# Siphonic Roof Drainage: Where Is it Headed?

*By John M. Rattenbury, P.E., LEEDap*

Perhaps one of the hotter topics discussed among the plumbing engineering community is siphonic roof drainage. It is growing from a once "obscure curiosity" in Europe to an emerging market in the United States. At the American Society of Plumbing Engineers (ASPE) 2004 Convention & Engineered Plumbing Exposition last October, siphonic roof drainage was presented as part of the technical learning program for the first time and was met with "full house" attendance. A European siphonic roof drainage company was present at the exposition and displayed a working model of a mini siphonic system. At this year's ASPE Technical Symposium in Chicago, siphonic roof drainage design will be part of the three-hour technical program sessions (Oct. 30 at 9 a.m.). With interest and recognition growing, many designers and engineers are probably wondering what products and services are available. Engineers want to know who makes siphonic roof drains and how they can obtain literature. They want to know what standards are in place and how this type of system relates to code compliance.

## An Engineered System

Siphonic roof drainage is not simply a new product to be specified. It is a technique for sizing drainage piping to allow the drainage system to flow full-bore, to utilize the full cross-sectional area of the piping and to exploit the potential energy available from the roof elevation to the point of discharge. There are many design advantages of this type of engineered system, and they have been discussed in other articles on the subject.[1] Siphonic roof drainage is a true "engineered system," requiring hydraulic analysis and an understanding of the principles of fluid mechanics as described by Bernoulli back in the 18th century.

**The design of siphonic roof drainage systems is growing in popularity in the U.S. thanks to new standards for design from ASPE and ASME.**

## Familiar Engineering

When sizing a centrifugal pump, engineers know that the operating point (i.e., the discharge pressure and flow) is determined by both the pump's performance curve and the system curve of the connected distribution system. Such a distribution system may be a wet pipe sprinkler system, a domestic water system or some sort of process system like an RODI distribution loop. The performance curve of a pump can be obtained by the pump manufacturer. However, the system curve is unique to

A horizontal drain manifold overhead at an IKEA in Atlanta, GA.

the pipe system and must be calculated using friction loss formulae and the resistance coefficients of pipe components, such as elbows, reducers and valves. Often, the pressure loss can be estimated using a friction loss chart and one or two "rules of thumb" to arrive at a reasonably accurate pump selection. In these familiar applications, designers and engineers have standards, references and experience to draw from. For example, NFPA 13 requires the use of the Hazen-Williams formula for calculating pressure loss through a sprinkler system and specifies the pipe roughness factors for different pipe materials. However, when it comes to siphonic roof drainage design, what equations, methods and resources are available? Can the Hazen-Williams formula and a spreadsheet provide adequate results? What are the standards to go by?

## Siphonic Roof Drainage Design

Much like sizing a centrifugal pump, siphonic roof drainage design centers on the balance between the energy available to the system and the energy loss experienced as a result of viscous flow through the pipe system in a full-bore steady state condition. In this case, the height of the building represents the available "potential energy" to the system and is analogous to a pump performance curve. With a given roof surface area to be drained at a specific rainfall intensity, the total design flow (including the flow to each drain) is the designer's starting point. The pipe system diameters, bends, increasers and even drains are then selected and analyzed for energy loss to a point where the energy balance is satisfied. This requires fairly precise calculations that have to be repeated until an acceptable accuracy is reached. The required resistance coefficients for common pipe components like elbows and increasers are available from engineering references, but the roof drain also has a resistance coefficient and a maximum flow capacity. This data is also required.

## Drain Standard A112.6.9

In August of 2002, the American Society of Mechanical Engineers (ASME) Committee A112 "Plumbing Materials and Equipment" formed A112 Support Team PT 6.9 (PIR 02-6) for the purpose of drafting a standard for siphonic roof drains. On March 15, 2004, the proposed standard (A112.6.9 "Siphonic Roof Drains") was put to ballot and received the required number of votes for approval. It was then submitted to and approved by the American National Standards Institute (ANSI) on July 8, 2005. This standard establishes the testing procedures for siphonic roof drains used to determine the product resistance coefficient, flow range and response to varying flow rates. The resulting data will be provided by the manufacturer to the specifying engineer for the performance of system calculation. The test procedures are based on those used by drain manufacturers in Europe. Manufacturers of siphonic roof drains will need to certify their product(s) as compliant with this standard in the same way other plumbing fixtures and equipment must comply with ASME standards.

## Design Standard

On March 14, 2005, ASPE initiated Work Group No. 45, assigned with the task of drafting a technical design standard for siphonic roof drainage systems. A draft of the proposed standard was sent to the Main Committee in April of 2005. This review resulted in apparent positive acceptance of the standard, and only minor but helpful comments had to be addressed. This standard establishes the calculation procedures for siphonic piping systems, acceptable pipe materials, performance requirements, and a set of "do's" and "do not's" necessary to avoid pitfalls. The standard is based on more than 30 years of accumulated experience by European siphonic roof drainage experts, including the co-developer of this technology, Dr. Per Sommerhein of Sweden.

Together, ASME A112.6.9 and the ASPE Design Standard provide an integrated set covering all aspects of siphonic roof drainage technology. The next step for the ASPE Standard will be submission to ANSI for accreditation. These standards will eventually be made available to plumbing engineers and manufacturers, and will be incorporated along with other ASME and ASPE Design Standards into state and model codes by reference, thereby giving code officials a basis for acceptance of siphonic roof drainage as an engineered drainage system.

A typical baffled siphonic roof drain.

## Software Support

Even with these standards available, however, the calculation procedure itself can be quite burdensome. Fire suppression sprinkler systems today are typically hydraulically designed using computer programs. The principles of siphonic roof drainage are quite simple and no different than any other piping system, but the sheer number of calculations required to arrive at a satisfactory result requires the assistance of computer software. The software unburdens designers of the "number crunching" task and leaves them free to evaluate the results of adjusting pipe lengths, adding fittings or offsets, or varying such parameters as rainfall intensity. Such a software package is currently being "beta tested" and will eventually become available to trained users at about the beginning of 2006. It is now a "desktop" Windows application, but is intended to be an Internet-based platform, giving licensed users access to the design tools and the connected database of pipe, pipe components and drain product data.

## New Products

Perhaps one of the more exciting developments in the siphonic roof drainage market is the pending rollout of a siphonic roof drain product by a major manufacturer of engineered commercial plumbing and drainage products. The drain prototypes are slated for their ASME A112.6.9 performance testing in August and should be available on the market at the same time as the software product. Presently, siphonic roof drains are available only from European suppliers, and then only if the supplier's proprietary software is used to design the piping system. The availability of both non-proprietary design tools and specified products promises to open the siphonic roof drainage market wide open in the U.S. European suppliers of proprietary siphonic roof drainage systems have already discovered that selling proprietary systems will not work in the states.[2]

## A Warning About ASTM F 2021

Plumbing engineers who have researched siphonic roof drainage may have come across an American Society of Testing and Materials (ASTM) standard for plastic siphonic roof drainage systems. Designated ASTM F 2021, this document was first published in 2000 and focuses on high-density polyethylene (HDPE) as a pipe material for siphonic roof drainage systems. Review of this document by experts in siphonic roof drainage has found fundamental technical errors and inadequacies. Under the section "System Calculations," one reviewer commented, "This part is inadequate and fails to provide any performance requirements necessary to ensure well functioning siphonic roof drainage solutions." Tables 2 and 3 of this document indicate piping is sized based only on projected roof area, regardless of pipe length, elevation, static pressure and bends. According to another reviewer, "(the standard) is rubbish and should be withdrawn." The F17 sub-committee of ASTM has been asked more than once to provide the name(s) of the author(s) of this document. However, nobody has come forward to defend the standard. After a subcommittee ballot was submitted to rescind this document, the subcommittee conceded to have the standard rewritten rather than having it deleted. This effort is underway as ASTM F17.63 Work Item 6941, Letter Ballot F17.63 (05-06), issued July 18, 2005. In the meantime, however, F 2021 as it is currently published should be avoided.

## Looking Toward the Future

Siphonic roof drainage offers many benefits. System costs are reduced due to smaller pipe diameters. Velocities are higher, making the inner bores self-cleansing. The ability to run the piping overhead without pitch reduces or eliminates the need for pipe trenching and saves money. Pipe inverts leaving a building are up high, making deep trenching on the site unnecessary and saving money. Flexible pipe location and the consolidation of drains to a single vertical pipe reduce column chases both in quantity and size, and save money. European experts predict that siphonic roof drainage could be the standard in large-roof construction. Such applications include factories, warehouses, airports, convention centers, stadiums and "big-box" retail. As the technology moves forward, appropriate standards will be in place to guide the industry properly. More importantly, the technology is being

A drain tailpiece joining with a horizontal manifold.

shifted away from proprietary to open specification. However, this approach relies on plumbing engineers being the consummate responsible professionals that they are and specifying systems with appropriate training and expertise. But once you've designed one and you see that it works, designing the next one is easy. PME

## References

[1] *Building Design & Construction*, June 2002; *PM Engineer*, March 2001; *PME*, May 2000.

[2] *Plumbing Systems & Design*, June 2005.

*John Rattenbury is president of RMS Engineering LLC, an engineering firm based in Salem, VA. He's been involved in siphonic roof drainage system design since 1999. He can be reached by e-mail at jrattenbury@comcast.net.*