Guide for Steam Condensate and Hot Water Service

General

This guide provides specific information about the material requirements, design criteria, assembly and testing methods recommended to assure a successful steam condensate return line or a hot water line such as for district heating or geothermal applications using Bondstrand pipe and fittings.

Material

Bondstrand Series 2000 pipe and fittings are suitable for steam condensate return service.[1,2] Joined using Bondstrand RP-34 or PSX™•34, this piping carries hot water safely at temperatures up to 250°F (121°C) when the system is properly designed and installed.

The BONDSTRAND FITTINGS AND ENGINEERING GUIDE[3] provides details on parts certified in accordance with Military Specification MIL-P-28584,[4] an RTRP specification written especially for steam condensate return service. Certificates are available on request.[5] Another military specification offers guidance on design and installation.[6]

In choosing parts for your system, Ameron suggests that you consider also the following:

1. Heavy-duty, filament-wound flanges are recommended in 2-, 3-, and 4-inch (50, 80, and 100 mm) diameter, particularly when systems are blocked or buried. In larger diameters, standard filament-wound flanges provide the necessary strength for this service.
2. As an exception to the use of filament-wound products, molded blind flanges are suitable for steam condensate service and are found on the approved list.[6]
3. For reductions in pipe diameter, Bondstrand filament-wound tapered body reducers are recommended over molded reducer bushings.
4. Tees are recommended for branching. Saddles for branching to either Bondstrand or steel lines are not recommended for steam condensate. Of course, saddles are excellent for supports and for in-line anchor details.[7]
5. Gaskets for both Bondstrand-to-Bondstrand and Bondstrand-to-steel flanged connections should be 1/8-inch (3 mm) thick full-faced gaskets using a suitable elastomer such as ethylene propylene rubber with a Shore A hardness of 60±5.
6. Connections to metal condensate piping are always made using flanges. Metal pipe should be blocked at points of connection to Bondstrand pipe to prevent metal pipe loads from being transferred to the Bondstrand pipe. This applies to drip leg connections as well as condensate lines.
7. Metal piping within manholes may facilitate positive anchoring and provide improved resistance to vibration, torque loads on valves and physical abuse.
8. Bondstrand maintenance couplings are recommended for repair of damaged lines where the ends cannot be separated enough to make a bell and spigot joint. (See **Field Repairs**.)

Systems Protected Against Live Steam

Bondstrand piping performs best in systems designed to carry condensate only in the liquid phase. In these systems, a vented receiver tank or "hot well" collects the condensate from the steam traps. From the tank, Bondstrand piping returns the condensate to the boiler by gravity flow if elevations permit or by a pump arrangement as in Figure 1. These systems are free of steam-induced water hammer and have been shown to perform for up to 20 years without evidence of significant deterioration.

Systems Exposed to Live Steam

Where hot wells are not feasible, other means of dissipating the energy in the drip discharge must be used. Except where possible to design steam transmission lines without steam traps,[8] it will be necessary to remove the condensate from the steam line at drip legs between the boiler and the equipment. Here complete protection against live steam exposure may not be possible, but must be kept to a minimum. Steam flashing within the lines tends to degrade the pipe liner over a period of time, particularly when this flashing also produces water hammer.

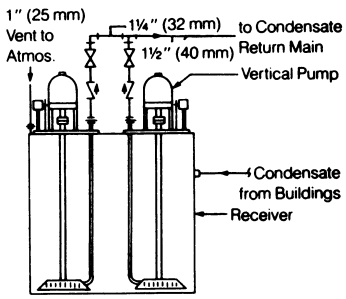


Fig. 1. Typical Hot Well for Pumped Condensate Return

Water hammer occurs in lines filled or partially filled with condensate. When a high temperature (>212°F or 100°C) condensate discharge from a trap is released into these lines, a portion of it flashes to steam. At the instant of release the pressure is nearly that in the steam line. The flash steam immediately formed at the new lower pressure expands greatly, even explosively, and a high-velocity pressure wave moves through the line.

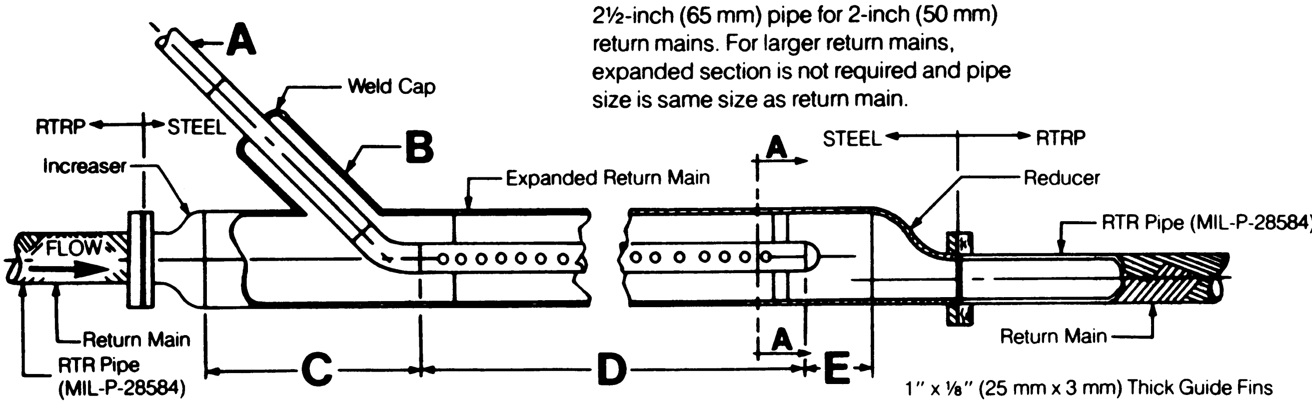
In an empty condensate line, the positive pressure wave would move rapidly through the line, and then, on cooling , collapse back to its original water volume, producing a similar negative pressure wave. With the line full or partially full of condensate, the high-velocity steam pressure wave may become a slug of water which is then slammed through the pipe in a manner destructive to both pipe and equipment. As the steam rapidly cools and recondenses, a reverse wave can develop.

The following steam properties outline the extent of this expansion and contraction. One ounce (28 grams) of steam occupying over 2900 cubic inches at 212°F (47,500 cc at 100°C) and atmospheric pressure will occupy only 1.8 cubic inches (30 cc) after condensing. The flash steam formed on discharge to atmospheric pressure of condensate at 25 psi (1.7 bar) is 5.7 percent by weight, and at 50 psi (3.4 bar) it is 9.0 percent.

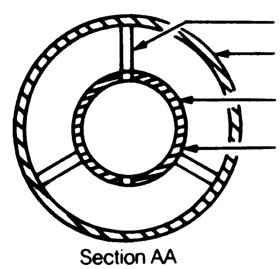
Where some exposure to flash steam is unavoidable, special precautions can be taken to alleviate the problem (see below). Remember, these precautions for systems with some exposure to live steam are not necessary for systems fully protected against live steam-that is, where the condensate temperature is below the boiling point and there are no drip leg connections.

Fig. 2. Detail for Typical In-line Steam Dissipation Chamber at a Trap Discharge Connection

Note: Expanded return main is made from 2½-inch (65 mm) pipe for 2-inch (50 mm) return mains. For larger return mains, expanded section is not required and pipe size is same size as return main.



A	Size, Trap Discharge Line	½" (15 mm)	¾" (20 mm)
B	Size, 45 Weld Nipple	1" (25 mm)	1¼" (32 mm)
C	Length of Expanded Main Ahead of Trap Discharge Pipe	7" (175 mm)	7" (175 mm)
D	Length of Perforated Pipe	16½" (420 mm)	16½" (420 mm)
E	Length of Expanded Main Following Perforated Pipe	2" (50 mm)	2" (50 mm)



All Pipe Shall Be Schedule 80

For ½-inch (15 mm) perforated tube, provide 40, ⅛-inch (3 mm) holes spaced 1½ inches (40 mm) on centers in 4 rows.
For ¾-inch (20 mm) perforated tube, provide 78, ⅛-inch (3 mm) holes spaced 1⅛ inches (28 mm) on centers in 6 rows.

Systems Exposed to Live Steam (cont'd)

1. Take care to assure a uniform grade line in the condensate lines. A gradient of not less than one inch drop in 40 feet (2 mm per m) in the direction of flow is recommended for both buried and suspended systems. Be aware that water-filled low points in the line, particularly those near steam traps, can greatly aggravate water hammer problems.
2. Select suitable traps and develop a program of regular maintenance. Features of trap design to consider should include:
   - minimizing the amount of condensate dumped per trap operation,
   - mode of failure, open or closed, and,
   - selection of the minimum workable size.

   Avoid the temptation to install bypasses; While maintaining traps, valve off the drip line.
3. Provide a dissipator at the steam trap from drip leg connections as shown in Figure-2. Developed by Mr. Bill Stevenson, an engineer with the General Services Administration, these widely used devices serve to absorb the initial shock of the steam flash as well as to quickly dissipate some of the heat energy. They are used in steel as well as RTRP condensate lines.
4. Do not undersize the return piping. Larger sizes dramatically reduce the velocity of the surge wave within the pipe and its potential for damage.

Corrosion Inhibitors

Where a corrosion inhibitor is required to prevent attack on steel components of the piping system, morpholine is recommended. Other amine additives such as cyclo-hexylamine, may cause degradation of the pipe liner if used in concentrations in excess of 1000 parts per million.

Layout of the Buried System

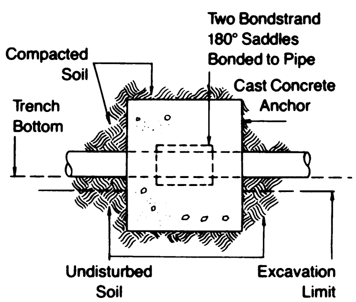


Fig. 3. In-Line Anchor

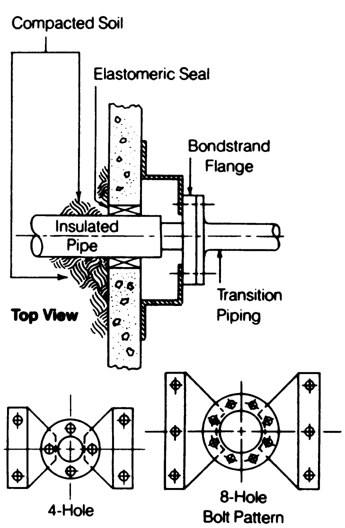


Fig. 4. Anchor Inside Manhole or Wall Penetration

Buried condensate and hot water systems operate at temperatures that normally require anchor blocks at valves, turns and branches. The temperature-induced stress in the blocked Bondstrand pipe will be absorbed in the pipe.[9,10] For lines bedded directly in soil, the designer should not expect that expansion will be absorbed as movement at turns, by expansion loops or by expansion joints.

At lower temperatures (<180°F or 82°C) for short runs (<10 ft. or 3 m) from anchor to fitting, and in poor soils (<1000 psf or 48 kN/m^2), anchor blocks may not be required. However, these are special cases and should be carefully analyzed before the decision is made to install the lines without anchor blocks.[11]

In certain locations it may be necessary to place equipment such as pumps, valves or steam dissipation chambers in restrained lines. Equipment replacement or repair, or flange gasket replacement, will then be necessary from time to time. On heat-up, normal thermal expansion produces a compressive longitudinal load in the restrained Bondstrand pipe. Over a period of time this causes a shortening of the pipe such that, unless the flanges are anchored, flanged joints often separate an inch or more when cooled down and disassembled. This makes reassembly potentially difficult.

Reassembly will be much easier if the Bondstrand inlet and outlet lines are suitably anchored at manhole and building wall penetrations. This can be done using an in-line anchor block outside the wall as shown in Figure 3 or a steel anchor inside the wall as shown in Figure 4. Good soil compaction under the lines around the manholes is necessary so that excessive settlements cannot damage the pipe.

In some locations the stability of the soil under the pipe at penetrations cannot be assured. Soil movements can produce excessive shearing loads on the pipe at the interface to the fixed penetration. Here the anchor should be moved three to five feet from the penetration and the penetration itself sleeved and sealed around the pipe.[12]

As an alternative to sealing between the pipe and sleeve with a "firm but pliable mass, " a Link-Seal* provides an elastomeric seal by means of a preformed modular unit which is bolted into place. These units may also be used to seal pipeline casings at road crossings.

The detail of Figure 3 must not be used to resist the expansion and thrust of restrained steel lines. Connecting steel lines should be both anchored and supported to avoid transferring excessive loads to the Bondstrand pipe.

Refer to Ameron literature[11, 12, 13] for helpful information on the design and placement of anchor blocks at buried fittings. The properties of Bondstrand pipe at elevated temperatures are such that thrust blocks must be designed to resist both tensile and compressive loads.

Layout of the Suspended System

Suspended systems are generally designed using expansion loops rather than thrust blocks, in part because the required supports are more economical when the pipe is allowed to move freely.[7] Anchors between the loops are required, of course, to control the position of the runs.

Some layouts are simply too restricted to permit the use of loops.Large diameter casings or tunnels are examples. The line may have to be blocked and guided to keep it from “snaking,” or expansion joints may be used.

Assembly

Bondstrand pipe, fittings and flanges in condensate and hot water systems should be assembled in accordance with Bondstrand assembly instructions and heat blanket cure times should be 60 minutes for pipe joints and flange mountings, and 75 minutes for joints or fittings.

Field Test

Simple hydrostatic testing of installed Bondstrand pipe and fittings to 150 psi (10 bar) or to 1.5 times working pressure for four hours is usually sufficient to assure proper performance. Testing of a buried system is best accomplished prior to placing backfill and blocking.

In every installation operating at an elevated temperature, maximum reliability is served by heating the system slowly the first time. A temperature rise of not more than 20°F (11°C) per half hour generally will relax fabrication stresses and ensure optimum pipe and joint performance.

Field Repairs

Repairs of leaking pipe, whatever the cause, should be made by removing the faulty section or a short length containing the fault, not by overwrapping the fault with any type of patch or other material. If a joint is damaged during the laying operation, it should be cut off and a coupling bonded to the cut-off end and laid in the line as a normal pipe.

If the damage occurs to an installed pipe which is blocked or otherwise restrained from movement, the section to be repaired is cut out of the existing system and replaced by inserting a length of new pipe or a new fitting or assembly in place of the damaged part. The required buttend joint may be made using a Bondstrand maintenance coupling.

References

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Important Notice

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