Armstrong®

APPLICATION GUIDELINES

STEAM MAIN DRAINAGE

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1) Steam Main Drip Leg Dimensions

In order to trap your system mains, some important dimensions should be considered when designing the system. Drip legs are the key to successful, water hammer free, system start-up.

Drip Legs:

a) Let condensate escape by gravity from the fast moving steam. The properly sized drip leg acts as a separator by providing an increase in flow area, which slows the steam flow down allowing the condensate to drop out. This is important during operation as well as start-up. During operation steam velocities can approach 150 miles (241 kilometers) per hour. Condensate that is carried along at this velocity will not be drained easily unless the velocity is reduced. Therefore, drip leg diameter must be large enough to create the separator effect by reducing velocity.

Once the system is up to pressure the large drip leg keeps the condensate from being sucked out of the drip leg. This can happen when high velocity steam moves across the opening to a small drip leg causing a “piccolo effect.” The high velocity gas experiences a pressure drop, which will cause condensate to be sucked out of a small pipe. A large drip leg does not experience this pressure drop and therefore able to collect and discharge condensate.

b) Store the condensate until the pressure differential is great enough for the steam trap to discharge it.

On start-up cold piping causes steam to collapse and pressure to drop. This causes a very high condensate load for the trap to handle, but with virtually no pressure for the trap to use in discharging the condensate. This is compounded when the condensate line is located above the steam line. So, rather than flood the steam main, a large drip leg gives the water a place to accumulate until the pressure is sufficient for the trap to handle the accumulation.

Steam Main Drainage

General:

The selection of drip leg sizes to drain steam mains depends on the warm-up method that will be used:

Figure 1 – Steam Mains

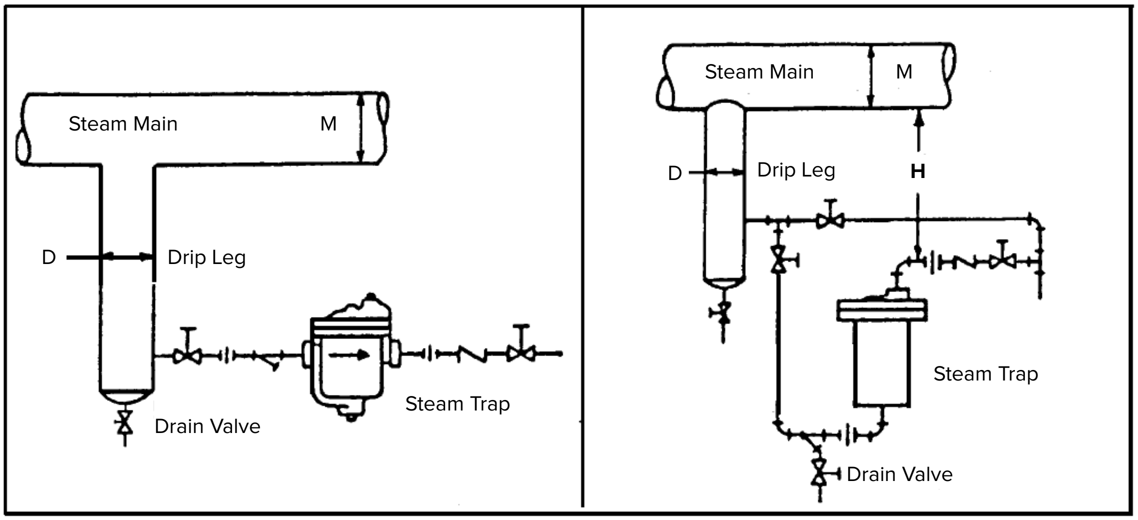

Table 1 – Recommended Drip Leg Sizing

M		D		Drip Leg Length			
Steam Main Size		Drip Leg Diameter		Supervised Warm-Up		Automatic Warm-Up	
in	mm	in	mm	in	mm	in	mm
1/2	12.7	1/2	12.7	10	254	28	711.2
3/4	19.05	3/4	19.05	10	254	28	711.2
1	25.40	1	25.40	10	254	28	711.2
2	50.8	2	50.8	10	254	28	711.2
3	76.2	3	76.2	10	254	28	711.2
4	101.6	4	101.6	10	254	28	711.2
5	127	4	101.6	10	254	28	711.2
6	152.4	4	101.6	10	254	28	711.2
8	203.2	4	101.6	12	304.8	28	711.2
10	254	5	127	15	381	28	711.2
12	304.8	6	152.4	18	457.2	28	711.2
14	355.6	8	203.2	21	533.4	28	711.2
16	406.4	8	203.2	24	609.6	28	711.2
18	457.2	10	254	27	685.8	28	711.2
20	508	10	254	30	762	30	762
24	609.6	12	304.8	36	914.4	36	914.4

NOTES:

1. Drain valve is required for supervised start-up only. Drain valve needs heat tracing or insulation on outdoor installations where freezing is possible.

2. Steam traps are shown in the piping set-ups: side-in, side-out or bottom-in, top-out. On supervised start-up, the H dimensions is to the top of the trap or the top of the drain piping, whichever is higher. Either trap type can be used.

3. Drip leg piping should always follow the "D" dimension. The take-off to the trap can be the same connection as the trap. We are constantly asked for a 3" (80 mm) trap to drain a 3" (80 mm) line. A 3" (80 mm) trap is grossly oversized, and a 3/4" (20 mm) trap will work better, because it is sized for the load.

4) Static pressure head "H" must always be positive on automatic warm-up.

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2) Types of Warm-Up:

a) Supervised Warm-Up: is widely used for initial heating of large diameter above 8" (20 cm) or long more than 1000 ft (304 m) mains. Such mains may be warmed up only once in a lifetime. The drain valves for free flow to the atmosphere are opened wide before steam is admitted to the main. These drip valves are not closed until after all or most of the warm-up condensate has been discharged. The the trap is opened and can take over the job.

A supervised warm-up will not need such a long drip leg, because only operating load condensate will be removed automatically by traps, and the condensate load will stay about the same.

(Warm-up of principal piping in a power plant will follow the same procedure.)

b) Automatic Warm-Up: In this case, the boiler is fired, letting the mains and some or all equipment come up to pressure and temperature without manual help. This kind of warm-up is used more for occasional steam use or steam system shutdown every night, weekend, or seasonally. In this case, you will need a bigger drip leg because the condensate load handled by the trap will be much greater, due to the start-up load.

At start-up a high condensate load occurs at low pressure. Once up to temperature there will be less condensate at high pressure. In this type of warm-up, the steam trap will discharge all the condensate, because there are no manual drain valves.

3) Spacing of Drip Legs:

Drip legs and drain traps should be provided at intervals no longer than 500 ft (75 m) because steam main condensate should be drained while it is a "heavy dew" rather than a dangerous slug.

4) Low Pressure Drainage -- Sizing Traps for Automatic Warm-up:

A static head dimension is used only on automatic warm-up because we have two pressure conditions. Start-up low pressure and operating high pressure.

During start-up the trap is discharging condensate because of the static head dimension. Condensate can be discharged during the warm-up only because the static head pushes condensate through the trap.

Generally, a trap that can handle the line's running load can also handle the start-up load as long as the line is heated no faster than 200°F (93°C) per hour. The traps's capacity is actually quite high at cold start-up conditions because:

1. Cold condensate does not flash when discharged. The flashing causes flow to be choked off when being discharged from the orifice.
2. Cold water is more dense than hot (by more than 10%) so more pounds per hour are able to pass through the fixed orifice in the trap.

To check trap capacity you must know:

1. The total warming up load (see Armstrong Conservation Guidelines, Table CG-1: Warming Up Load).
2. The time period over which warm-up takes place.
3. The static head dimension "H".

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Divide the head dimension by 28(H/28) to get psi. Then divide the warming up load by the start-up time (in hours) to get lbs. per hour. Table 2 lists orifice capacities at these very low pressures. If your pressure is not listed, do not interpolate. Capacities can be approximated using this equation:

$$C_1 = C_2 \times \frac{\sqrt{P_1}}{\sqrt{P_2}}$$

Where:

C1 = Unknown capacity (#/hr) at actual pressure (P1)

P1 = Actual pressure in psi

P2 = Pressure from chart

C2 = Capacity from chart

Table 2 Orifice Capacities at Low Pressures.

Use only for sizing traps for automatic warm-up.

Pressure	0.5	0.07	1	1.014	2	0.28
	psig	barg	psig	barg	psig	barg
Orifice	Pounds (kg) per hour					
5/64”	37	16.78	52	23.59	71	32.21
No. 38	49	22.23	69	31.30	121	54.89
7/64”	73	33.11	103	46.72	140	63.50
1/8”	94	42.64	134	60.78	182	82.56
5/32”	148	67.13	209	94.80	284	128.82
3/16”	214	97.07	302	136.99	410	185.98
7/32”	291	132.00	411	186.43	559	253.56
1/4”	379	171.91	535	242.68	728	330.22
9/32”	482	218.64	680	308.45	925	419.58
5/16”	595	269.89	841	381.48	1145	519.37
11/32”	715	324.32	1010	458.14	1370	621.43
3/8”	851	386.01	1205	546.59	1640	743.90
7/16”	1160	526.18	1640	743.90	2230	1011.53
1/2”	1515	687.20	2140	970.70	2910	1319.98
9/16”	1875	850.50	2650	1202.04	3600	1632.96
5/8”	2375	1077.30	3350	1519.56	4550	2063.88
3/4”	3100	1406.16	4160	1886.98	5400	2449.44
7/8”	4225	1916.46	5700	2585.52	7250	3288.60
1 1/16”	6240	2830.46	8400	3810.24	10700	4853.52

5) Trap Types

We recommend the use of inverted bucket steam traps because this kind of trap works on the density principle thereby discharging condensate as soon as it reaches the trap.

Another advantage of the inverted bucket traps is that they fail open, so, incase of trap failure, the main won't flood.

Notes

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