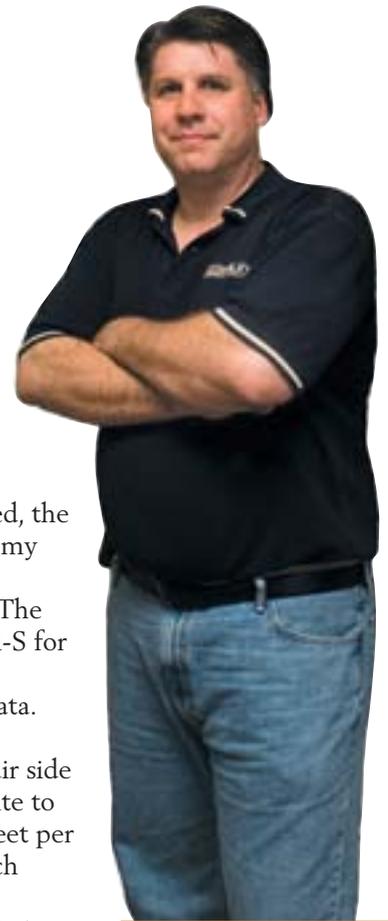## HYDRONICS

FROM THE FIELD

Mechanical Design – Part I

BY **DAN FOLEY** CONTRIBUTING WRITER

I have received several inquiries from readers asking how I design my projects. I offered to address this question in a future column. First, this begs the question: Which type of design? Is it hydronics, radiant, forced air, geo, AC, chilled water? I use different design methods for different types of systems. Also, the design of a small addition will be different than that of a 20,000 square foot new home. Since about half of my business, by dollar volume, is from the design and installation of mechanical systems for new custom homes, I will focus on the design of these types of systems here.

All of my mechanical designs start with a load calculation, commonly referred to as a Manual-J or a J-Calc after the Air Conditioning Contractors of America (ACCA) developed load calculation method. This calculation is the basis for the mechanical design. It not only sizes the equipment, but it also determines the amount of heating and cooling provided to each room as well as the duct/pipe size, emitter size and air/water flow required. It is critical that this step is performed accurately.

I first learned to perform load calculations by hand at an ACCA seminar almost 25 years ago. From there, I gravitated to a DOS based computer program based on ACCA Manual-J. I now use the Right-Suite program (www.wrightsoft.com) that automates the current Manual J-8 version. There are many other programs available based on the ACCA Manual-J, as well as the ASHRAE method and the Canadian CSA standard. As

out over the background drawing. Floor, wall and roof structures are entered through drop down menus.

Once an accurate heat loss is performed, the next step is to select the equipment. On my larger projects, there may be multiple selections of equipment based on zones. The Right-Suite program uses ACCA Manual-S for equipment selection using a database of manufacturer equipment performance data. Once I have selected the proper size equipment, I split up my design for the air side versus the hydronics side. I use Right-Suite to size the ductwork, airflow CFM (cubic feet per minute), and supplies and returns for each room using ACCA Manual-D. I use the manufacturer data to determine the right size blower and total external static pressure available. From there, the Right-Suite program can calculate supply and return trunk sizes, branch sizes and register and grille sizes to deliver the proper airflow to each room.

Right-Suite has a radiant module that can design radiant systems as well. I have tried this, but found it to be difficult to use, hard to edit and not intuitive to my design method. For my hydronics design, I use several programs. For radiant design, I use Uponor's Advanced Design Suite (ADS). The ADS requires that the data be entered a second time but it is so quick and easy to use this software that I don't consider this to be a hardship.

Once the data is correctly entered and the installation method is determined (slab, staple-up, plates, etc.), the ADS output gives me the information I need to design a radiant system: heat loss by room, number of loops, pipe size, on-center dimension, loop length and flow rate. It also allows me to play "what if?" For example, what happens if I go from 6 to 9 inches on center? What happens if I increase the maximum loop length from 250 to 300 feet? What if I put three loops instead of two into a room? What happens if a room has hardwood flooring instead of tile?

These "what if" exercises allow me to fine tune my design. I can massage the design to allow me to specify standard, readily available products. For example, I may have a design that specifies a certain flow rate and head loss that requires a high-head pump that may be expensive

Figure 1: An example of the Manifold View of a Radiant Design report.

my local jurisdictions require load calculations based on the ACCA Manual J-8, I will focus on that method.

The Right-Suite program allows you to import an AutoCAD plan view of the house, which increases the speed and accuracy of the calculation process. The alternative method of scaling the plans by hand and entering in the data is tedious and less accurate. Once a CAD plan view is imported, the rooms are quickly traced

or available only by special order. I may go from 3/8 inch tubing to ½ inch tubing, or from three 400 feet loops to four 300 feet loops to get the flow/head calculations to match a standard pump. I may also go to tighter spacing with shorter loops to get a supply water temperature as low as possible to maximize the efficiency of a condensing boiler or a geo system. This program allows

| FROM THE FIELD | CONTINUED FROM PAGE 40

Figure 2: An example of a LoopCAD drawing.

from your favorite tubing manufacturer to create material lists. This program can create scaled drawing outputs set to whatever scale and paper size you desire. An example of a LoopCAD drawing is shown in Figure 2 to the left.

There are a few limitations with this software. Square or rectangular rooms are a piece of cake but odd-sized rooms, angles and curves can cause it to do strange things. It is often quicker and easier to manually draw the loops in these types of rooms, which the program allows. Going back to edit a design can be a chore, but I'm sure I would get more proficient if I used it every day. I will say that it is a quick and easy way to generate a tubing layout very similar to what a manufacturer or CAD draftsman would create. It is also very easy to format the output for use in other drawing programs.

I have found that while the tubing layout drawings look impressive, they are typically requested by the clients, engineers and architects. My installers prefer the simplicity of the ADS radiant design report when they are installing systems. The larger tubing layout plots seem to get lost on the job or thrown away, while the smaller 8-1/2 by 11 inch design reports tend to stay in the job folders.

Another program I use on a regular basis is Taco's Hydronic System Solutions (HSS), which I use to model my hydronic systems. I use it to size piping, pumps, heat emitters, expansion tanks and hydronic accessories, such as air separators, heat exchangers, control valves and hydraulic separators. I also use this program to size the piping and pumps for my geo projects. This is a powerful program that calculates flow rates and pressure drops through the system allowing for accurate component sizing and specification. It allows the designer to specify various piping materials including copper, steel, CPVC, PEX and even newer piping materials such as Aquatherm. Best of all, the program can be downloaded, free of cost, at the Taco website (www.taco-hvac.com). The output is easily converted to a PDF or can be imported into other drawing programs. Tune in next month for Part II. I will share how I use the design data and reports outlined above in a complete mechanical design. ●

you to easily change parameters to see what results from the changes, allowing you to create an optimum design.

ADS will also calculate the flow rate and head loss of the supply/return mains from the boiler room to the manifold location. This takes the guesswork out of pipe and pump sizing. We will typically run our mains to remote manifold locations with insulated Pex-Aluminum-Pex composite pipe. I often find that I can run 5/8 inch or even ½ inch tubing without exceeding the pump or flow limitations, and making the installation much easier.

ADS has several output reports that can be helpful. The two that I use most often are the Quotation Report and the Radiant Design Report. The Quotation Report creates a material list with part numbers and list prices. I use this report for pricing as well as creating a PO to order materials from my supplier. The second report I use extensively is the Radiant Design – Manifold View. I give this report to my crew when they are installing the radiant system. It gives them information on the installation method, number of manifolds and zones, tubing sizes, loop lengths, on center dimensions, flow rates and required supply water temperature. I use this report more than any other. An example of this report is shown in Figure 1 on page 40.

Just about every tubing manufacturer offers a design software program with similar outputs. I use ADS because I have used it for the last 15 years and I can use it quickly and easily. But, other programs can do the same.

Many of my jobs are for architects and require a tubing layout drawing. Most manufacturers can provide this, but often it is for a fee and may require some lead time. I have used several drawing programs with mixed results. Right-Suite has this capability but I have found it difficult to use, hard to edit and all but impossible to import into other drawing programs or convert to other formats.

For scaled loop layouts done in house, I use LoopCAD software (www.avenir-online.com). It is fast, simple to use and reasonably priced. This program will automatically create tubing layouts for each room. You can import data

Dan Foley is president and owner of Foley Mechanical, Inc. based in Lorton, Va. (www.foleymechanical.com). FMI specializes in radiant, hydronic and steam systems, as well as mechanical systems for large custom homes. He can be reached at (703) 339-8030 or dfoley50@verizon.net