# The evolution of primary/secondary pumping

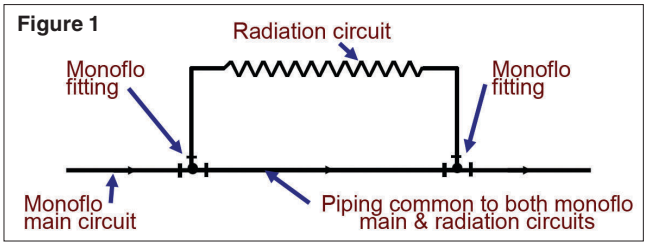
*by George Carey*

Although it has been around since 1954 when Gil Carlson, who worked at Bell & Gossett, presented it to the engineering community, Primary/Secondary Pumping has become increasingly popular over the last five years or so. The applications for this piping technique are numerous, but first let's look at the basic premise.

### The Essence of Primary/Secondary Pumping

When two piping circuits are connected, flow in one circuit will cause flow to occur in the other circuit, based upon the pressure drop in the piping common to both circuits. This describes exactly how a monoflo system is supposed to operate. Flow in the primary main will cause some flow to occur in the monoflo circuit due to the pressure drop of the monoflo fittings in the piping common to both circuits. (See Figure 1) What Gil discovered, some 50 years ago, was if the pressure drop in the piping common to both circuits was eliminated, flow in one circuit will not necessarily cause flow to occur in the other circuit.

**Figure 1**



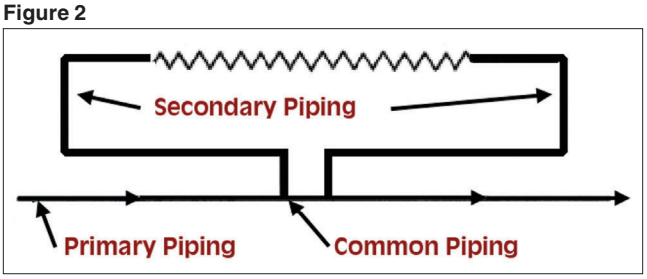

That is the basis for Primary/Secondary Pumping; the pressure drop in the common pipe *has* to be designed for a minimum amount of resistance. By keeping the pressure drop very low, you have hydraulically isolated one loop from the other. Therefore, each loop's circulator can operate as if the other circulator does not exist. The benefit of this is you can have different size circulators co-existing without pumping problems. You can isolate flow through the off circuits by simply turning off that particular circuit's pump. You can prevent heat from traveling into off circuits (boilers, radiation zones, etc.). The spacing of the supply and return tees for each secondary circuit is critical. By keeping the tees close together (maximum 3-4 pipe diameters apart), the pressure drop between the tees is almost negligible. (See Figure 2)

Therefore, as the primary pump is circulating water along the main, the water will not flow through the secondary circuit if its circulator is off. You have successfully isolated one circuit from the other.

### Law of the Tee

Gil used to say that to fully understand primary/secondary pumping, you had to understand the concept of "*the law of the tee.*" What he was referring to is what happens in the common piping. The flow rate and the direction of the flow rate that occurs in the common pipe needs to be discussed. Because we have hydraulically isolated one circuit from the other, we can have different flow rates occurring in each circuit. These different flow rates will meet in the common piping. What occurs there can be very interesting. The flow in the primary piping can be greater than the flow in the secondary circuit; the flow rates can be equal and the secondary flow rate may be greater than the primary. What is the significance of all this? Well, with different flow rates coming together in this "common pipe," mixing of water temperatures is going to occur. And depending upon the flow rates of the primary circuit versus the secondary flow rate, you can mix down supply water temperatures that are going to the secondary circuit. You can elevate the return water's temperature going back to the primary main. The possibilities are endless and that is one of the reasons why a system designed with primary/secondary pumping can achieve what other more traditional systems cannot.

**Figure 2**




Fast forward to today's modern hydronic heating systems: multiple boilers, multiple water temperatures, different types of heating terminal units in the same heating system (fan coils, baseboard, panel radiators and radiant heating). All of these applications can and do incorporate some form of primary/secondary pumping. To keep up with these modern systems, a few manufacturers have introduced a modern primary/secondary arrangement called a "*Low-loss Header.*" This new device simplifies the P/S piping circuit and also eliminates a few other necessary components. (See Figure 3)

These low-loss headers (meaning these very low pressure drop devices) have become a combination air separator, dirt collector and most importantly, a manifold that creates stand-alone primary and secondary circuits.

### How do they Work?

These primary/secondary headers efficiently separate the primary and secondary circuits by acting as a set of "closely spaced tees," the piping arrangement you would normally see in a traditional primary/secondary piping system. In addition

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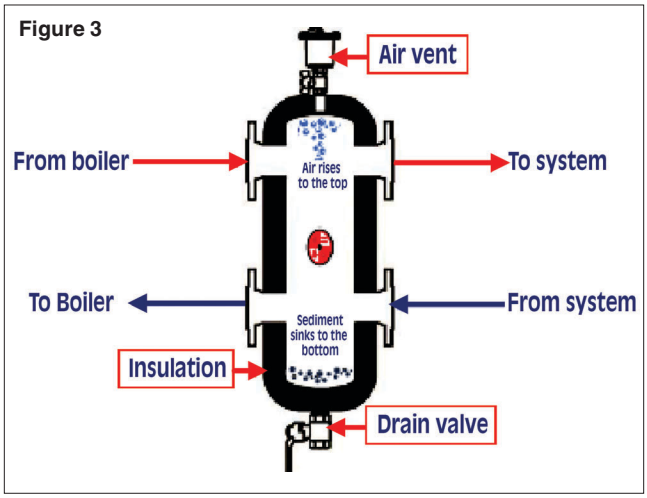
**Figure 3**



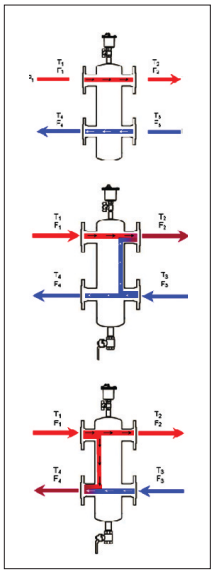

to that, these engineered devices also act like air and dirt separators. Its design is to create a low velocity area that allows:

1) independent operation of primary and secondary circulators without "bumping" into each other
2) air bubbles to rise to the top and vent out through the float vent
3) any sediment floating around in the piping system to sink to the bottom and be blown out through the drain-off valve.

There are three possible flow paths that are all dependent on the flows within the primary and secondary circuits. If you look at Figure 4, you will see a line drawing depicting the three possibilities.

The first example shows where the flow in the primary circuit is equal to the flow in the secondary circuit. In this situation, the flow and temperature from the boiler become the flow and temperature to the distribution system. The hot water from the boiler remains at the top and exits out the top system-side port (red arrow). A similar situation occurs at the bottom two ports. The flow rate and temperature from the system is the flow and temperature back to the boiler…there is no mixing going on in this scenario.

**Figure 4**



The second example shows a system where the flow rate in the secondary circuit is greater than the boiler/primary flow rate. Because the flows are no longer balanced, the temperature of the water going to the secondary/system circuit is no longer the same as the boiler's temperature. This is because of the mixing that takes place within the primary/secondary header. (Just like in the common pipe of a traditional primary/secondary piping system.)

Because the greater flow rate is coming from the secondary/system circuit (blue arrow), a portion of its return water blends with the flow and temperature coming from the primary/boiler circuit. This mixing creates a "mixed" supply temperature (lower than boiler water and warmer than the system's return temperature).

The third and final example shows a system where the flow rate in the primary/boiler circuit is greater than the secondary/system circuit. This is another unbalanced flow rate example. This time, the flow rate in the system is less than the boiler's flow rate. Therefore, a portion of hot boiler water will "blend" with the cooler system return water, thus raising the temperature of the water entering the boiler(s). This can be a good thing when you are trying to protect the boiler from colder return temperatures. But it can also lead to boiler short cycling if the boiler output far exceeds the system's requirement. Proper control of the boiler firing is necessary for good, efficient operation.

The next time you are faced with piping a multiple boiler application, and you want to pipe them correctly, you would be wise to at least consider trying one of these "low-loss" headers. They hydraulically isolate the boilers from the system conveniently; separate and vent air from the system; collect dirt and sediment from the system; simplify what can be considered complicated piping and reduce installation and labor costs by reducing the number of fittings and piping required.

If you have any comments or questions please call me at 800-423-7187 or email me at gcarey@fiainc.com.

PS: I would like to take the opportunity here to congratulate my father on his retirement. By the time this article is published, he would have retired on March 28, 2008 from Glen-Mor Fuel Company, a branch of Petro (Petroleum Heat & Power). He headed up their service and installation division for the past 10-12 years. In that time he created a very dynamic and proud group of oilheat technicians. He became a disciple of Dan Holohan and his teachings and introduced them to the installation crew. They quickly embraced the piping techniques that my father had learned for both hot water and steam boilers. Over the years, the company's reputation for installing first class systems that functioned properly has been noted throughout the industry. (Real Estate Management companies, wholesalers, boiler manufacturers, etc.)

On a personal level, he has been very influential in my career. When I graduated college, I had visions of taking the summer off; hanging out at the beach with my friends…he had other ideas. He cut out an ad from the Sunday paper and handed it to me. It was from a local wholesale distributor looking for an inside sales position. He suggested I conduct an interview with this company, you know… "just to practice taking interviews while you're enjoying the summer," he said. Sounded innocent enough to me…until I came home from the first interview with a job! I complained that I didn't go to school to work in the heating business. He said that everybody in New England needs heat…especially in the winter! So much for hanging out on the beach.

Twenty some-odd years later, I have been lucky enough to work in the same industry as my father. He has taught me a lot…about the industry, people and life. He has consistently shown me what's really important in life and what's NOT. At various family parties or dinners, inevitably he and I would end up in the kitchen with a couple of cold beers, allegedly "doing the dishes," but really we would be discussing some funky old steam system that was driving the oil company crazy or laying out a multiple boiler hot water job on a paper napkin in the kitchen pantry. Of course, the rest of my family thought we were both nuts for wanting to do the dishes…we looked at it differently…this was our chance to get away from everyone else!

Congratulations, Dad, on your retirement…you deserve it!

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