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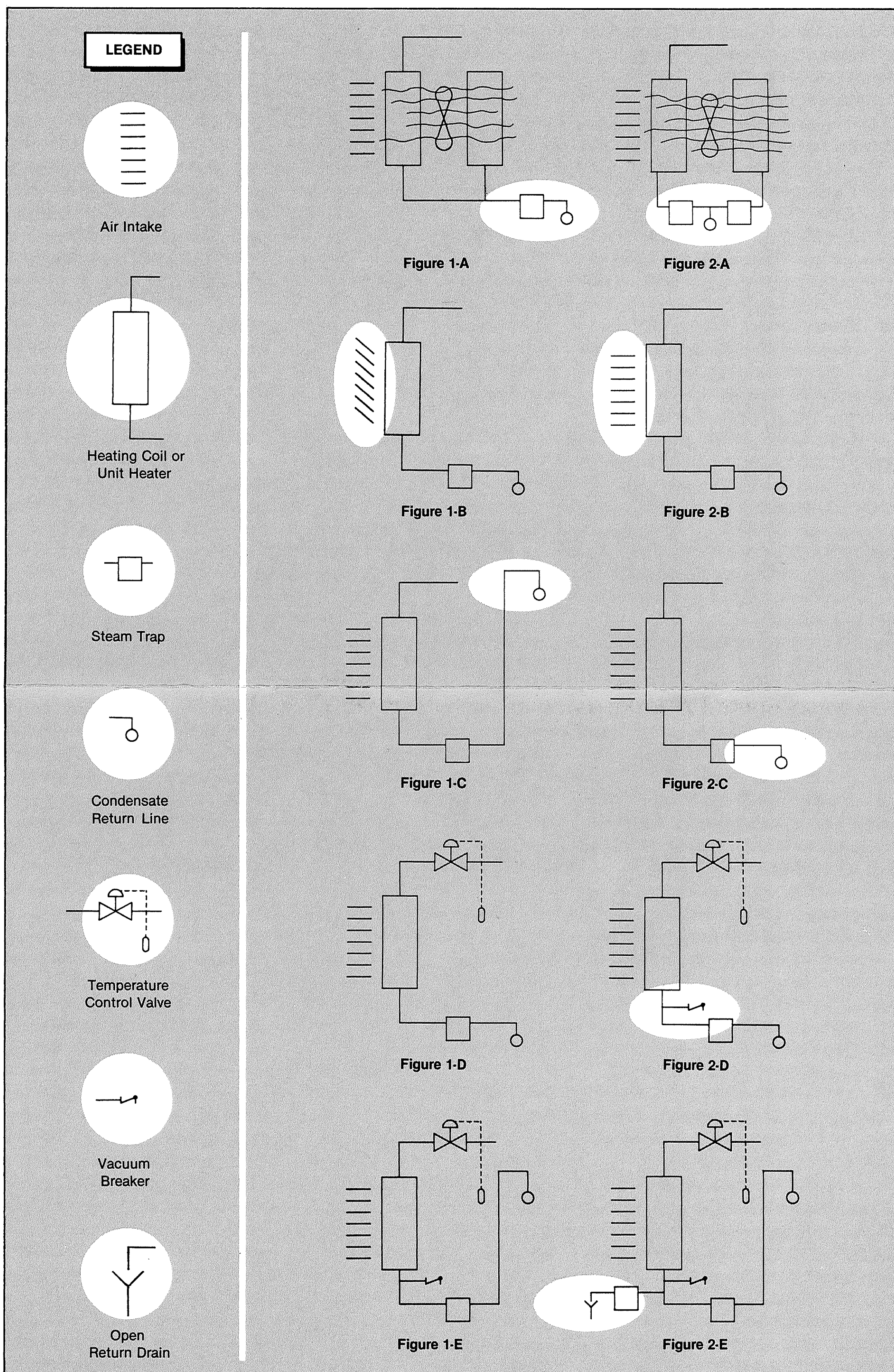
energy emphasis

Frozen steam coils: Five causes and the cures

□ Frozen steam coils are an annual industrial headache, north and south. Burst coils are expensive to repair or replace. Wasted steam through a leaking coil means wasted energy dollars. And the downtime means lost production and employee discomfort.

UNFORTUNATELY, the chance of frozen air make-up coils and unit heaters is greatest in dead of winter, when you can least afford it. That's because excessive demand on a steam system is likely to result in residual condensate in the heating coil, and that's a key element in many coil freeze-up situations.

The return of spring affords an opportunity to review those frosty problems of the past winter—and an opportunity to prevent it from happening again with the following discussion of the five most common causes of frozen coils, presented by Walter Deacon, Application Engineer at Armstrong Machine Works. It should be noted first, however, that steam trap failure is not generally a cause of frozen coils. But LACK of steam traps is a major problem. This is evident in. . . .



Problem #1: Two coils, one trap

In this situation, two (or more) coils share one steam trap. (See Fig. A-1) Though the coils are presumably running the exact same steam pressure, that isn't the case in the condensate drainage lines. That's because any difference in coil construction, air flow rate, air temperatures or dirt build-up will cause the coil steam side pressure drop to differ. A pressure drop difference too small to register on a pressure gauge is enough to let steam from one coil block the flow of air or condensate to the trap from the other coil. This "short circuit" gradually causes condensate to build up until it floods the coil with the lowest pressure at its outlet. And despite the proximity of live steam, any build-up of condensate will freeze if the temperature drops low enough.

Solution? Always use a separate trap for each coil. (See Fig. A-2) This holds true in every application, even process applications where freezing isn't possible, because many factors cause uneven pressure that will short-circuit the other coil or heat exchanger.

Problem #2: Uneven air flow

In this example, (see Fig. B-1), only one coil is involved but the cold air flow over it is not uniform. This can be due to louvers being partially opened, aiming the blast of cold air toward the bottom of the coil. The bottom coil tube or tubes will condense steam quicker than other tubes. This causes a condensate build-up and a steam pressure drop in that tube. The tube could eventually freeze, even if it is not totally flooded with condensate.

Solution? Make sure the air flow is even over the entire face of the coil. (See Fig. B-2) This can be done with any air velocity measurement device, such as a Pitot-static tube type. When uneven air flow is detected, a change in damper positioning, or even an air flow mixing device, is required.

Problem #3: Condensate elevated too high

Assume the steam pressure entering the coil is 5 psig. (See Fig. C-1) Coming out of the coil the pressure will necessarily have dropped somewhat to, say, 4.5 psig. In this case, the condensate must be elevated 15 feet to an overhead condensate return line. Since it requires approximately 1 psi of steam pressure to lift condensate 2 feet, it will require 7.5 psi to lift the condensate to the return line. Because we have only 4.5 psi, the condensate will back up, flooding the trap and the coil. This backed-up condensate can then freeze the coil. Solutions? 1. Increase the steam pressure. 2. Lower the condensate return. 3. Pump the condensate up to the return line. (See Fig. C-2)

Increasing the steam pressure isn't always feasible, especially in an older plant where the boiler may already be at capacity. Pumping the condensate is expensive. The best bet may be to reroute the condensate return line to a lower level. (Also see Problem #5).

Problem #4: Vacuum in coil

Here the steam is fed through a temperature control valve. (See Fig. D-1) At a pressure of 15 psig the steam is at 250 degrees F. Assume the steam heat load is reduced due to a brief January thaw, or a management decision to reduce the plant temperature. The control valve will then reduce the steam pressure to reduce the coil temperature. Assume a coil temperature of 205 degrees F is sufficient to maintain the desired air temperature. The steam pressure required to obtain 205 degrees F is below 0 psi.

Steam is still entering the coil but it is now condensing so fast that positive pressure does not exist in the coil. The result is a negative pressure in the coil. This negative pressure (vacuum) prevents the condensate from draining. The coil floods and is subject to freezing.

Solution? A vacuum breaker is needed on the discharge side of the coil, between the coil and the steam trap, or integral to the trap. (See Fig. D-2) A vacuum breaker is essential in any steam coil system exposed to freezing temperature, and many have them. Some of these have not been properly maintained, however. They are clogged with dirt and won't open. Or they've leaked a little steam and someone figured the best solution was to cap it off.

Problem #5: Vacuum in coil with elevated or pressurized condensate return

This system and the circumstances are nearly identical to that in Problem #4 except that the condensate return is elevated 15 feet. (See Fig. E-1)

In this case, even with the vacuum breaker open there isn't enough pressure to force the condensate 15 feet high. Eventually it will back up into the coil.

Solution? Install a second steam trap to serve as a safety drain. (See Fig. E-2) It should be installed higher on the system than the primary trap (or its inlet must be higher) so that the condensate will continue to flow through the primary trap under normal circumstances. When the pressure is reduced too low to force the condensate up the 15-foot return line, it will back up through the primary trap and up to the level of the safety drain trap. The condensate is discharged to the drain, which means there is an energy loss by not returning that hot condensate to the boiler. But this temporary energy loss is more than offset by saving the coil from freezing and bursting.

There are many other benefits from the proper installation and use of steam traps, but the elimination of frozen heating coils is one that will give your plant maintenance staff a warm feeling on a cold winter day.

Technical assistance provided—and free literature available from—Armstrong Machine Works, 3 Rivers, MI 49093.