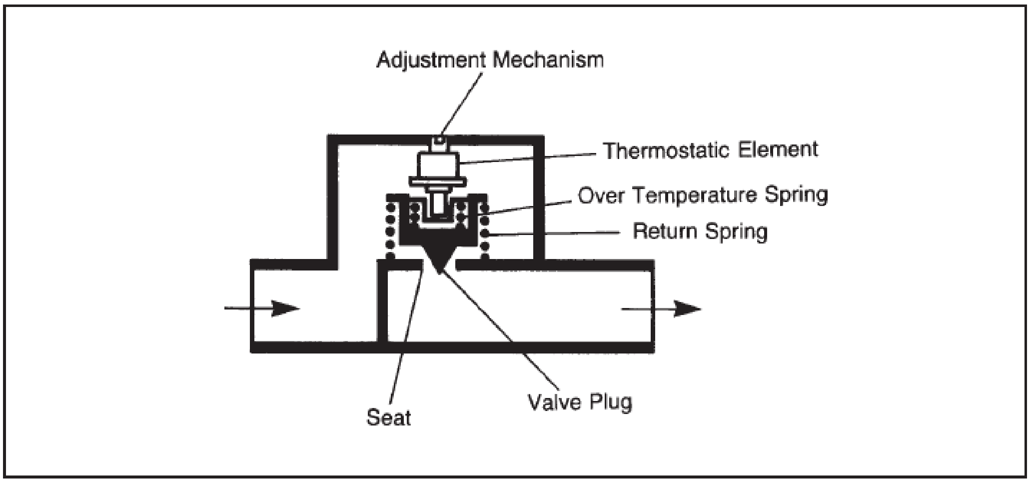
This is a balanced pressure bellows trap. It has a liquid filled bellow, a valve, and a seat. The bellows responds to changes in condensate temperature within the trap body and operates the valve. (Fig.7)



BELLOWS TRAP (COURTESY OF YARWAY CORPORATION)
Fig. 7

c) Wax element

This thermostatic trap operates by the expansion and contraction of a temperature sensitive wax element. Except for freeze protection where the valve is fully open on condensate or water at 2 °C, these traps are not used much anymore. They are discussed here to make sure the engineer finds a better type of trap. (Fig.8)



WAX ELEMENT TRAP (COURTESY OF YARWAY CORPORATION)
Fig. 8

6.2 Operating Characteristics and Suggested Applications

The key to trap selection is understanding the application requirements and the characteristics of the steam and knowing which traps meet those requirements while handling the steam condensate. Table 1 summarizes the operating characteristics and suggested applications for each type of trap.

6.2.1 Trap Performance characteristics

The performance characteristics of traps and drainers can be divided into three groups. The following are generalized statements but will help to illustrate the variations:

6.2.1.1 Mechanical and thermodynamic traps

- Have the fastest response rate—because they readily discharge condensate as soon as it arrives at the trap

- Follow varying steam pressures—both rising and falling (They are the primary choice for equipment with control valves.)

- Due to their characteristic on-off or cyclic operation (with the exception of the continuous / modulating F&T) they tend to be:

  – self-flushing of dirt and scale

  – easy to check by either sight or sound methods

6.2.1.2 Thermostatic traps

- Slower response than those in group one, which may not be critical in steady or uniform applications, but means they may not be the best choice in applications with quickly changing loads

- Tend to close or throttle on falling pressures, therefore may not be a good choice on control valve equipped applications (particularly on-off control valves)

- Due to their characteristic modulating or continuous discharge characteristics, these traps:

  – may be more sensitive to dirt conditions

  – are harder to check because there are no easily observed changes in operation, either sight or sound

6.2.1.3 Thermostatic drainers

- Very slow response

- Discharge at constant subcooled temperature

- Due to the above characteristics, these traps are used:

  – where their substantial backup provides for utilizing condensate’s sensible heat content (preheating vats, tanks, etc.)

  – to reduce the amount of flash discharge when the backup can be tolerated

TABLE 1-COMPARISON TABLE TO BE USED TO IDENTIFY WHICH STEAM TRAP TO CONSIDER FOR A PARTICULAR APPLICATION

TYPE OF STEAM TRAP	ADVANTAGES	DISADVANTAGE	FREQUENTLY RECOMMENDED SERVICES
Thermodynamic Traps			- Steam mains drips, tracers - Constant pressure -Constant load applications - Installations subject to ambient conditions below freezing
Thermodynamic Disc Traps	- Simple construction - Small size and light weight - Can be mounted in any position - Rugged, withstands water hammer - Self-draining, not damaged by freezing - Function not impaired by superheat - Versatile, suitable for wide pressure range - Condensate discharge temperature closely follows the saturation curve - Performance is easily checked in field	- Marginal air handling capability - Condensate discharge temperature cannot be adjusted - Excessive backpressure in return systems can prevent trap from closing - Life is reduced significantly as pressures move above 300 psi - High discharge noise level - Dirt particles can increase cycle rate causing wear	- The primary choice for equipment with control valves. -In light condensate load Applications.
Variable-Orifice (Piston).	- Suitable for high pressure - Can be mounted in any position - Good response to changing condensate load conditions - Rugged, withstands water hammer - Self-draining, not damaged by freezing - Function not impaired by superheat - Good air handling capability - Small size and light weight	- Excessive backpressure in return systems can prevent trap from closing - Condensate discharge temperature follows the saturation curve over a limited range	- It is a hot trap ,providing excellent service in high-pressure applications.
Lever-Valve.	- Suitable for high-pressure applications - Good response to changing condensate load conditions - Rugged, withstands water hammer - Not damaged by freezing - Function not impaired by superheat - Good air handling capability - Small, compact, easy to install and service	- Excessive backpressure in return systems can prevent trap from closing - Can only be mounted horizontally	- Applications having large - condensate loads especially on heat exchangers and benefiting from the very rapid discharge of condensate after its formation.
Mechanical Traps	- Unaffected by sudden or wide pressure changes	- Can only be mounted horizontally	
Float & Thermostatic	- Responds very quickly to condensate load changes - Condensate discharge temperature closely follows the saturation curve - Function is not impaired by high backpressures - Energy efficient - Simple construction - Continuous condensate discharge - Handles rapid pressure changes - High noncondensable capacity	- Suitable only for relatively low pressures - Requires auxiliary air vent, which is an additional source of failure - Not self-draining - Relatively large and heavy - Float can be damaged by water hammer - level of condensate in chamber can freeze damaging float and body - some thermostatic air vent designs are susceptible to corrosion	- Heat exchangers with high and variable heat transfer rates - When a condensate pump is required - Batch processes that require frequent start up of an air filled system

(to be continued)

TABLE 1-(continued)

Inverted Bucket	- Simple construction - Condensate discharge temperature closely follows the saturation curve - Reliable - Function is not impaired by high backpressures - Fast response to changing condensate loads - Rugged - Tolerate water hammer without damage	- Marginal air handling during start up - Not self-draining; subject to freeze up - Can lose prime, and is not self-priming - Can be mounted only in a single position - Discharge noncondensible slowly - Pressure fluctuations and superheated steam can cause loss of water seal (can be prevented by check valve) - Level of condensate can freeze , damaging float and body	- Continuous operation where non condensable venting is not critical and rugged construction is important
Thermostatic Traps			
Bimetallic	- Rugged, withstands corrosion, water hammer , high pressure and superheated steam - Energy efficient - Self-draining - Capable of discharge temperature adjustment - Can be mounted in several positions - Small size and weight - Maximum discharge of noncondensable at start up - Unlikely to freeze, unlikely to be damaged if it does freeze	- Dirt particles can prevent tight valve closing - Condensate discharge temperatures do not follow the saturation curve closely - Difficult to field check when operating in a throttling mode - Bimetallic elements are relatively susceptible to corrosion - Responds slowly to load and pressure changes - Back pressure changes operating characteristics	- Drip legs on constant pressure steam mains - Installations subject to ambient conditions below freezing
Bellows	- Excellent air handling capability - Energy efficient - Self-draining - Various condensate discharge temperatures available depending on bellows design - Condensate discharge temperature follows the saturation curve - Can be mounted in several positions - Simple construction - Small size and weight	- Bellows elements tend to be failure prone, especially when subjected to water hammer - Difficult to field check when operating in a throttling mode - Generally not suited for high-pressure applications - Limited superheat capability - Short stroke diaphragm design susceptible to dirt initiated failures	- Installations subject to ambient conditions below freezing - Drip legs on steam mains and tracing
Wax Elements	- Rugged - Good air-handling capability - Can be mounted in any position - Self-draining - Utilizes sensible heat of condensate - Allows discharge of non condensable at start up to the set point temperature - Not affected by superheated steam, water hammer, or vibration - Resists freezing	- Dirt particles can prevent tight close - Requires substantial sub cooling - Difficult to field check - Slow response to changing condensate loads - Actuator damaged by exposure to high temperature - Element subject to corrosion damage - Condensate backs up into the drain line and/or process	- Ideal for tracing used for freeze protection - Freeze protection, water and condensate lines and traps - Non critical temperature control of heated Tanks

7. DESIGN CRITERIA

Surveys have found that only 58% of all steam traps are functioning properly. Other studies have found that almost half of all failures were not due to normal wear, but were, in fact due to misapplication, under sizing, over sizing, or improper installation.

That is why it is essential to follow these three steps (in addition to proper steam trap installation, checking and trouble shooting and correct steam trap maintenance) for successful steam trapping:

1) Application definition

2) Steam trap selection

3) Steam trap sizing.

7.1 Application Definition

Steam trap application fall into two categories:

1) Drip and tracer

2) Process.

7.1.1 Drip and tracer traps

Drip traps drain condensate caused by natural heat loss that is formed in steam mains and steam driven equipment. If this condensate remained in the piping, water hammer, corrosion and damage to the piping, valving and equipment would occur. Tracer traps drain condensate from steam tracers, which is tubing or pipe strapped to a process pipeline, water line, or instrument to keep it warm. Winterization tracing protects against freezing, while process tracing maintains the temperature of process liquids. Both drip and tracer traps are for system "protection". The failure of these traps can cause severe and costly consequential damages.

7.1.2 Process traps

Process application fall into four categories based on the type of equipment, with steam either heating a liquid indirectly, air or gas indirectly, a solid indirectly, or a solid directly. Table 2 provides examples of each type of process application.

Process applications typically involve these characteristics:

- Fluctuating steam pressures
- Heavy condensate loads
- Fluctuating air handling requirements

Unlike the steady state characteristics found for drips and tracers, the above conditions vary for each process application.

Therefore, the major consideration for process traps is the individual selection and sizing of traps for each piece of equipment.

Process applications differ according to what is being heated. They develop heavier condensate loads than drips and tracers, so larger capacity traps of different types are generally used.

TABLE 2-CATEGORIES OF PROCESS STEAM TRAP APPLICATIONS

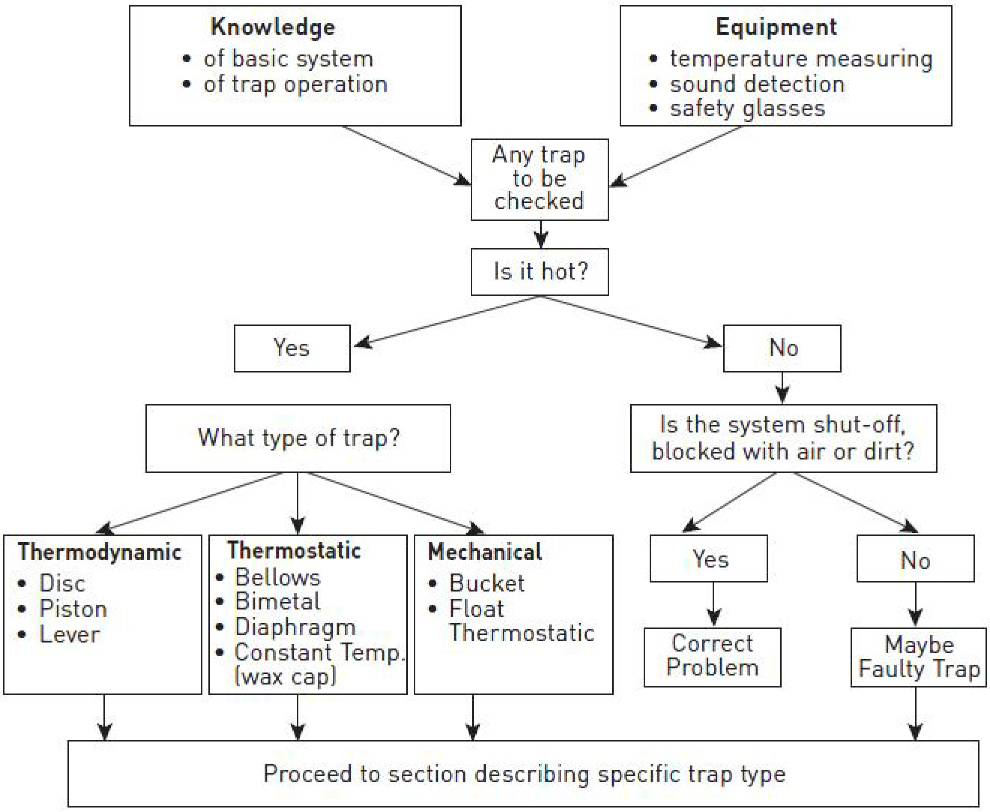
TYPE OF HEATING EQUIPMENT	TYPICAL EXAMPLES OF EQUIPMENT BEING HEATED
1. Steam heats a liquid indirectly	Submerged surfaces (batch still, evaporator, fuel heater, shell and tube exchanger, tank coil, vat water heater) Jacketed vessel (pan, kettle, concentrator) lift or syphon drainage (tilting kettle, sulfur pit, submerged pipe or embossed coil, shipboard tank)
2. Steam heats air indirectly	Natural circulation (dry air: convector, pipe coil, moist air: blanket dryer, dry kiln, drying room). Forced circulation (air blast heating coil dry kiln, air dryer, pipe coil, process air heater, unit heater)
3. Steam heats a solid or slurry indirectly	Gravity drained (chest-type ironer, belt press, chamber dryer, hot plate, platen) Syphon drained (cylinder ironer, cylinder dryer, drum dryer, dry can, paper machine)
4. Steam heats a solid Directly	Gravity drained (autoclave, reaction chamber retort, sterilizer)

7.2 Steam Trap Selection

After defining the application, the next step is to select the correct type of steam trap based on performance criteria such as design failure mode (open or closed), speed of response, air handling capability, ease of checking, ambient temperature, potential for water hammer in the system, steam pressure, condensate load and temperature, venting and drainage requirement, and maintenance work. With rare exception, a steam trap should always be selected for fail open service. Other criteria which are more feature-oriented include ease of maintenance, (see Appendix E) ease of installation (including flexibility of horizontal or vertical piping) and integral strainer and blowdown valve. Table3 provides some selection guidance. Selected trap types are subject to Company's approval.

TABLE 3-CHART TO BE USED FOR NARROWING THE CHOICE OF STEAM TRAP TYPE

TYPE OF STEAM TRAP	FAILURE MODE	OPERATES OVER WIDE PRESS. RANGE	EASY TO CHECK	AIR HANDELING ABILITY	DESIGNED FOR SUPERHEAT	DESIGNED FOR FAST RESPONSE	RESISTANT TO WATER HAMMER
Mechanical							
F&T	Closed or open	No	No	Excellent	No	Yes	No
IB	Closed	No	Yes	Poor	No	Yes	Yes
Thermostatic							
Bellows	Closed or open	Yes	No	Excellent	No	Yes	No
Bimetal	Open	No	No	Fair	Yes	No	Yes
Wax element (Diaphragm)	Closed or open	Yes	No	Fair	No	No	No
Thermodynamic							
Disk	Open	Yes	Yes	Poor	Yes	Yes	Yes
Piston	Open	Yes	Yes	Good	Yes	Yes	Yes
Lever	Open	Yes	Yes	Good	Yes	Yes	Yes



STEAM TRAP CHECKING DECISION TREE

Fig. 9*

* Reference is “Yarway Industrial Steam Trapping Handbook chapter 6” (2013).

When choosing a steam trap, the following steam trap codes and standards which define steam trap design, performance and manufacturing are applicable:

1) PTC 39 (2005) "Steam Traps, Performance Codes"

2) ANSI/FCI 69-1, "Pressure Rating Standards for Steam Traps"

3) ANSI/FCI 85-1, "Standards for Production and Performance Tests for Steam Traps"

7.3 Steam Trap Sizing

7.3.1 Once the correct trap type has been selected, it must be sized. A steam trap must be sized based on the condensate load, not on pipe size. Sizing a trap based on pipe size typically results in an oversized trap, which will cycle more frequently or operate with the valve too close to the seat causing wear and short service life.

The procedure for sizing a steam trap is as follow:

1. Determine the inlet and outlet pressure conditions of the trap.
2. Calculate the condensate load produced by the equipment being drained.
3. Select a suitable safety load factor
4. Solve the sizing equation.

(Operating condensate load) × (Safety load factor)
= Required trap capacity

The operating condensate load is determined by using heat transfer formulae, the form of which depend on the type of heat transfer process.

Size of trap's condensate lines/subheaders/headers shall be enough to avoid excessive back pressure on trap to facilitate proper trap functioning.

For drip and tracer applications, which typically operate at constant steam pressure and have relatively light condensate loads, a safety load factor of 2 to 3 shall be considered.

Process applications, however typically operate with a controlled steam supply with variable pressure and have condensate loads and are both variable and heavy.

The appropriate safety load factor will depend on such factors as:

- The heating category (as defined in Table 2)
- The variations of steam pressure
- The variations of condensate load
- Air handling requirements
- Equipment operating characteristics
- Trap response time
- Inaccuracies in the data

Values range between 2 and 5. Table 4 shall be used to select the safety load factor based on the type of equipment and whether the steam pressure, constant or variable (the latter of which implies the use of control valve to regulate steam pressure based on a signal from the process controller).

7.3.2 Once the correct trap type has been selected. it must be sized. A steam trap must be sized based on the condensate load, not pipe size. Sizing a trap based on pipe size typically results in an oversized trap, which will cycle more frequently or operate with the valve too close to the seat, causing wear and short service life.

The procedure for sizing a steam trap is to first calculate the condensate load based on equations (or other means) subject to Employer approval. Once the condensate load has been calculated, the trap should be sized using a reasonable safety factor. For drip and tracer applications, which typically operate at constant steam pressure and have relatively light condensate loads, a safety load factor of 2 to 3 shall be considered.

Size of trap’s condensate lines/subheaders/headers shall be enough to avoid excessive back-pressure on trap to facilitate proper trap functioning.

Process applications, however typically operate with a controlled steam supply with variable pressure and have condensate loads that are both variable and heavy. The appropriate safety load factor will depend on such factors as the heating category (as defined in Table 2), the type of equipment and whether the steam pressure is constant or variable (the latter of which implies the use of control valves to regulate steam pressure based on a signal from the process controller). Values range between 2 and 5. Table 4 shall be used to select the safety load factor.

TABLE 4-CHART TO BE USED FOR SELECTION OF SAFETY FACTOR FOR TRAPS IN PROCESS APPLICATION

HEATING CATEGORY *		STEAM PRESSURE	
		CONSTANT	VARIABLE
1	Drainage to trap: Gravity Syphon/Lift	 2 3	 3 4
2	Ambient air: 0°C and higher Below 0°C	 2 3	 3 4
3	Drainage: Gravity Syphon	 3 5	
4	Warm-Up: Normal Fast	 3 5	

*** From Table 2.**

7.4 Other Consideration

7.4.1 In addition to the considerations mentioned above, the following items shall be strictly followed:

1) Impulse type steam traps shall be used for general service such as headers, branches and tracing as detailed in the relevant piping specifications.

2) Inverted bucket traps shall not be used without written permission from Company in cases where these types apply.

3) Vacuum or lifting traps shall be used for draining condensate from low pressure systems where the available pressure differential is too low for other types of traps.

4) Automatic drain valves, either float or diaphragm type for draining condensate or liquid from air or gas lines and receivers shall be used.

5) Ball float traps (continuous drainers) shall be used for modulating service such as draining condensate from temperature controlled reboilers, for trapping liquid in gas or air streams and for venting air or gas from liquid streams.

6) Strainers shall be installed in the piping upstream of all continuous drainers. Metallic gaskets shall be used for steam pressure above 2000 kPa and/or 20 bar. integral strainers are preferred.

7) The body material for ball float traps and automatic drain valve shall be as follows:

a) 1700 kPa and/or 17 bar (a) and lower, cast steel;

b) over 1700 kPa and/or 17 bar (a) forged steel or stainless as applicable.

8) End connections shall conform to piping specifications, except for steam tracing traps which shall be screwed type.

9) Trim material for traps and strainers shall be stainless steel.

10) The body material for steam tracing traps shall be stainless steel.

11) Minimum body size shall be DN15 (½" NPS) for traps in steam tracing or unit heater services. Minimum size shall be DN 20 (¾" NPS) for all other traps.

7.4.2 For traps in winterizing and heat conservation services the items listed below shall be strictly followed:

1) Condensate collecting piping for grouped tracer traps shall be such as to avoid excessive back pressure on traps and trap discharge lines and should be based on the lowest expected steam supply pressure. Minimum size of condensate collecting piping for grouped tracer traps shall normally be as follows:

- 1 to 2 traps DN20 (¾" NPS)
- 3 to 5 traps DN25 (1" NPS)
- 6 to 15 traps DN40 (1½" NPS)

2) Each tracer shall have its own steam supply valve and steam trap.

3) For heat conservation service, each trap shall have a block valve upstream and downstream of trap. Traps will have an integral strainer and plugged drain. In winterization service no blocks will be required at steam traps. Drains will be valved.

4) Steam trap shall be impulse tilting disc type with DN15 (½") or DN20 (¾") threaded ends with integral strainers and blow off valves with removable internals as shown in Appendix E. Body shall be forged steel, seat and disc shall be stainless steel or stellite. Traps shall be preferably installed with the flow down. If the trap is in a horizontal run, it shall be installed on its side to prevent freezing.

5) The condensate discharge from the tracers shall be carried out through one steam trap for each individual tracer. The steam trap may service two tracers only if they are tracing the same pipe in parallel for the same length and follow the same route. The steam trap may collect the discharge of more tracers in the particular cases of pumps and instrument tracing provided the tracers are completely self-draining with no pockets.

6) Valves and piping at trap shall be same size as the trap size.

7) Piping from the trap discharge to the header shall normally be DN15 (½") minimum piping. Condensate recovery shall be 100%, however in exceptional approved cases where it is not practicable to recover, discharge piping shall be short, without elbows and discharged into sewage or into a properly designed soakaway sump.

8) Instrument steam tracers shall be supplied only from independent main headers which will not supply steam to any other facility.

9) For detail of condensate collection system reference shall be made to IPS-E-PR-420, "Process Design of Heat Tracing & Winterizing".

8. COMMON PROBLEMS OF STEAM TRAPS

8.1 Freezing

If subjected to ambient conditions below 0°C, condensate in the trap will freeze unless it is continuously replenished with hot, newly formed condensate. Generally, freezing is a problem only when the steam system is shut down (or idled) and a heel of condensate remains in the trap.

Some traps, such as the Float-and-Thermostatic (F & T) and Balanced Pressure (BP) traps using conventional bellows, are more easily damaged by freezing than other types of traps. The Inverted Bucket (IB) trap can also freeze, subjecting its body to damage.

8.2 Air Binding

Air and other noncondensibles in the steam system reduce heat-transfer rates and can confound steam trap operation. When subjected to excessive air removal requirements, thermodynamic traps can stay closed longer than normal and IB traps will release the air only very slowly. When these types of traps are used for frequently shut-down batch operations, the steam system should be fitted with an auxiliary vent for noncondensibles. Such a vent valve is usually similar in design to a BP trap. It should be installed at a high point in the steam system or parallel with the trap.

8.3 Noise

Noisy operation is generally not a problem with steam traps that discharge condensate to a closed pipe. With the exception of the thermodynamic trap, most traps tend to operate relatively silently. In some circumstances, however, a trap may cause a slight, audible "woosh" sound as condensate flashes into steam downstream of the trap valve. Noise in steam systems is usually caused by lifting condensate up vertical return lines, water hammer, or a failed trap that leaks live steam into a condensate line.

8.4 Steam Leakage

Like any valve, the valve seat in a steam trap is subjected to erosion and/or corrosion. When seat is damaged, the valve will not seal completely and the trap may leak live steam. Some trap designs allow seat replacement without removing the trap body from the line, others may require replacement of the entire trap.

Steam trap valve seats are specially susceptible to a type of erosion called "wire drawing". This phenomenon is caused by high-velocity droplets of condensate eroding the valve seat in a pattern that looks like a wire has been drawn across the surface. Oversized traps are more susceptible to wire drawing.

8.5 Insufficient Pressure Difference

Steam traps rely on a positive difference between process steam pressure and the pressure downstream of the trap to remove condensate. If such a difference is not present, condensate will not drain from the trap and a pump will be required.

There are two circumstances where insufficient pressure difference will occur:

1) When the pressure downstream of the trap is too high because of overloading of a condensate return line (that is high back-pressure).

2) When the process steam pressure is too low. This condition frequently occurs in modulating service where the process temperature controller throttles steam pressure in the exchanger to a pressure below that of the pressure downstream of the trap. In some circumstances the pressure in the exchanger will actually fall below atmospheric pressure if the exchanger calls for a heat source below 100°C.

When either circumstance occurs, condensate will back up into the exchanger, no matter which type of trap is used. In modulating service, the temperature controller will eventually increase the steam pressure and force the condensate out of the trap. This filling and emptying of the exchanger causes temperature cycling that cannot be controlled by any instrumentation system. Also, when the high-pressure steam forces condensate out of the exchanger at a high velocity, the exchanger will be subject to physical damage from water hammer. The tube bundle may also be corroded at the condensate-steam interface inside the exchanger.

(This interface is a point at which the corrosive effects of oxygen and CO_2 in the steam can be concentrated.)

The only way to stabilize condensate removal in such circumstances is to install a condensate pump in conjunction with the trap.

8.6 Dirt

Steam condensate often contains particles of scale and corrosion products that can erode trap valves. If the particles are large enough, they can plug the trap discharge valve or jam it in the open position. Levers in the F&T and IB traps also can be jammed by particulates and valve movement in BM traps can be restricted by solids jammed between the bi-metal plates.

To extend trap-life, a strainer should be installed immediately upstream of each trap. Strainers should be cleaned frequently when the system is first started up and when any steam piping is replaced so that any millscale present is removed upstream of the trap. Subsequently, strainers should be cleaned on schedule consistent with how quickly they load up with particulate.

8.7 Maintenance

Most traps can be repaired rather than replaced. The repairs can usually be done in-line without removing the trap body from the connecting piping. Such repairs usually require less labor than replacement, because removing the trap cover is easier than removing the trap from the line. Repairing the steam trap also eliminates the possibility of having to replace pipe if the trap piping is damaged when the trap is removed. Of course, it also costs less to buy trap parts than to buy an entire trap.

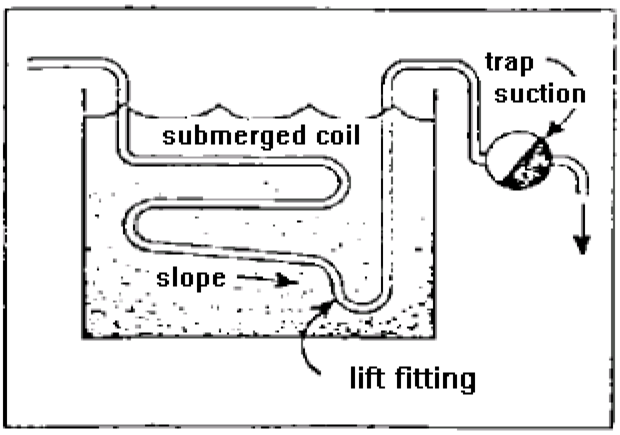
9. PROPER STEAM TRAP INSTALLATION

Certainly, steam traps should be installed according to the manufacturer's guidelines. There are, however, some basic considerations worth noting.

9.1 Condensate gets into steam traps by gravity. Thus, a steam trap should always be installed below the equipment that is being drained by gravity flow.

However, there are applications where a steam trap can not be installed lower, such as buried tanks, drop-in (submerged) heating coils, or rotating drum dryers.

In these instances, special consideration should be given to providing tank coils with a lift fitting, as shown in Fig. 10 and utilizing steam traps with control orifices to vent flashed condensate.

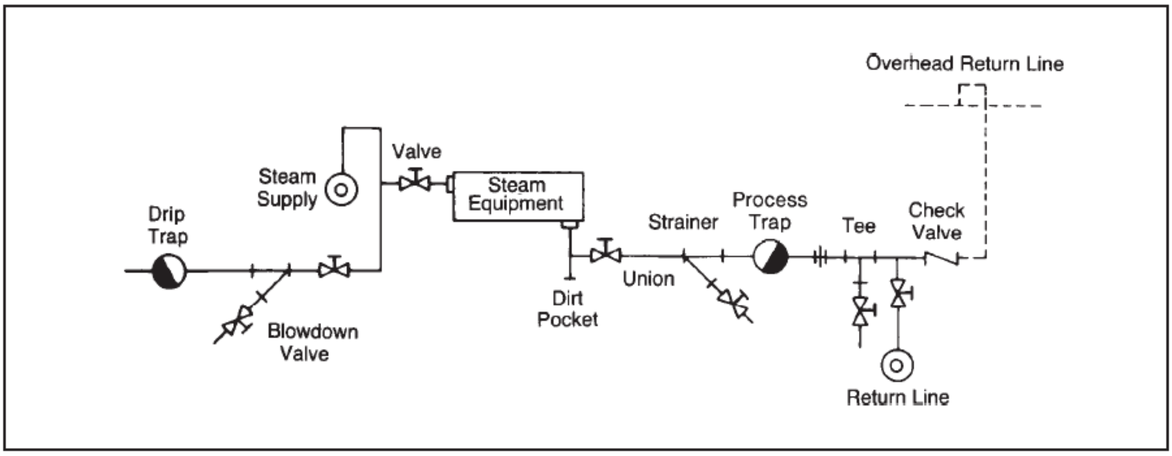


A LIFT FITTING MUST BE INSTALLED TO DRAIN CONDENSATE FROM EQUIPMENT THAT IS LOWER THAN THE STEAM TRAP

Fig. 10

A lift fitting is a loop into which condensate drains, a syphon tube is then placed down into it to syphon out the condensate. Control orifices are orifices in steam traps to vent flash vapor by providing continuous drainage (that is, the trap never shuts tightly). Control orifices are common to thermodynamic piston and lever traps, other types of traps may have internal or external orifices, but only if specified as an option.

Beyond gravity drainage, proper trap station and support shall be considered. Fig. 11 shows a typical steam trap station with recommended piping and specialties.



TYPICAL STEAM TRAP INSTALLATION

Fig. 11

9.2 Some key points to remember are:

1) Adequate drain legs should be provided to ensure collection and storage of condensate prior to the trap to permit operation free of water hammer. Size of drain legs should be the same as the equipment outlet connection and generally 460-610 mm long. Their length is generally limited based on the equipment installation and clearances to grade.

Process equipment engineers should consider these necessary clearances when designing equipment support structures.

2) A Y-type strainer (integral or separate) with blowdown valve is essential. Dirt is a major cause of steam trap failures. The strainer catches impurities and can then be flushed to remove them.

In addition to protection from dirt, a strainer is also a good diagnostic tool. A cold trap can be checked by simply blowing down the strainer. If pressure is present, the trap is either failed closed or plugged with dirt. It is also possible that a downstream condensate valve is closed or some other restriction exists. And most important, the strainer blowdown valve depressurizes the trap station for safe maintenance.

3) A test tee should be installed in systems where condensate is collected and either returned to the boiler or some other location. A test after the trap provides quick visual examination of trap discharge for ease of checking and troubleshooting.

4) Steam trap stations that include isolation block valves allow steam trap maintenance to be performed without having to turn off the steam supply at the root valve (that is, steam supply valve or the first valve in the system).

5) Flanges or pipe unions may be required for installations that use nonrepairable steam traps or repairable steam traps that require removal from the pipe for repair. In threaded pipe installations, only downstream unions or flanges are recommended, as upstream unions or flanges may leak and cause expensive high pressure steam to be lost.

Flanges or unions will not be needed if in-line renewable steam traps are used for simplicity of installation and reduction of maintenance costs. (The term "renewable" is an alternative to "repairable"). Repairing implies changing a bad part.

In renewable steam traps, the maintenance results in a "new" trap, in that the valve, seat and (operating mechanisms are all replaced).

9.3 Bypasses around steam traps are to be installed when traps are needed to be removed or repaired, or when traps could not handle either the air or the heavy condensate load during start-up.

9.4 In rare instances, where the process can not even be shut down for quick in-line maintenance of the steam trap, installing a backup steam trap with the necessary valves, strainers and so on in parallel is the best alternative arrangement.

9.5 Simple instrumentation with pressure gages and thermometers on the upstream and downstream side of steam traps in critical process applications can provide valuable assistance in future troubleshooting of system problems and trap performance. Such instrumentation is recommended for process heat exchangers where loss of temperature control may ruin a batch of material and cause significant monetary losses. Steam main drips and tracing do not require such monitoring.

Typical steam trap piping is shown in Appendix B. Proper drip pot installation and general notes applicable to typical steam trap piping drawing (in Appendix B) are shown in Appendix C.

Insulation is an enemy to a good steam trap maintenance program and should not be used. To avoid problems, it is recommended that pipe insulation start approximately 300 mm. upstream and downstream from the trap. Insulating steam traps makes them difficult to check and maintain because once insulated, a steam trap may never be accessed unless it is clearly affecting process operation. Additionally, the performance of a steam trap can be affected by insulation, thermostatic traps, for example, tend to be sluggish when insulated and bucket traps can lose their prime (that is fail open).

As for safety, the use of expanded metal screening wrapped around a trap, instead of insulation, can provide personnel protection where necessary.

APPENDICES

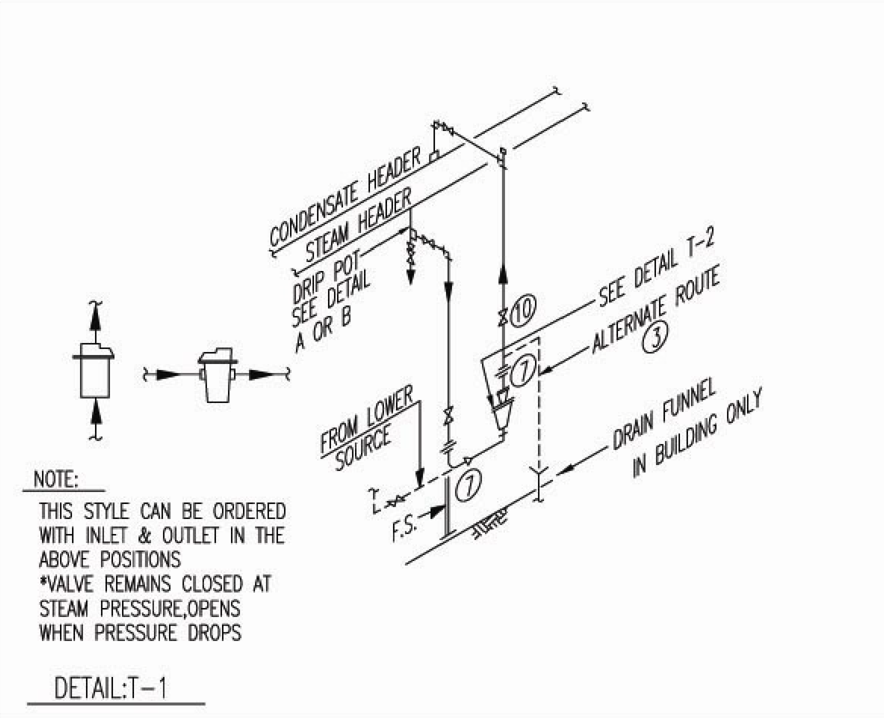
APPENDIX A

TYPICAL STEAM TRAP DATA SHEET

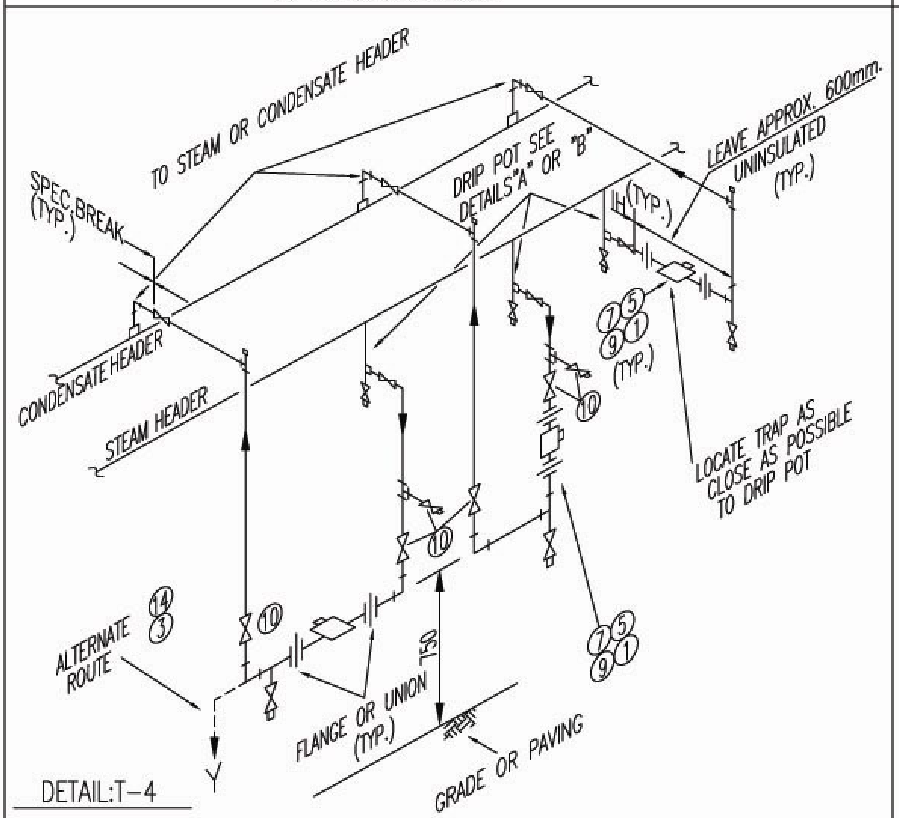
General	+1	Tag No.	
	+2	Flowsheet: frame No.	
	+3	Quantity	
	+4	Service	
	+5	Installation (horizontal/vertical)	
	6	Type	
Body	7	Test pressure (hydraulic)	
	+8	Material	
	9	Size Inlet | Outlet	
	+10	End connections/flange facing	
	+11	Rating: press: temp. (bar: °C)	
	12	Equalization conn. Size	
	13	Conn. Orientation	
	14	Drain connection (plugged/valved)	
IRM	+15	Material	
	16		
Accessories	17	Internal check valve	
	18	Internal bi-metallic vent	
	19	Thermostatic Vent | Material	
	20	Gage glass	
	21		
Strainer	+22	Internal-External	
	23	Type: size	
	24	Body material	
	25	Rating: Press.: Temp.:	
	26	End connections	
	27	Blow off connections	
	28	Mesh size: material	
Process	29	Heat treatment	
	+30	Fluid	
	+31	Normal flow kg/h | max. flow kg/h	
	+32	Load safety factor	
	33	Max. capacity kg/h	
	+34	Flow temp. °C | °C superheat	
	+35	Pressure bar (ga) | in out	
	+36	Allow press. diff. bar max. | min.	
	+37	R.D (S.G): F.T. top | bottom	
Orifice	38	Calculated	
	39	Selected	
	40		
MFR	41	Outline dimensions	
	42	MFR. model No.	

APPENDIX B

TYPICAL STEAM TRAP PIPING



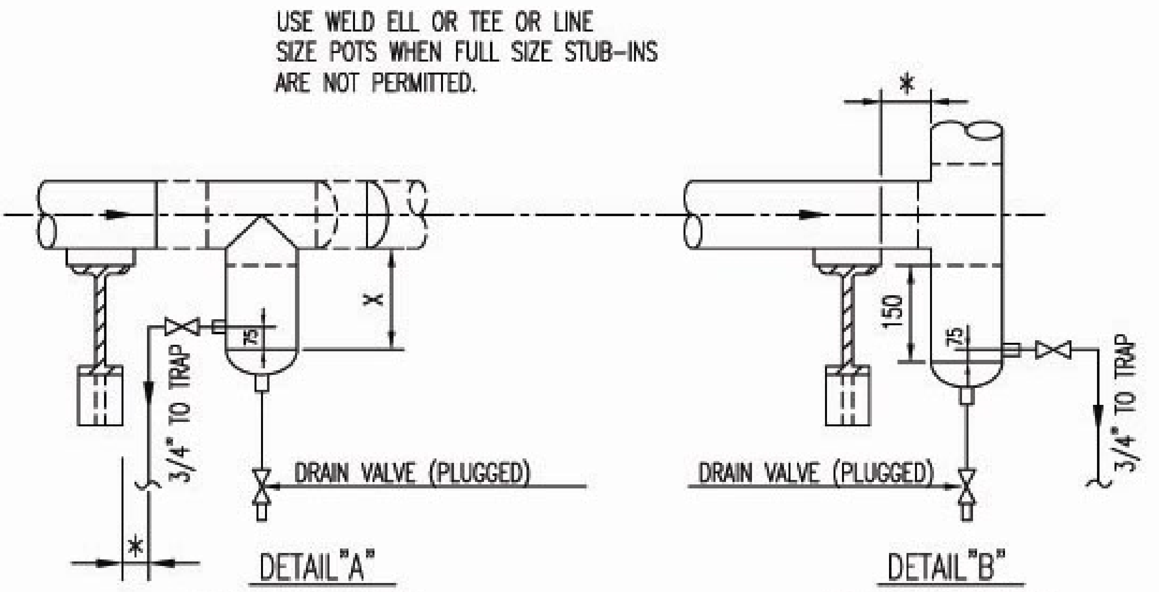
BUCKET TRAP
PIPING ARRANGEMENT



THERMODYNAMIC TRAP
(IMPULSE TRAP)

APPENDIX C

DRIP POT INSTALLATION AND GENERAL NOTES APPLICABLE TO STEAM TRAPPING



DETAIL"A"

DRIP POT INSTALLATION AT ENDS OR RUNS OF HEADERS.
FOR SIZE OF DRAIN AND POT REFER TO TABLE-C

DETAIL"B"

DRIP POT INSTALLATION AT CHANGE OF DIRECTIONS.
FOR SIZE OF DRAIN AND POT REFER TO TABLE-D

TABLE-C

HEADER SIZE	POT SIZE	DRAIN VALVE. SIZE	X (mm)
8" & SMALLER	LINE SIZE	3/4"	220
10" THRU 16"	8"	1"	305
18" THRU 38"	12"	1 1/2"	LINE SIZE

TABLE-D

HEADER SIZE	POT SIZE	DRAIN VALVE. SIZE
8" & SMALLER	LINE SIZE	3/4"
10" THRU 16"	LINE SIZE	1"
18" THRU 38"	LINE SIZE	1 1/2"

NOTE:

STEAM TRAPS SHALL BE PROVIDED AT LOW POINTS, DEAD ENDS, AND IN LONG RUNS OF STEAM PIPING AS REQUIRED FOR SUFFICIENT CONDENSATE REMOVAL TO ENSURE DELIVERY OF STEAM AT ITS DESTINATION. (SEE ALSO NOTE-2)

* ALWAYS CHECK DIRECTION OF THERMAL EXPANSION VRS.P.S.

APPENDIX D

PIPE COMPONENT-NOMINAL SIZE

The purpose of this Appendix is to present an equivalent identity for the piping components nominal size in SI System and Imperial Unit System, in accordance with ISO 6708-1980 (E).

TABLE 1 - PIPE COMPONENT - NOMINAL SIZE

NOMINAL SIZE		NOMINAL SIZE		NOMINAL SIZE		NOMINAL SIZE	
DN (1)	**NPS (2)**	**DN**	**NPS**	**DN**	**NPS**	**DN**	**NPS**
6	¼	100	4	600	24	1100	44
15	½	125	5	650	26	1150	46
20	¾	150	6	700	28	1200	48
25	1	200	8	750	30	1300	52
32	1¼	250	10	800	32	1400	56
40	1½	300	12	850	34	1500	60
50	2	350	14	900	36	1800	72
65	2½	400	16	950	38		
80	3	450	18	1000	40		
90	3½	500	20	1050	42		

1) Diameter Nominal, mm.

2) Nominal Pipe Size, inch.

APPENDIX E

DETAILS OF THERMODYNAMIC STEAM TRAP (WITH REMOVABLE INTERNALS)