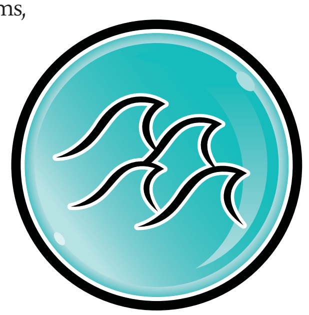
Yes, balancing is important!

Whenever you hear of a building where occupants are constantly complaining about poor temperature regulation, it's a pretty safe bet that the HVAC system is not properly balanced.

Air

There are two sides to hydronic HVAC system balancing, the air side and the water side. The output of any terminal unit, be it a baseboard radiator, coil, or water-source heat pump, is directly related to the change in temperature of the air and the fluid flowing through it. The change in temperature of these mediums, among other things, is a result of their respective flowrate. So there we have it, for an HVAC system to perform properly, the flowrates have to be right.



Water

Some camps profess that if a system is designed properly, and the construction is executed properly, and the control system is designed, installed, and programmed properly, no additional provision for fluid flow balancing is required. Question: Then why wouldn't we also suggest that pressure testing isn't required?

If we accept two principles: "Everything else being equal, a fluid will follow the path of least resistance" and, "To err is human"; it doesn't take much of a stretch to understand why the "no balancing" approach often ends up as an exercise in "correction by litigation."

Photo: Runtal

Design Conditions

Diagram 1 illustrates a typical 250-ton chiller under design conditions. When the system is running wide open, at least 100 gpm has to be available to each floor's terminal units. At this flowrate, the delta T (change in temperature) of each floor, and hence across the chiller plant is 10F.

Under these conditions, the chiller plant delivers 100 per cent of its design capacity, delivery 600 gpm of chilled water to the building. So how often does a system need to run at capacity? If we only consider design day conditions, the answer would be about 2.5 per cent of the time. However, when we also consider the implication of night set-back reset, capacity demand may be called for every day of the year!

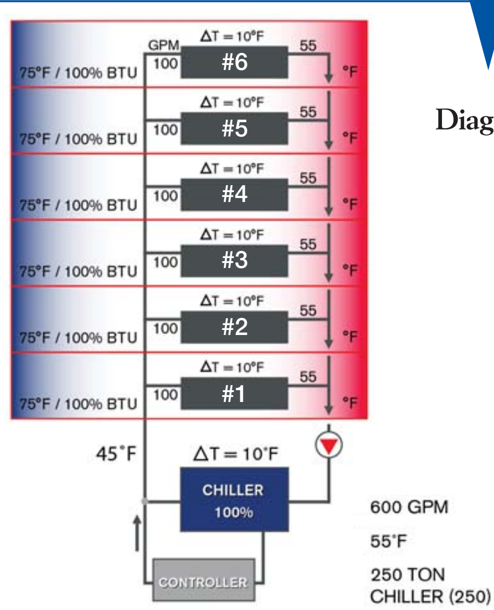


Diagram 1

Seeing what happens within a properly balanced HVAC system, running as the designer intended, let's look at Diagram 2, which shows what happens within an unbalanced system.

An Unbalanced System

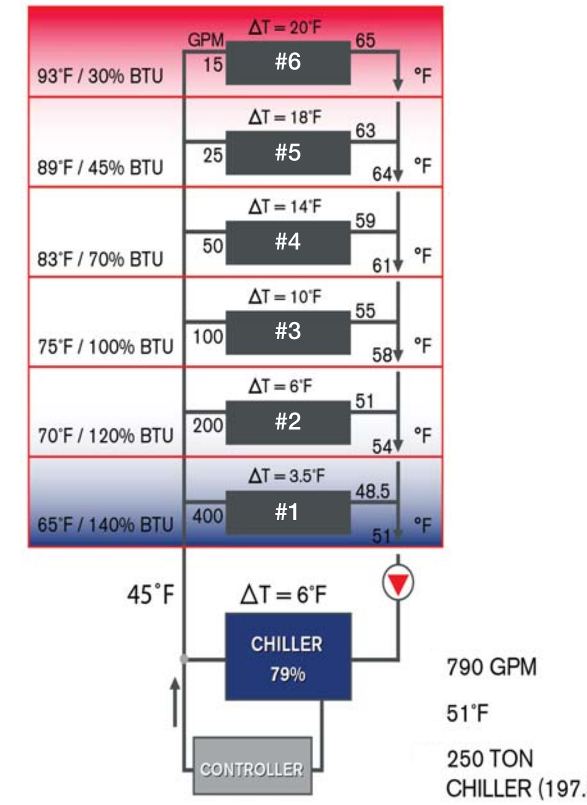
Diagram 2 illustrates what happens in a building when no attention is paid to balancing the flow of hydronic fluid to the various floors.

Let's assume the target temperate is 72°F and the night setback just reset from 75°F. Immediately, there is a demand for cooling for every floor. However, because the system is not balanced, following the path of least resistance, the terminal units of the lower floors receive the majority of fluid flow.

Meanwhile the terminal units on the upper floors are starved. Because of the short retention time, the delta T across the lower floor terminal units is well under design, whereas the delta T on the upper floors is well over, with the resultant system delta being only 6F.

Now we have a 250-ton chiller delivering only 197.5 tons of cooling capacity, operating at only 79 per cent of design. At the same time, more energy is consumed to deliver 790 gpm to the building, instead of the 600 gpm intended. The higher flowrate results in increased flow velocity through the chiller plant, increasing the risk of noise, erosion, and reducing the life expectancy of the most expensive part of the HVAC system.

Diagram 2



In the example shown in Diagram 2, for anything less than a design day, eventually demand for lower floors will be met and control valves will shut down allowing more flow to less advantaged terminal units. However, it may take several hours for the building to stabilize. Without provision for balancing the HVAC system, the building manager has little recourse.

FAST FACT

The heat transmitted by a terminal unit depends on the supply water temperature and the water flow.

When a hydronic HVAC system is properly balanced, the minimum design flow is available to each and every terminal unit. In a future article we'll investigate what happens when more than design flow is available.

Rod Brandon is a technical marketing specialist with S.A. Armstrong Limited. He can be reached at rbrandon@armlink.com.

Advantages of HVAC System Balancing:

- Engineer's design intent met;
- Design/construction errors detected early;
- Maximum plant capacity realized;
- Optimum efficiency (energy savings);
- Prolonged system life expectancy;
- Reduced flow-velocity-induced noise;
- Maintenance cost savings;
- Improved occupant comfort;
- Higher productivity/fewer errors;
- Fewer temperature regulation complaints;
- Higher tenancy rates and lower turnover; and
- Lower advertising, showing, renovation costs.