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Guide for Steam Condensate

This guide provides specific information about the material requirements, design criteria, assembly and testing methods recommended to assure a successful steam condensate return line installation.

Materials: Series 2000 filament wound FRP composite pipe has proven particularly suitable for steam condensate joined with the Series 2000/4000 filament wound FRP fittings. Joined using PSX-34 epoxy adhesive, these products can carry hot condensate water safely at temperatures up to 250ºF - when properly designed and installed.

In designing your steam condensate system, you should use:

1. Heavy duty hubless style filament wound FRP flanges for 2", 3", 4", and 6" diameters, particularly when piping systems are blocked or buried. In larger diameters, standard hub style filament wound FRP flanges provide the necessary strength for this service. Although for extra "peace of mind", the heavy duty flanges may also be preferred for the larger sizes.

2. Filament wound tapered body reducers for reduction in pipe diameters - instead of molded FRP reducer bushings.

3. Tees instead of saddles for pipe branching. Saddles for branching to steel lines should never be used for steam condensate. Saddles are excellent for pipe supports and in-line anchors.

4. Full faced 1/8" thick rubber (ethylene propylene or other suitable elastomer) gaskets with a Shore A hardness of 60 ± 5 for FRP flanged connections.

5. Flanged connections where FRP composite pipe is joined to metal condensate piping. This is a **must**. Metal pipe should be blocked at points of connection to the Series 2000 FRP composite pipe to prevent metal pipe loads from being transferred to the FRP pipe. This requirement applies to drip leg connections as well as condensate lines.

6. Metal pipe within manholes to achieve positive anchoring and resistance to vibration, torque loads on valves, and physical abuse.

7. Industrial Fiberglass' maintenance couplings for repair of damaged lines where the ends cannot be separated enough to make a bell and spigot joint. (See section on Field Repairs below.)

Systems Protected Against Live Steam: FRP composite piping performs best in systems designed to carry condensate only in the liquid phase. In these systems, a vented received tank or “hot well” collects the condensate from the steam traps. From the tank, the Series 2000 FRP composite 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 evidencing 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, it will be necessary to remove the steam condensate from the steam line at drip legs between the boiler and the equipment. Complete protection against live steam exposure may not be possible, but such exposure must be kept to a minimum. Steam flashing within the condensate lines tends to degrade the inner pipe corrosion liner over a period of time, particularly when this flashing also produces water hammer.

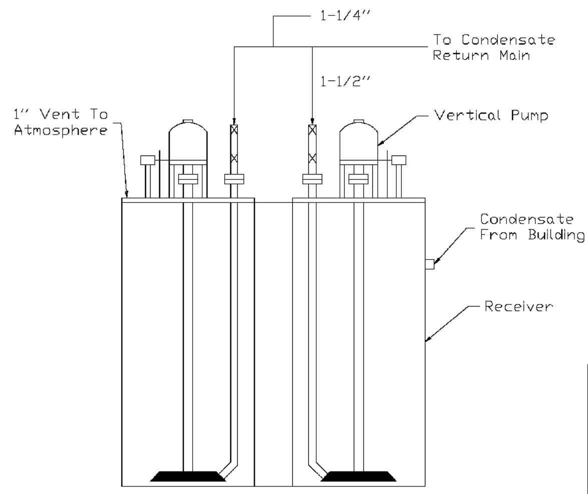

Figure 1 - Typical Hot Well for Pumped Condensate Return

Water hammer occurs in lines filled or partially filled with condensate. When a high temperature (>212ºF) 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 of 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 in reverse. 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 re-condenses, a reverse wave can develop.

The following steam properties outline the extent of this expansion and contraction. One ounce of steam occupying over 2900 cubic inches at 212ºF and atmospheric pressure will occupy only 1.8 cubic inches after condensing. The flash steam formed on discharge at atmospheric pressure of condensate at 25 psi is 5.7 percent by weight, and at 50 psi it is 9.0 percent.

Where some exposure to flash steam is unavoidable, special precautions must be taken to alleviate the problem. 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.

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 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 steam traps and develop a program of regular maintenance. Features of trap design to consider should include:

   A. Minimizing the amount of condensate dumped per trap operation
   B. Mode of failure, open or closed
   C. Selection of the minimum workable size
   D. Avoid the temptation to install bypasses
   E. While maintaining traps, valve off the drip line

3. Provide a "dissipater" at the steam trap from drip leg connections as shown in **Figure #2 (attached)**. 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. These dissipaters are used in steel as well as FRP composite condensate lines.

4. Do not undersize the return piping. Larger pipe sizes dramatically reduce the velocity of the surge wave within the pipe and therefore 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 cyclohexylamine, may cause degradation of the FRP composite pipe liner if used in concentrations in excess of 1000 parts per million.

Layout of the Buried System: Buried condensate systems operate at temperatures that normally require anchor blocks at valves, turns and branches. The temperature induced strain in the blocked FRP pipe will be absorbed as stress in the pipe. In these layouts, no expansion will be absorbed at turns, by expansion loops or by expansion joints.

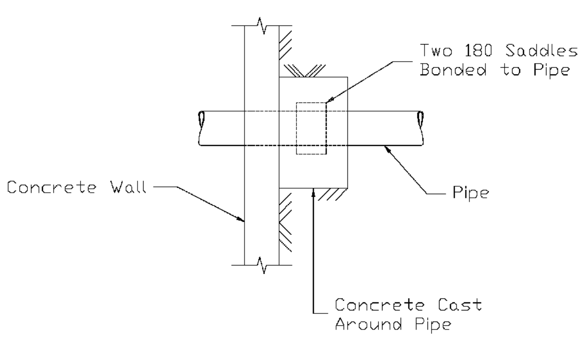

Figure 3 - Detail of Anchor Restraint at Wall and Manhole Penetrations in Buried Systems

At lower temperatures (<180ºF), or for short runs (<10 feet) from anchor to fitting, and in poor soils (<1000 psf), anchor blocks may not be required. However, these are special cases which should be carefully analyzed before the decision is made to install buried steam condensate lines without anchor blocks.

In certain locations it may be necessary to place steam and condensate equipment such as pumps, valves and steam dissipation chambers in restrained lines. Equipment replacement or repair or flange gasket replacement will then be necessary from time to time. Because FRP composite pipe in hot systems tends to shorten in length over time, reassembly of flanged joints can be a problem. To avoid this, provide a short horizontal loop within the manhole. Then anchor both inlet and outlet lines where they penetrate the manholes as shown in Figure #3. Good soil compaction under the lines entering such manholes is necessary so that excessive settlement does not damage pipe at these fixed in-line anchors.

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

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 pre-formed modular unit which is bolted into place. These units may also be used to seal pipeline casings at buried road crossings.

The detail on Figure #3 shows a means which may also serve to anchor pipe at below-grade building wall penetrations. At either building wall or manholes, this method 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 expansion loads to the FRP pipe.

Contact Industrial Fiberglass for information on the design and placement of anchor blocks at buried fittings. The creep properties of FRP 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. Anchors between the loops are required 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 such examples. The line may have to be blocked and guided to keep it from "snaking", or expansion joints may be used.

Assembly: Series 2000 FRP pipe, fittings and flanges in condensate systems should be assembled in accordance with current Industrial Fiberglass assembly instructions. Heat blanket cure times should be 60 minutes for pipe joints and flange mountings, and 75 minutes for the joints of fittings.

Field Test: Simple hydrostatic testing of installed FRP composite pipe and fittings to 1-1/2 times working pressure for two hours is usually sufficient to assure proper performance. Testing of buried pipe systems should be done 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 per half hour generally will relax fabrication stresses and ensure optimum pipe and joint performance.

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Field Repairs: Repairs of leaking pipe, whatever the cause, should be made by removing the faulty section or a short length of pipe containing the fault, not by over-wrapping 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, then laid in the line as a normal length of pipe.

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

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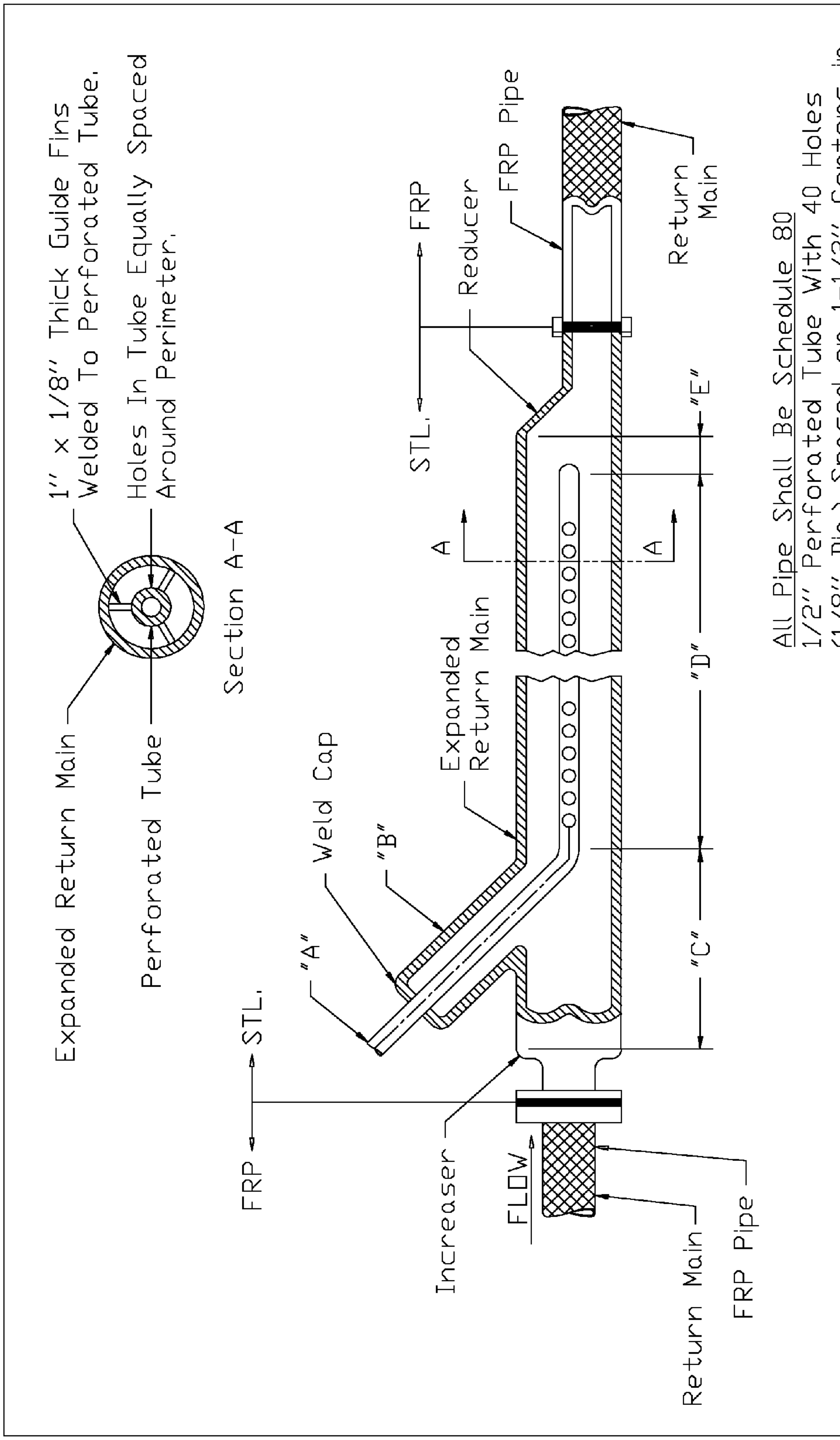

All Pipe Shall Be Schedule 80

1/2" Perforated Tube With 40 Holes (1/8" Dia.) Spaced on 1-1/2" Centers in 4 Rows.

3/4" Perforated Tube With 78 Holes (1/8" Dia.) Spaced on 1-1/8" Centers in 6 Rows.

A	Size, Trap Discharge Line	1/2"	3/4"
B	Size, 45 Weld Nipple	1"	1-1/4"
C	Length of Expanded Main Ahead Trap Discharge Pipe	7"	7"
D	Length of Perforated Pipe	16-1/2"	16-1/2"
E	Length of Expanded Main Flowing Perforated Pipe	1/2"	2"

Return Main Size	2"	3" & Over
Exp. Ret. Main Size	2-1/2"	Same Size

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