CORRECT TRAP SIZING FOR STEAM SERVICE

is a simple matter when the following information is known:

A. Pressure Conditions
B. Condensate Load
C. Adequate Safety Factor

The following is a brief description of how each of these is determined which may be helpful in sizing your requirement. If there are any additional questions on sizing or trap selection our local representative or our factory engineers will be pleased to be of assistance if you will write or telephone

Clark·Reliance

16633 FOLTZ INDUSTRIAL PARKWAY, STRONGSVILLE, OHIO 44136
(440) 572-1500 • FAX: (440) 238-8828

PRESSURE CONDITIONS

1. **DETERMINE THE MINIMUM AND THE MAXIMUM INLET PRESSURES AT THE TRAP.**

2. **DETERMINE THE TRAP OUTLET PRESSURE (OFTEN CALLED "BACK PRESSURE").**

   a. Outlet pressure less than zero gage– where a trap drains into a return line carrying vacuum (sub-atmosphere), every 2" of vacuum LOWERS outlet pressure approximately 1 lb.

   b. Outlet pressure greater than zero gage– where a trap drains into a return line carrying a definite pressure and/or where the discharge line is elevated above the trap outlet, outlet pressure will be INCREASED by approximately 1 lb. for every 2 feet of LIFT.

3. **DETERMINE BOTH THE MINUMUM AND THE MAXIMUM TRAP DIFFERENTIAL.**

   a. Minimum differential is used to determine the seat orifice that has the required continuous flow capacity (condensate load x safety factor).

   b. Maximum differential is used to determine the pressure rating of trap to be selected.
   Example: A steam boiler operates at 125 psi during the day and at 30 psi during the night. Main steam line is drained by a trap discharging to atmosphere.
   Minimum differential=30 - 0 = 30 lbs.
   The maximum condensate load x a safety factor= the continuous flow capacity required. Then select a seat orifice large enough to handle this capacity at the 30 lbs. pressure
   Maximum differential=125 - 0=125 lbs.
   Select a trap with a pressure rating that will operate at this differential with the seat orifice selected above.

CONDENSATE LOAD

Condensate loads may be determined by several methods according to the data available.
Some frequently used methods are:

1. THE B. T. U. METHOD

This method is used when the B.T.U. rating is given by the equipment manufacturer, or it can be computed.

Divide this rating in B.T.U:/hour by the latent heat of evaporation of steam pressure used (see steam table back page), and we find the condensate load in lbs./hr.
Example: Given a rating of 900,000 B.T.U./hr. @ 65 psi gage steam pressure, from steam table we find latent heat @ 65 lbs. pressure = 900 B.T.U. (approximately).

Then $\frac{900{,}000}{900}$=1000 lbs./hr.=condensate load

2. ACCORDING TO RADIATION IN THE AIR

Condensate load can be computed in two ways:
a. Lineal foot-Table "B"
Given steam pressure, size and linear feet of pipe radiation, use values direct from Table B to determine condensate load.

TABLE B

APPROXIMATE POUNDS PER HOUR OF WATER CONDENSED IN EACH LINEAR FOOT OF BARE STEEL PIPE WHEN CARRYING STEAM AT INDICATED PRESSURES
(Based on normal movement of AIR at 60°F room temperature)

Steam Pressure in Lbs./Sq. In. GAGE	STANDARD STEEL PIPE SIZES — CONDENSATE IN LBS/HR./LINEAR FOOT OF PIPE												
	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"	5"	6"	8"	10"
1	.104	.124	.152	.189	.214	.261	.309	.368	.464	.563	.664	.851	1.046
4	.113	.135	.165	.205	.229	.282	.335	.398	.500	.606	.716	.918	1.129
6	.118	.140	.172	.213	.241	.294	.348	.415	.526	.637	.753	.961	1.177
10	.127	.152	.187	.232	.261	.318	.376	.449	.567	.687	.812	1.041	1.280
25	.158	.189	.231	.287	.323	.398	.473	.562	.707	.859	1.011	1.297	1.597
50	.196	.234	.287	.356	.402	.496	.589	.702	.889	1.080	1.277	1.634	2.006
75	.228	.273	.336	.417	.469	.576	.687	.820	1.038	1.262	1.488	1.912	2.357
100	.256	.307	.377	.469	.530	.650	.772	.922	1.168	1.422	1.682	2.156	2.658
125	.280	.337	.416	.517	.583	.716	.854	1.020	1.289	1.570	1.858	2.390	2.948
150	.304	.365	.448	.558	.629	.775	.922	1.105	1.402	1.702	2.014	2.585	3.178
200	.346	.414	.507	.631	.713	.881	1.052	1.255	1.592	1.934	2.290	2.939	3.627
250	.387	.464	.570	.707	.798	.987	1.176	1.407	1.781	2.159	2.556	3.293	4.065

Example: Given the equivalent of 500 feet of 3" bare steel pipe carrying steam at 200 psi gage, Table B under 3" pipe at 200 lbs. steam pressure indicates a value of 1.255 lbs./hr. for each linear foot; therefore,

500 x 1.255=628 lbs./hr.=condensate load.

b. Square foot of radiation-Table "C"

Given steam pressure and the equivalent square feet of radiation heating surface, the condensate load can be determined from values in Table "C".

Example: (1) Given 122 sq. ft. of radiation surface heated by steam at 100 psi gage, in Table C for 100 lbs. steam pressure, we find a value of 0.981 lbs./hr. for each square foot; therefore,

122 x 0.981 = 120 lbs./hr.=condensate load. (approx.)

(2) Given 250 feet of 3" bare steel pipe carrying steam at 125 psi gage, in Table E we find that 3" pipe has 0.916 square feet of external surface per linear foot. In Table C, for 125 lbs. pressure we find a value of 1.088 lbs./hr. per square foot; therefore,

250 x 0.916 x 1.088=249 lbs./hr.=condensate load.

3. SUBMERGED RADIATION

Where heating process is a continuous operation, such as a hot water storage heater, the normal condensate load should be determined.

Example: 50 feet of 2" iron pipe coil submerged in water with temperatures of 46° F. inlet and 160° F. outlet, steam pressure is 125 psi gage.

In Table "E"

A 2" pipe has 0.622 square feet of external surface face per linear ft.; then 50 x 0.622=31.1 Total of sq. ft. of radiation surface. Temperature of steam @ 125 lbs. gage=353° F. (Steam Table). Average Temperature of Water=$\frac{46 + 160}{2}$=103° F.

Temperature difference between steam and average temperature of water=353° F - 103° F=250° F.

Using Table "D"

For iron pipe coil, under 250° F. difference, we find a value of 88 lbs./hr. per sq. ft., therefore

31.1 x 88=2737 lbs./hour=normal condensate load

To determine in this example the peak condensate load, use the maximum temperature differential in place of average differential in your computation.

SAFETY FACTOR

is used to provide additional capacity to assure adequate intermittent trap operation during periods of unusually heavy condensate conditions, such as startup, surges, lower than normal differential pressures, and the fast removal of excessive air.

	Safety Factors (Suggested)
Radiation in Air	3 or 4 to 1
Bare Pipe or Coils — Outside Air	3 or 4 to 1
Unit Heaters: — Inside Air	2 or 3 to 1
Drying Rooms, Kilns	7, 8, 9, to 1
Cylinder Dryers	4 to 1 up to 10 to 1
Submerged Radiation — Coils, Instant Heaters, Reboilers	3 or 4 to 1
Steam-Jacketed equipment	6 or 8 to 1

TABLE D

POUNDS OF CONDENSATE FORMED/HR./SQ. FOOT of STEAM RADIATION with **COILS SUBMERGED** in WATER with Natural Circulation.

(A liberal allowance has been made for pipe incrustation, usual drops in pressure, etc. Bright clean pipe will increase these figures approx. 75%).

Type of Coils	Difference in Degrees F. between Steam Temperature and Average Temperature of the Water							
	50°	100°	125°	150°	175°	200°	250°	300°
Iron	5	15	25	38	49	61	88	109
Brass	8	25	35	52	69	89	130	164
Copper	10	28	41	59	82	102	146	192

TABLE C

LBS. OF WATER/HR. CONDENSED to Each Sq. Ft. of Uncovered Flat Steel or Iron Radiation Surface at Indicated Steam Pressures. (Normal Movement of Air at 60° F.)

Steam Pressure in Lbs./sq. in.	Lbs./Hr. of Condensate
1	0.389
4	0.423
6	0.444
10	0.481
25	0.597
50	0.750
75	0.878
100	0.981
125	1.088
150	1.182
200	1.355
250	1.519

TABLE E

STANDARD WEIGHT PIPE DATA

NOMINAL PIPE SIZE	DIAMETER IN INCHES		Internal Transverse Area in Sq. Inches	Sq. Ft. of External (Heating) Surface per Linear Ft. of Pipe	Linear Ft. of Pipe equal to One Sq. Ft. of External Surface
	External	Internal			
1/2"	0.840	0.622	0.304	0.220	4.547
3/4"	1.050	0.824	0.533	0.275	3.637
1"	1.315	1.049	0.864	0.344	2.904
1-1/4"	1.660	1.380	1.495	0.435	2.301
1-1/2"	1.900	1.610	2.036	0.497	2.010
2"	2.375	2.067	3.355	0.622	1.608
2-1/2"	2.875	2.469	4.788	0.753	1.328
3"	3.500	3.068	7.393	0.916	1.091
4"	4.500	4.026	12.730	1.179	0.848
5"	5.563	5.047	20.006	1.458	0.686
6:	6.625	6.065	28.891	1.736	0.576
8"	8.625	7.981	50.027	2.262	0.443
10"	10.750	10.020	78.855	2.817	0.355

THE AMOUNT OF STEAM CONDENSED IN ANY SYSTEM IS SELDOM CONSTANT. BECAUSE OF VARYING CONDITIONS, IN MOST INSTALLATIONS, THERE IS A CONSIDERABLE VARIATION IN THE CONDENSATE LOAD. WITH SO MANY CONTRIBUTING FACTORS, IT IS SOMETIMES DIFFICULT TO DETERMINE THE EXACT CONDENSATE LOAD UNDER ALL CONDITIONS. HOWEVER, IF THE EXACT CONDENSATE LOAD CAN NOT BE DETERMINED, THE SAFETY FACTOR USED CAN BE MADE ADEQUATE ENOUGH TO COVER ANY VARIABLES.

CONDENSATE LOAD

Other methods for figuring condensate loads:

1. UNIT HEATERS

Are usually rated in BTU per hour by the various manufacturers. To determine condensate load, use the BTU method explained on preceding page.

2. STORAGE WATER HEATERS

Must be completely drained to prevent "water hammer" damage to heating elements and maintain heat transfer efficiency.

Condensate load may be figured in the following manner:

Using

T = Desired temperature rise of water (in °F.)

G = Gallons per hour of water to be heated.

W = 8.33 lbs. weight of 1 gallon of water.

L = Latent heat of steam at pressure used (See steam table.)

C = Condensate load in lbs./hour

Formula: $\frac{T \times G \times W = C}{L}$

Example: 1000 gal./hr. of water to be heated from 40° F. to 180° F., using 100 psi gage steam –

$$\frac{140 \times 1000 \times 8.33}{880} = 1325 \text{ lbs./hr. condensate load}$$

3. STEAM SEPARATORS

Under normal conditions, with insulated pipe, trap continuous flow capacity should be about 12% the volume of steam thru the separator.

4. STEAM MAINS AND RISERS

Drainage of steam mains and risers are important in operating as well as starting up periods even though lines are well insulated. Sudden changes in pressure, flow or water conditions may cause prime carry-over from boiler. Small slugs of water at high velocity can rupture a steam line. Steam main and riser traps should be sized with a capacity for starting-up and/or surge loads.

LOCATION – INSTALLATION OPERATION – MAINTENANCE

LOCATION: Traps should be placed in plain view in an accessible location where they will not be overlooked or forgotten. This promotes closer inspection and care, also reducing both installation and upkeep costs by making the job easier and more agreeable for the maintenance crew. Good gravity drainage from unit being trapped is preferable but when necessary, traps can be installed above the drained unit. When placed above it is good practice to provide a check valve as well as a water seal in the inlet line to trap.

INSTALLATION:

- Be sure trap is connected properly. Check the inlet and outlet markings on the trap.
- See that the pressure rating corresponds to the highest pressure to which the trap will be subjected.
- Blow line out thoroughly to remove all scale, pipe cuttings, joint cement dirt, etc. Install trap in an upright level position.
- Provide shut-off valves and unions on both sides of trap for easy removal when necessary.
- A test outlet on medium size and large traps will permit easy inspection of trap operation.
- It is recommended that a Clark Strainer be installed on inlet side of trap. If this is not done the next best thing is a dirt leg below trap inlet.
- Provide a bypass where it is imperative to continue drainage when trap is taken out of line.
- When connected for the first time, or when blown out to remove accumulated dirt or scale, BE SURE to fill trap with water ("prime") unless there is a sufficient back up of condensate in inlet line of trap to automatically do so.
- Discharge line from trap can run either below, horizontal to, or even be elevated above trap if there is sufficient pressure at trap outlet to overcome any back pressure and/or the condensate head in the discharge line. (Every pound of pressure at trap outlet will lift the condensate approximately two feet).

OPERATION: A trap under normal conditions will operate intermittently. The force of the discharge will vary according to the pressure, a forceful discharge being evident at higher pressure, becoming less forceful as the pressure drops. When trap discharges to atmosphere there is considerable flash which should not be confused with a trap blowing steam. Flash occurs only during discharge period, while a leaking trap will blow steam continuously. Abnormal amounts of air tend to slow up trap operation, particularly during cold starting periods, and in such cases an auxiliary thermal air by pass such as Clark Thermostatic Trap will greatly speed up the action. Traps exposed to freezing temperatures will not freeze as long as steam pressure is maintained at the trap and the discharge line is not restricted. Keep return lines short and covered if possible. A frozen return line will eventually cause trap to freeze. If steam is turned off be sure trap is properly drained.

MAINTENANCE: Traps are installed to remove condensate and in so doing effect savings by elimination of harmful condensate and by promoting more efficient heat transfer. Traps only perform this function when they are operating properly. Traps, like any other mechanism of moving parts, should be periodically checked and inspected for correct operation and wear. Traps should be inspected at regular intervals and necessary repairs made, also interior and parts cleaned, so as to keep them in top operating condition.

TRAP CONDITION	REASON	REMEDY
DOES NOT DISCHARGE	1. Condensate does not flow into trap. (a) Obstruction in line to trap inlet. (b) Bypass open or leaking.	(a) Remove obstruction. (b) Close or repair bypass.
	2. Inlet Pressure may be above trap pressure rating. (a) Pressure change has occurred in system without considering trap pressure rating. (b) Wrong pressure ratings specified.	(a) & (b) Accurate pressure gauge installed at trap inlet will give exact condition. Replace with disc and seat of correct pressure rating.
	3. Accumulation of foreign matter within trap.	Clean out trap by means of blow-off valve or dismantle if necessary (A Clark Strainer installed at trap inlet will cure this trouble permanently).
	4. Trap held closed by defective mechanism.	Perform needed repairs.
DOES NOT SHUT OFF	1. Trap undersized	Determine condensate load and install correct size trap.
	2. Trap held open by defective mechanism.	Perform needed repairs.
	3. Condensate load has increased over the amount present when trap was installed. (a) May be due to excessive boiler foaming or priming. (b) Greater volume of steam used. (c) Leaking submerged steam coils allows infiltration of surrounding liquid.	(a) Cure conditions causing excessive condensate, or install a Clark Separator. (b) Refigure condensate load and install correct size trap. (c) Repair leaking coils.
BLOWS STEAM	1. No prime. (a) Trap not orignally primed when installed. (b) Failure to reprime after clean out or blow-off. (c) Inverted bucket type trap, very much oversized, eventually blows out seal. (d) Open or leaking bypass valve.	(a) Prime the trap. (b) Prime the trap. (c) Reducing seat orifice size will frequently correct; if not replace with smaller trap. (d) Close or repair bypass valve.
	2. Valve mechanism does not close. (a) Held open by foreign matter. (b) Mechanism worn or defective.	(a) Remove foreign matter. (If contact surface between disc and seat is cut, relapping will be necessary). (b) Repair or replace. (Relapping of disc and seat will often restore original tightness).
	3. Flash steam - If it appears that steam escapes each time trap discharges, remember hot condensate forms flash steam when released to atmosphere or lower pressure, however flash steam usually condenses very quickly in return line.	
CONDENSATE FAILS TO DRAIN FROM SYSTEM	1. Pressure may be too low to force condensate through trap.	Increase steam pressure.
	2. Abnormal volume of air at low temperature and pressure slows up trap operation.	Add to present installation an external thermal air bypass (Series 530) or, Replace with Series 70-T, if within capacity of this series or, replace with a larger trap.
	3. "Short-circuiting" where one trap drains several units.	Install separate trap for each unit.
TRAP CAPACITY SUDDENLY DECREASES	1. Trap differential pressure appreciably reduced. (a) Reduction in operating pressure. (b) Increase in back pressure.	(a) Raise operating pressure to former level. If impossible, install larger trap. (b) Look for: Obstruction in return line. Plugged vent in return line. Traps blowing steam into return line. Open bypasses.

FACTORS THAT INFLUENCE INVERTED BUCKET TRAP CAPACITIES

There are many reasons why the same orifice in various size traps will give varying capacities. Two of the more important factors are:

1. Piping connections - - the larger the pipe, the less choking from flash steam.
2. Larger, heavier buckets are less inclined to lift with velocity and will give more continuous flow capacity than smaller, light buckets under the same conditions. This effect is more apparent with the larger orifices.

To make for ease in sizing traps by capacities, we have grouped traps together where orifice capacities would be approximately the same. The capacities between traps in these groups may vary as much as 20% - -this is particularly true in the larger orifices in pressures below 125 pounds. Using this table as a guide, even where the minimum safety factor of 2 to 1 is used, this variation should cause no particular problem.

SERIES 190 AND 180

Orifice Diameters at Pressures Indicated

	125	180	250	300	400	500	600	700	800	900	1000
190	9/32	7/32	13/64	3/16	11/64	5/32	9/64				
191	23/64	21/64	9/32	1/4	1/4	7/32	13/64				
192	7/16	25/64	25/64	25/64	21/64	19/64	1/4				
194	45/64	9/16	15/32	7/16	3/8	21/64	5/16				
180	9/32	7/32	13/64	3/16	11/64	5/32	9/64	1/8	1/8	7/64	7/64
181	23/64	21/64	9/32	1/4	1/4	7/32	13/64	3/16	11/64	5/32	5/32
182	7/16	25/64	25/64	25/64	21/64	19/64	1/4	1/4	7/32	7/32	13/64
184	45/64	9/16	15/32	7/16	3/8	21/64	5/16	9/32	1/4	1/4	15/64

Note: For Capacities of Orifices Shown Below 250 psi, Refer to Capacity Chart B.

CAPACITY CHART C

THE CLARK-RELIANCE CORP.
Strongsville, Ohio 44136