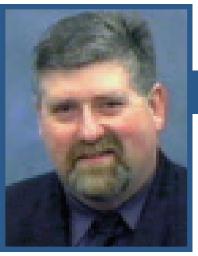
plumbing

BY MARK EVANS



PIPE SIZING IN A MODERN WORLD

Pipe sizing for potable distribution systems is relatively straight forward and not an area where the National Plumbing Code of Canada (NPC) allows much latitude or room for interpretation. In fact, potable distribution pipe sizing is virtually prescribed in all plumbing codes, but it is still worthy of some discussion and an exploration of the issues and developments that have led us to where we are today.

In Chapter 35 of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) *2001 Fundamentals Handbook*, the following observation on pipe sizing is made: "Two related but distinct concerns emerge when designing a fluid flow system; sizing the pipe and determining the flow-pressure relationship. The two are often confused because they can use the same equations and design tools. Nevertheless, they should be determined separately."

Simply stated, this describes the conflict between providing enough flow (in gallons per minute), limiting flow velocity, ensuring adequate minimum pressures at point of use and specifying a reasonable pipe size (diameter) that will deliver all of this without being oversized. It is interesting to note that while the rest of Canada follows flow velocity targets reflected in ASHRAE 35.3 Table 6, British Columbia uses lower values – five feet per second (fps) on cold service, four fps on hot service and three fps on recirculation lines. The impact of this will be explained in an example to follow.

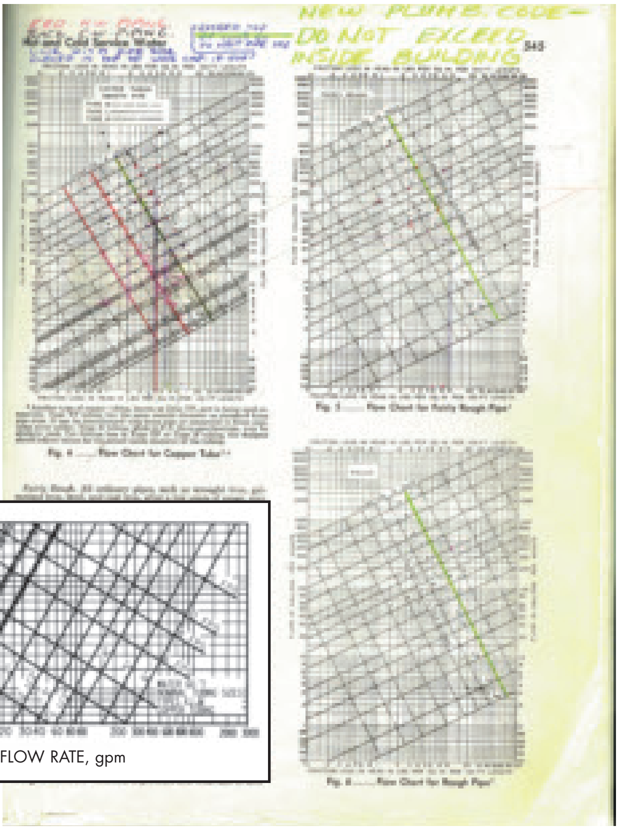
MULTIPLE LOAD DEVICES

The topic of reasonable pipe sizing for potable water distribution is one that has generated a great deal of consideration over the years. Another interesting observation is made in ASHRAE 35.7 Service Water Piping. It states, "Sizing of service water piping differs from sizing of process lines in that design flows in service water piping are determined by the probability of simultaneous operation of a multiplicity of individual loads such as water closets, urinals, lavatories, sinks, and showers. The full flow characteristics of each load device are readily obtained from manufacturers; however service water piping sized to handle all load devices simultaneously would be seriously oversized."

The same document discusses the work of Dr. Roy B. Hunter. We work in an industry full of unsung heroes, and Hunter is a case in point. He was employed by the U.S. National Bureau of Standards (now known as the National Institute of Standards) in the early 1940s.

Hunter published the paper *Water Distributing Systems for Buildings NBS Report 79*. This paper has formed the basis of standard industry practice and became an integral part of every North American plumbing code. Figuratively speaking, every time you use the facilities in a modern building of any size, a little piece of Hunter's legacy shares your experience. His contribution to our everyday lives is sizeable indeed.

So, while load calculation procedures are now code driven, they take into account diversity factors that can be plotted on a curve to determine a load producing value. Hunter's finding, known as Hunter's Curve, allows us to take the individual load curves of large quantities of similar fixtures and plot



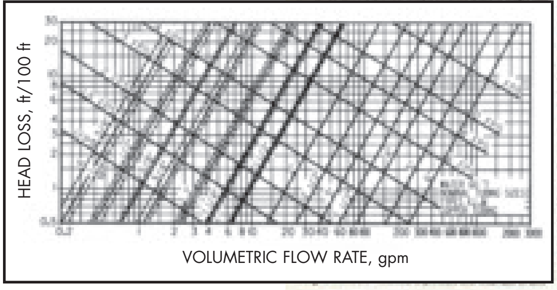


Figure 1 Fixture unit values/flow velocity charts, 1970 (right) and 2001 (below) show little change.

them on a weighted scale. Such curves are still widely used.

CONSUMPTIVE LOADS

A lot of his work, and a lot of the work we do today, is tied to arbitrary values assigned to various types of fixtures and fittings based on anticipated water consumption or use. These are known as fixture units. A fixture unit is an estimate of the load that the presence of this fixture will place on the mechanical system (potable systems, and drain, waste and vent systems are considered separately). The fixture unit value is larger for fixtures that have greater consumptive loads. Compare a water closet (flush tank) with a fixture unit value of three (public use) to a water closet (flush valve) with a fixture unit value of 10 (public use). The larger fixture unit value assigned to the flush valve water closet in the public use building assumes that these would consume more gallons per flush, and have more units in service simultaneously based on the common events taking place in the building (when everyone goes to lunch at the same time for example).

These are logical assumptions. It is understandable that a grouping of such water closets would require a larger supply of water than a similarly sized grouping of the flush tank water closets in a private home. However, should something else now be considered?

A conversation about these issues with Peter Hughes, a principal at Keen Engineering in North Vancouver, BC, took an interesting turn. Many of the new public use building designs Keen has on the go are being designed with Leadership in Energy and Environmental Design (LEED) certification in mind. As such, they use low-flow fixtures and fittings. Going beyond this, he noted that CSA had instituted new requirements for flow restriction on all faucets and fittings in the early 1990s.

The point? The fixture unit values and the flow/velocity charts shown in Hughes' copy of the 1970 ASHRAE *Guide and Data Book* are virtually identical to the ones found in the 2001 volume referred to earlier in this article (see *Figure 1*). The same thing is true of the values used in our plumbing code; they have not changed in keeping with the evolution of the products concerned, with six-lpf versus 16-20 lpf on water closets being a prime example.

When asked whether they should change, Hughes responded, "Some entity needs to issue new fixture unit values to reflect current state-of-the-art in water consumption vis-à-vis low-flow fixtures." He suggests that the American Society of Plumbing Engineers (ASPE) Research Foundation or ASHRAE have the facilities to do this. Is there consensus to move the issue forward to make this happen? In Canada, who would confer this mandate, National Research Council Canada?

SIGNIFICANT IMAPCT

Consider the impact of such a change on

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potable water distribution. Using data from the BC Plumbing Code, the fixture unit limit on a four-inch cold water riser would be 850 fixture units. On a six-inch riser the limit is 2,875 fixture units.

On a given job where the load is only marginally more than allowed, and using 1,200 fixture units as an example, the change to a six-inch riser is required nonetheless. I asked Henning Thomsen, chief site superintendent for Phase Mechanical Systems Ltd., a design-build/design-assist contracting firm, about the impact of making such a change. "The difference in labour and materials between a four-inch and a six-inch riser could be very significant," said Thomsen.

So if the fixture unit values of faucets and fittings in private use were reduced by as little as 30 per cent in our example, a four-inch riser would suffice as opposed to the six-inch one currently required. Data suggests that using Hunter's assumptions on the frequency and interval of use, the value derived using the flow rates of today's products would be less than half of what would have been calculated by Hunter using the flow rates of his day.

This would tend to support the assertion that the integrity and performance capability of the system would likely remain unchanged if the fixture unit values were adjusted lower to reflect the use of low-flow fixtures and fittings.

REVISE UNIT VALUES

My own experience is that designers and contractors alike sometimes choose flush tank urinals over flush valve urinals because of the impact that this choice can make on pipe sizing, particularly on smaller and medium jobs. Further, flush tank water closets are often chosen over flush valve styles for the same reason. Bottom line, these choices may not always be the optimum choice, but are made to try and balance out costs and maintain reasonable pipe sizing on a given job.

Do we want to have to make fixture and fitting choices on this basis? I believe there should be some discussion of revising fixture unit values to reflect the lower flow requirements of all fittings and fixtures in use today. This may provide an incentive for stakeholders to invest more in water saving fixture and fitting technology given the potential for payback with regard to the installed cost of the mechanical system. HPAC

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