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April 2009

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Dave Moreno (l) & Jake Lawrence stand tall amid the backdrop of steel framing for a replacement hospital in New Jersey.

Also Inside:

- Solar Commercial Hot Water Design
- Rainwater Harvesting
- GeoExchange System

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Plumbing Engineer
A TWB Publication

Volume 37, Number 4
April 2009

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Dave Moreno, PE, (l) & Jake Lawrence, PE, stand tall amid the backdrop of steel framing steel framing for Capital Health System's new replacement hospital located in Hopewell Township, N.J., currently in construction. This 1,000,000-sq.-ft. facility will provide comprehensive and state-of-the-art, patient-focused care.

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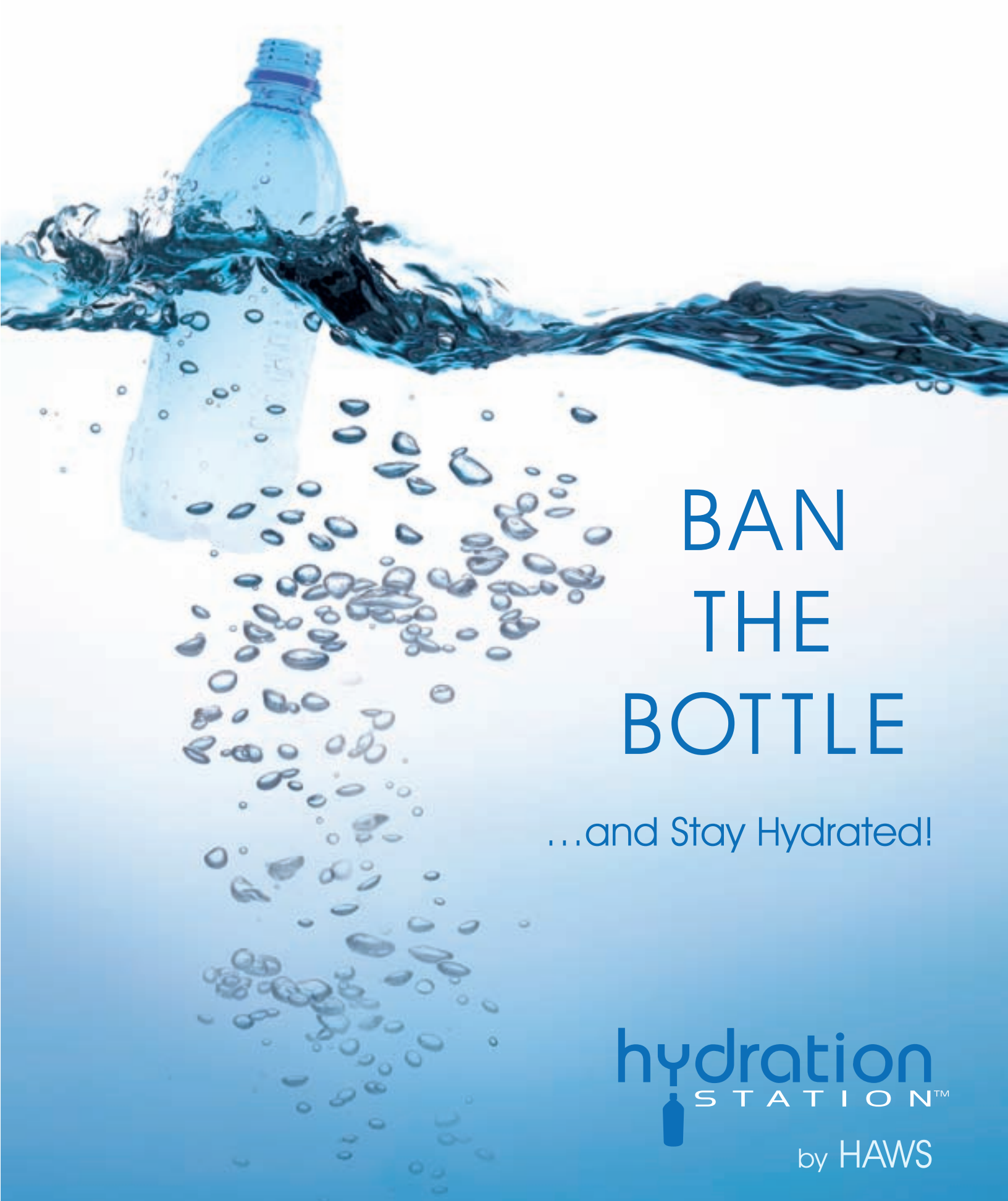

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Editor's Letter

John Mesenbrink, Editorial Director

The global economy – locally

Call me crazy, but every time I enter a commercial restroom, I am intrigued by the design, plumbing fixtures, technology, manufacturer's footprint, etc., and I make a mental note of it. I guess it's part of the job.

Recently, the good people from Viega, an innovative global leader in plumbing and heating technology, invited me to join a great group of contractors, wholesalers and engineers on a trip to Germany to tour the Viega manufacturing facilities and visit ISH-Frankfurt. The Viega facilities — which manufacture the highly-touted ProPress fittings — are state of the art. The size and scale of Viega's production capabilities and the amount of production automation is impressive. Quality control is imperative, insomuch that every fitting is hand inspected. The logistics facility — the mechanisms employed for storing product and picking orders for shipping — also was impressive.

As the Viega tour took us to Frankfurt, Weimar, Attendorn, Cologne and Heidelberg, one thing became apparent to me. Every commercial restroom I attended — whether it was in a truck stop, restaurant or trade show — had a sense of "country pride." German manufacturing was apparent in every bathroom. From Viega and Grohe plumbing fixtures to Geberit toilets, the plumbing manufacturing industry in Germany seems to be doing just fine, in my opinion.

Here at home I tend to notice similar "regional pride." For instance, the next time you are in Wisconsin, take a look at the commercial restrooms and, more often than not, you will find industry manufacturers that call the Dairy State home. From Kohler to Bradley Corp. to Bemis Manufacturing, Wisconsin likes to reward their own first. So here's my point:

The current state of the economy has started me thinking of the global economy vs. U.S. economy crux. American manufacturers are feeling this recession's mighty grip. Thousands of hard-working Americans have lost their jobs. Work has been outsourced overseas. And, the U.S. automotive industry teeters on the edge of bankruptcy.

As consumers and specifiers of plumbing and heating products, what is the thought process that goes into purchasing a particular product? Price? Reliability? Efficiency? Support? I realize designers and installers need to base their decision on what is best for the client and application, but have you ever thought about the person on the assembly line making that product? That perhaps your support of the company may keep him/her job-secure? The U.S. economy has never needed consumer help more than right now.

Supporting a global economy can be advantageous if it supports the local economy, and in this case, the U.S. economy. Case in point: In the past, I have purchased Honda automobiles and I would take flack for not purchasing American-made cars. Well, my automobile was manufactured in Ohio, which employs thousands of workers. I felt OK knowing that good Ohioans worked on my car.

Viega plans to open a manufacturing and distribution center later this month in McPherson, Kansas, America's heartland. Supporting Viega products and services allows the company to grow here in the States, establishing great jobs.

The next time you review a product for spec, think of the person on that line, and the effect you could have on the local economy.

I welcome your thoughts on this subject. Please contact me at editor@plumbingengineer.com. ■

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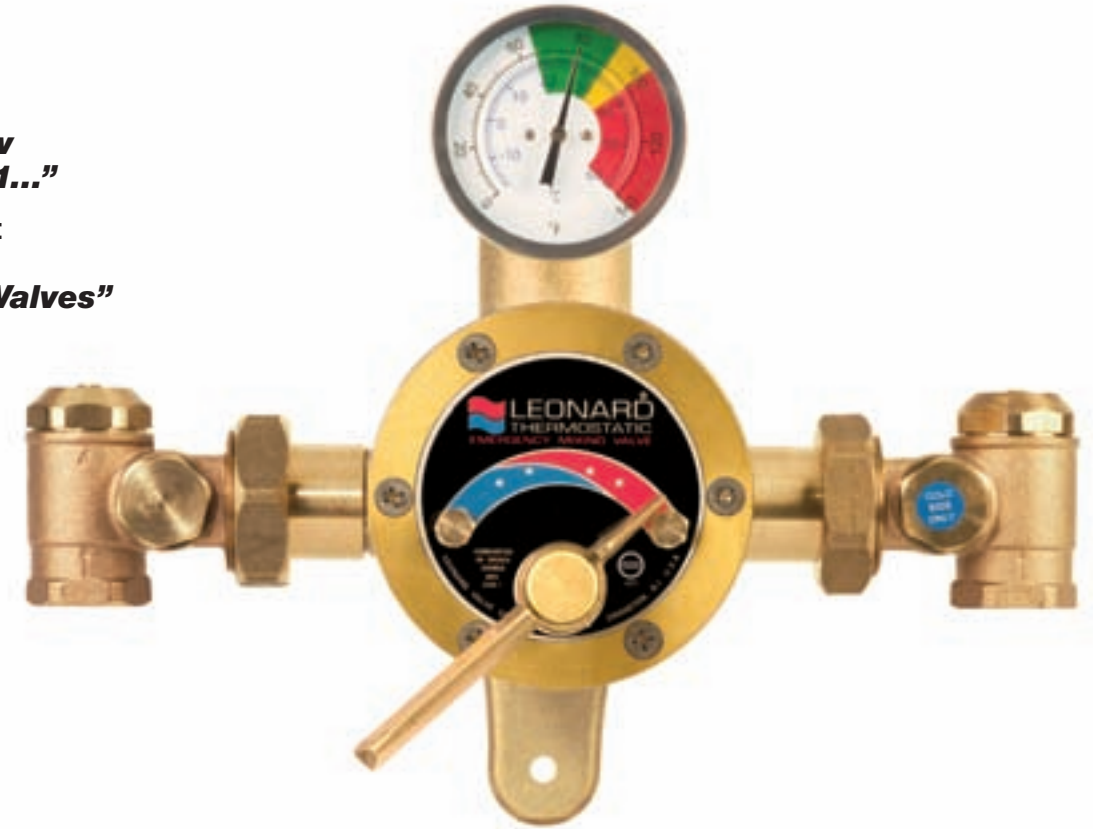
If you specify this:
"Must meet the new ASSE Standard 1071..."

All you need to know is:
"Leonard Valve, Emergency Mixing Valves"



Leonard Valve's series of emergency mixing valves still provide the same quality and performance and are now certified to the new ASSE 1071 standard.

ASSE Standard 1071 was developed to work with systems that comply with ANSI Z358.1 (2004) for emergency equipment (i.e. eye/face wash and drench showers). It adds a logical assurance that emergency mixing valves provide tepid water to the emergency devices.

Key performance requirement is Cold Water Failure, Section 1.2.6, stating that "upon cold water failure, the hot water shall continue to flow at a rate not to exceed the values listed in Table 1."

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Table 1

Flow @ 30.0 psi ± 0.5 psi (206.9 kPa ± 3.4 kPa) differential		Permissible temperature variation above or below set point		Maximum allowable flow with cold water shut off	
GPM	**L/min**	**°F**	**°C**	**GPM**	**L/min**
<7.0	<26.5	+3.0/-5.0	+1.7/-2.8	0.5	1.9
7.0<20.0	<26.5<75.7	+5.0/-8.0	+2.8/-4.4	1.0	3.8
20.0<40.0	<75.7<151.4	+7.0/-12.0	+3.9/-6.7	1.5	5.7
40.0 and over	Over 151.4	+7.0/-15.0	+3.9/-8.3	2.0	7.6

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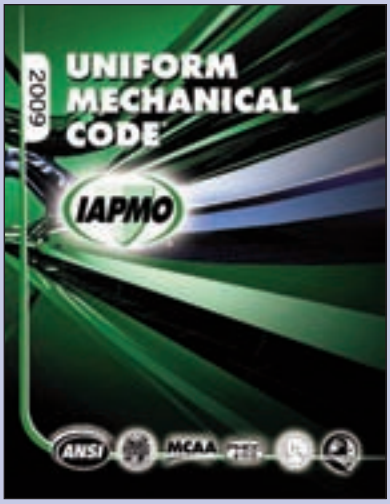
Industry News

2009 UPC and UMC designated American National Standards

ONTARIO, CALIF. — The American National Standards Institute (ANSI) announced that the 2009 editions of the Uniform Plumbing Code (UPC©) and Uniform Mechanical Code (UMC©), developed by IAPMO using an ANSI-accredited consensus process and released on March 1, have been awarded designation as American National Standards. This marks the third time the UPC and UMC have earned the designation; the 2003 and 2006 editions were similarly recognized.

ANSI accreditation signifies that the procedures used by standards setting organizations such as IAPMO meet the Institute's requirements for openness, balance, consensus and due process. This process brings together volunteers representing a variety of viewpoints and interests to achieve consensus on plumbing and mechanical practices. The UPC and UMC are the only plumbing and mechanical codes of practice to be named American National Standards.

Introduced in Los Angeles in 1928 and formally published as the Uniform Plumbing Code in 1945, the UPC is developed to govern the installation and inspection of plumbing systems as a means of promoting the public's health, safety and welfare. Published by IAPMO in 1967, the UMC provides the same governance for mechanical (HVAC, combustion, exhaust, refrigeration) systems. Developed and subsequently republished at the conclusion of each three-year code cycle, the UPC and UMC are designed to provide consumers with safe plumbing, heating and mechanical systems while, at the same time, allowing latitude for innovation and new technologies.



"We are extremely proud to once again have the UPC and UMC recognized by ANSI in this manner, primarily because this designation reaffirms our true consensus development process and the fact that our procedures allow each and every stakeholder a voice and a vote in the final product," said GP Russ Chaney, executive director of IAPMO.

The 2009 UPC and UMC complete the third ANSI-accredited development cycle for each code. Key changes to the 2009 UPC include new requirements for the installation of non-water urinals, new requirements for distribution of hot water and updates and revisions to the identification of potable and non-potable water systems. Key changes to the 2009 UMC include new requirements for outdoor air ventilation, new requirements for the protection of mechanical equipment against flood damage and new approved referenced standards for hydronics systems.

IAPMO now looks to gain the ANSI designation for its Uniform Solar Energy Code© and Uniform Swimming Pool, Spa and Hot Tub Code©, with new editions, developed for the first time using an ANSI-accredited process, due later this year.

Sioux Chief purchases fittings business from REHAU

LEESBURG, VA. — REHAU announced the purchase of its North American fittings business for PEX plumbing systems by Sioux Chief Manufacturing. This includes transition of REHAU's existing fittings inventory and associated certifications, as well as the licensing of the technology, to Sioux Chief.

"With a solid three-generation footing in the plumbing industry, we're excited to be expanding into the manufacture and supply of complete fitting systems by assuming REHAU's proven, high-quality line of compression sleeve fittings," said Ed Ismert, vice president of sales and marketing at Sioux Chief. "Building on REHAU's established reputation for quality and service in the industry, we anticipate a seamless transition into providing the complete range and support of plumbing fittings formerly available from REHAU."

Prior to the sale, which took effect April 1, Sioux Chief had been a supplier to REHAU for plumbing accessories and fittings. Completion of the sale provides Sioux Chief with full manufacturing, distribution and marketing capabilities for the plumbing fittings line throughout North America.

CSA and CIPH announce new education and training program for plumbing inspectors

TORONTO — Canadian Standards Association (CSA), a leading developer of standards and codes and the Canadian Institute of Plumbing and Heating (CIPH) are developing a new program to help ensure that standardized, quality education and training is available to plumbing inspectors across Canada.

The project is being funded by CSA and CIPH and is sup-

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ported by the Canadian Advisory Council on Plumbing (CACP). The program is being designed to help ensure that national plumbing inspection personnel are best able to provide the required level of quality as it relates to inspection, enforcement and installation processes.

As a first step, CSA has formed an Education and Training Scheme committee comprised of subject matter experts from across the country that will define the curriculum and oversee program development. This modular program will be an e-learning product and will be accessible to inspectors, plumbers and related professionals to learn at their own pace and from their own personal computers.

Regulators with CACP have already identified a number of key areas for the new CSA/CIPH program to address, including:

- Interpretation and application of codes, standards and regulatory requirements;
- Identification and management of counterfeit or non-approved plumbing products;
- Improving the inspection process, methodologies and allowable time for inspections;
- Recognized qualifications and abilities of inspection and enforcement personnel.

AFSA 2009: 'Navigating success in challenging times'

DALLAS — The American Fire Sprinkler Association (AFSA), an industry leader delivering relevant and comprehensive education for fire sprinkler industry professionals, is featuring a dynamic education program at its AFSA 2009: Navigating Success in Challenging Times convention and exhibition, October 14 -19 at the Manchester Grand Hyatt in San Diego.

InSinkErator® snags prestigious Emerson Technology Award

RACINE, WIS. — InSinkErator, a manufacturer of food waste disposers and instant hot water dispensers, was selected as the recipient of the 2008 Emerson Technology Award for the development and launch of the Evolution Series disposers.

Emerson selects one new product or technology each year to honor from among its many divisions around the world. According to Dr. Randall Ledford, Emerson's chief technology officer, the company typically develops and launches approximately 500 major new products each year. In consideration for this year's award, 17 products from the wide range of new products introduced over the past few years were reviewed by the Emerson Technology leadership. The nominations were judged on a range of criteria including:

- Originality and creativity
- New technology and intellectual property (patents)
- Best-cost situation
- Market leadership
- Industry recognition
- Financial return
- Importance to division

The Evolution Series® food waste disposers marked the first major technological advancement in the category in more than 40 years.

New courses announced for second quarter at B & G's Little Red Schoolhouse

MORTON GROVE, ILL. — Bell & Gossett, a leader in education for the hydronic heating and plumbing industries, has announced its training course schedule for Spring 2009. The free training seminars are offered at the Bell & Gossett Little Red Schoolhouse Education Center in Morton Grove, Illinois, a suburb of Chicago and are open to engineers, contractors and facility maintenance professionals.

The seminars are tailored to various industry occupations and cover a wide range of important topics. Upon completion of the three-day seminars, CEU credits are awarded to graduates.

The second-quarter Schoolhouse seminars include:

- Design and Application — April 6 - 8, June 15 - 17
- Modern Hydronics Advanced — April 20 - 22, June 1 - 3
- Modern Hydronics Basic — May 4 - 6, June 29 -July 1
- Service and Maintenance — May 18 - 20

Since 1954, more than 55,000 engineers, contractors and installers have been trained in the Little Red Schoolhouse's fully equipped learning center, while another 135,000 professionals have received training through B&G's "traveling classroom" program.

For complete descriptions and enrollment information for the Little Red Schoolhouse educational seminars, visit www.schoolhouse.itt.com.

CertainTeed introduces pipe diameter options

VALLEY FORGE, PA. — Responding to the needs of contractors and municipalities, CertainTeed Corporation is expanding its CertaFlo™ GreenLine PVC sewer pipe line to include larger pipe diameters.

When introduced in 2007, CertaFlo GreenLine offered diameters ranging from 4 to 8 inches. With the product line expansion, CertaFlo also will be available in larger 10- and 12-inch diameters, for use in upsizing overloaded smaller lines and for size-on-size replacement of deteriorated pipelines.

CSI Controls launches redesigned Web site

ASHLAND, OHIO — CSI Controls™, a leading controls provider for the water/wastewater industry, has launched its newly redesigned Web site, www.csicontrols.com. The new site architecture and design incorporates a fresh, updated look with user-friendly drop down menu navigation. Organized content allows users quick and easy access to CSI's full prod-

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Industry News

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uct line of water/wastewater control products and provides a better understanding of CSI's engineering capabilities.

Elkhart Brass teams up with GSG

ELKHART, IND. — Elkhart Brass Mfg. Co. Inc, has joined forces with Government Sales Group (GSG) of Georgia to market Elkhart Brass products to U.S. government agencies worldwide.

"Working with GSG provides Elkhart Brass and our government customers with a dedicated sales force committed solely to — and focused on — the specialized firefighting needs of the various U.S. government agencies," said Paul Albinger, director of government sales. "The combination of Elkhart's extensive lines of firefighting equipment and GSG's in-depth knowledge of the U.S. government's needs and procedures will create a more efficient sales experience for our customers."

Lubrizol completes CPVC-compatible testing of antimicrobial products

CLEVELAND — The Lubrizol Corporation has completed compatibility testing on the first two antimicrobial steel pipe coatings that have applied for inclusion in the company's FGG/BM/CZ system compatible program. As a result, the company's compatibility program now includes two additional BlazeMaster-compatible products to provide installers with a manufacturer-applied antimicrobial solution, as well as an effective after-market product.

The new additions include Potter Pipe-Shield Corrosion Inhibitor from Potter Electric Signal Company and Wheatland Tube Company's MIC SHIELD™ coating manufactured after February 22, 2009. Together, these products provide specifiers and contractors with a proven, CPVC chemically compatible option for a manufacturer-applied protective coating, as well as an aftermarket corrosion inhibitor.

Hydraulic Institute announces Webinar series on slurry pumps

PARSIPPANY, N.J. — Hydraulic Institute (HI), a pump industry knowledge leader and resource for pump education, has announced the kick-off of their Spring 2009 Webinar Standards series, titled "Making Sense of the ANSI/HI Slurry Pump Standard."

In this series, slurry pump expert, Graeme Addie, vice president of engineering and research and development for GIW Industries Inc., will explain nuances of the slurry pump standard and discuss industry terminology, design, application, installation, operation and maintenance guidelines. Under Addie's leadership, the Hydraulic Institute Slurry Committee developed the ANSI/HI 12.1-12.6, 2005 standard, *Rotodynamic (Centrifugal) Slurry Pumps for Nomenclature, Definitions, Applications, and Operation*.

The ANSI/HI Slurry Pump Standard was created to help eliminate misunderstandings between the pump manufacturer, the purchaser and the user. Standards also assist the purchaser in selecting and obtaining the proper product for pumping and transporting mixtures of solids and liquids, or so-called *slurries*. The standard also provides significant educational content, to help users understand the basic needs and design requirements of slurry pump and pipeline systems.

Following is a schedule for the Slurry Pump Webinars:

May 12, 1:30 - 3:00 p.m. EDT, Slurry Pump Design and Testing — In this session, Addie will discuss slurry pump types, their application, pump hydraulic design, mechanical design features, assembly, nozzle loads and testing.

June 9, 1:30 - 3:00 p.m. EDT, Slurry Pump Wear and Application — This session will focus on slurry pump wear, service classes, selection, application, materials of construction, operation and maintenance.

Registration for each Slurry Pump course is $119 per connection. Registrants may have a number of people in the room to view the session. All HI Webinar participants earn HI Professional Development Hours (PDHs), which are accepted by most certification and licensing entities.

To obtain more details about the Hydraulic Institute or to register for the course, please visit online at www.PumpLearning.org or e-mail Education@pumps.org.

Industry news continued on page 70

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Designer's Guide

Timothy Allinson, P.E., Murray Co., Long Beach, Calif.

Medical gas design, Part 2

This is a follow-up to last month's article that addressed medical vacuum systems. As promised, this piece will address pressurized gasses.

Medical air is essentially the inverse of medical vacuum. Like the vacuum, it uses pumps to supply the system but, instead of pulling a vacuum, it pushes a pressurized supply. Its configuration parallels the vacuum, with similar pipes and equipment. Supply air is drawn from the roof and, as with the vacuum, care must be taken to locate the air intake at least 10 feet from any door, window, exhausts, etc. Take particular care with the vacuum exhaust, loading dock truck exhaust, kitchen exhaust and the like. Consult the manufacturer's literature to size the intake pipe.

NFPA 99, 1999 (the edition selected for reference in this article) has a schematic detail of a typical medical air pump assembly, complete with all the necessary appurtenances (Fig. 4-3.1.1.9). As with vacuum pumps, all of these devices typically come with the medical air pump skid set, so, while familiarity is always important, it is not essential to study this level of detail. What is essential to know is that the pump set, as with vacuum pumps, must have 100% redundancy. For a duplex set, that means two pumps sized at 100% capacity each. For a triplex system it means three pumps of at least 50% capacity, such that if one pump fails there is still 100% capacity. For a quad set, it means four pumps at 33% each and so on.

One noteworthy difference between a medical air pump package and a medical vacuum pump package is that the compressors require air dryers. As air is pressurized, the moisture content increases. To prevent condensation from forming and traveling through the system, the compressors have air dryers that remove the moisture content before it leaves the pumping plant.

The system piping arrangement for med air is nearly identical to med vac. Med air piping is smaller because, as noted last month, there is more pressure available to overcome friction losses. There are also usually fewer med air outlets than med vac outlets.

While NFPA tells you virtually nothing about sizing medical air,

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Home-grown Performance

LEH-Series

The New LEH-Series sewage pumps, now in 1, 1.5 and 2 hp

LEH-Series submersible sewage pumps from Liberty are now available in larger horsepower models for higher heads and flow rates. The 2" solids-handling pumps are robust and durable with unique one-piece castings, quick-disconnect power cords and efficient, heavy-duty motors for long life.

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ASPE Data Book 3, coupled with the manufacturer's literature, becomes a valuable resource. Similar to med vac, a common design criterion is a friction factor of 0.5 psi/100'. As noted last month, this factor should be adjusted to accommodate unusually large or small systems. Flow rate for patient rooms is noted in ASPE Table 2-5 as 0.5 cfm per bed with a diversity of 10%. I think this is dangerously low and prefer to use 0.5 cfm per outlet with the scaled diversity factor in Table 2-21 listed for "medical laboratory compressed air."

Applying these criteria to determine flow rate per pipe size and the corresponding number of patient rooms served by each yields the following table. Note that the flow rates and numbers of rooms served for each pipe size are a dramatic increase compared with the vacuum sizing chart printed last month, even with the relatively conservative assumptions made.

Note that if we used the information as presented in ASPE Table 2-5, a 3/4" pipe would serve 334 patient beds: 16.7 cfm/0.5 cfm/bed × 0.1 = 334 beds

Medical Air Sizing		
Size	Flow (CFM)	Patient Rooms
1/2"	6.2	1 to 4
3/4"	16.7	5 to 41
1"	31.8	42 to 106
1-1/4"	65.7	107 to 328
1-1/2"	99	329 +

Notes:

Based on 0.5 psi drop per 100' of pipe

0.5 CFM per outlet

2 outlets per Patient Room

Supplying this number of patient beds with a 3/4" pipe would be absurd and irresponsible. This is why the engineer must temper the available data for designing medical gas, as none of it is perfect.

The other common medical gases, namely O_2, N_2O, N_2, and CO_2 are designed in a similar fashion as medical air. All of these gases are delivered by pressurized tanks rather than by pumps. The central oxygen supply is generally a large outdoor tank that receives delivery of liquid oxygen from a truck, while the other gases, because of lesser consumption, are supplied by small exchange tanks. Details of these arrangements are shown in NFPA Fig.'s 4-3.1.1.7 and 4-3.1.1.5 respectively.

All of these gases (except the nitrogen), like the medical air, operate with a 5 psi differential pressure available for friction, with 55 psi at the tanks and 50 psi required at the outlets. Nitrogen generally operates at 160 psi, because it is used for powering pneumatic tools. Actual nitrogen pressures can vary depending on hospital needs. The industry's need for nitrogen is continually reducing as more and more of the tools are electric rather than pneumatic, but it is still frequently used to power the braking system of operating room booms.

The oxygen supply, once inside the building, parallels the medical air and vac. There is a requirement for an emergency fill at the building exterior as shown in Figure 4-3.1.2. Design information on oxygen systems is in even shorter supply than medical air. For some reason, the little information that does exist for oxygen generally uses metric units (lpm) for flow rate rather than cfm. Note that 1 cfm is approximately equal to 30 lpm. Other criteria are very similar to med air, so the sizing is quite similar. In the case of our sample project there were twice as many oxygen outlets than air, so the sizing worked out a bit differently, as noted in the table below.

In contrast to air, oxygen and vacuum, the remaining med gases are used almost exclusively for operating

Oxygen Sizing		
Size	Flow (lpm)	Patient Rooms
1/2"	200	1 to 2
3/4"	525	3 to 26
1"	1080	27 to 59
1-1/4"	1940	60 to 97
1-1/2"	3010	98 to 150
2"	6240	151 +

Notes:

Based on 0.5 psi drop per 100' of pipe

20 lpm per outlet

4 outlets per Patient Room

rooms, meaning the demand is less but 100% critical. Below is a table for sizing nitrous, carbon dioxide and nitrogen based on the usual criteria described in the notes. Keep in mind that the nitrogen could be sized separately, since it operates at a higher pressure, has more pressure to lose to friction and has different friction characteristics, based on its elevated pressure, but, given the small pipe sizes, it is hardly worth the effort. If you chose to pursue it, ASPE Table 2-23 has good friction/flow data for nitrogen at 160 psi. A quick glance reveals that at 160 psi, a 1/2" pipe could carry 300 lpm at a 0.5-psi drop, and if you

N20, CO2 & N2 for OR's		
Size	Flow (lpm)	No. of OR's
1/2"	200	1 to 5
3/4"	525	6 to 17
1"	1080	18 to 36

Notes:

Based on 0.5 psi drop per 100' of pipe.

30 lpm per outlet for each gas.

1 outlet per OR for each gas.

No diversities taken.

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Designer's Guide

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increase the friction factor the capacity grows with it.

Another med gas system is Waste Anesthetic Gas Disposal, referred to as WAGD, or WAG for short. WAG is a vacuum system used in ORs to remove nitrous oxide that is exhaled by the patient, to prevent the doctors and nurses from getting woozy. At one time, WAGD was always a separate system with dedicated piping and vacuum pumps. In more recent years, the WAGD is piped from the OR boom to the zone valve box. Upstream of a dedicated valve in the box, the WAGD piping can connect to the medical vacuum piping, saving a great deal of redundant piping and a second set of vacuum pumps.

There is one caveat noted in NFPA section 4-3.3.1.3 (1999 edition) that says that when the medical vacuum pumps are used for WAGD, you must insure that the N2O vapors do not create an explosion hazard at the vacuum pumps. Generally, there is sufficient dilution in the system to avoid such a hazard, but it is hard to calculate, so it is safest to use liquid ring vacuum pumps when they serve a combined WAGD system.

In last month's article, I touched on where alarms were required in the piping system. These alarms report to an assortment of alarm panels. First and foremost are the master alarm panels. These two (or more) panels must be located in separate areas; one is generally in the engineer's office and the other is in an area with 24-hour supervision, such as the security station. The master alarm panel receives signals from the central supplies if they are low or if the reserve supply is in use, plus it receives signals from all the area alarm panels.

Area alarm panels are located at the nurses' station serving critical areas. They indicate whether there has been a drop or rise in pressure within the critical care area. In addition, although it is not specifically required by NFPA, it is fairly common practice to provide area alarm panels at nurses' stations serving patient rooms with alarms for the central supply.

One last noteworthy item in NFPA is Table C-4.8. It summarizes the medical gas outlet requirements for various areas within a hospital. A similar, more elaborate, table is ASPE Table 2-4. It is important to note that in many jurisdictions there are requirements in the architectural section governing hospitals that conflict with the two tables referenced above. This is why the med gas outlet provisions are generally dictated by the architect rather than by the engineer of record. ■

Timothy Allinson *is a senior professional engineer with Murray Co., Mechanical Contractors, in Long Beach, Calif. He holds a BSME from Tufts University and an MBA from New York University. He is a professional engineer licensed in both mechanical and fire protection engineering in various states, and is a LEED accredited professional. Allinson is a past-president of ASPE, both the New York and Orange County Chapters.*

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Code Update

By Ron George, CIPE, CPD
President, Ron George Design & Consulting Services

Proposed mandates for low flow fixtures renew concerns about health and safety issues

A new alliance of five plumbing industry organizations was formed in February 2009. The alliance, the Plumbing Efficiency Research Coalition (PERC), was made official when the participants — the Alliance for Water Efficiency (AWE); the International Association of Plumbing & Mechanical Officials (IAPMO); the International Code Council (ICC); the Plumbing-Heating-Cooling Contractors Association (PHCC) and the Plumbing Manufacturers Institute (PMI) - signed a Memorandum of Understanding (MOU).

The Coalition is seeking to conduct much-needed research in a number of areas

and has identified drainline transport as its first research project. Pete DeMarco of IAPMO will serve as project coordinator for the inaugural research study, and he will also chair the technical committee assigned to the project. Each PERC member association has named a representative to this committee. The first order of business is to define the parameters of the project.

To gain perspective, we need to look back at the United States Energy Policy Act of 1992, which required all water closets in the United States to flush a maximum of 1.6 U.S. gallons per flush (gpf). The mandate allowed a couple of years before implementation and became effective January 1, 1994, for residential water closets and January 1, 1997, for all commercial water closets. In 1992, there was a concern about the ability of only 1.6 gallons to be able to adequately flush the water closet bowl clean and to transport the contents efficiently down the drain line. This was confirmed with independent testing of 1.6 gpf fixtures, which showed that many early models performed poorly or actually flushed more than 1.6 gpf. Early on, many manufacturers did not redesign their water closet bowls; they only redesigned their tanks to flush with less water. This caused a brief period (in 1994 and 1997) when many of the new models did not perform very well. Manufacturers were forced to re-engineer and test their products to meet the ASME A112.19.2-2003 *Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals*.

The water closet testing requirements include the following tests:

5.1.1 Performance Requirements. Water closets shall be tested at the test pressures specified in Table 5, or at the manufacturer's recommended minimum pressure. In no case shall the higher test pressure specified in Table 5 [80 psi (550 kPa)] be substituted. If the manufacturer's recommended minimum pressure is higher than those shown in Table 5, the manufacturer's literature, packaging, and installation instructions shall be marked with the minimum recommended pressure.

Table 5 Static Test Pressures for Hydraulic Performance Tests for Water Closets

Test Order (Note (1))	Paragraph	Test	Gravity and Flushometer-Tank Water Closets	Flushometer-Valve Water Closets	
				Siphonic Type	Blowout Type
1	8.4	Flush volume, cycle time, and trap seal	80 psig (550 kPa), 50 psig (350 kPa), and 20 psig (140 kPa)	80 psig (550 kPa) and 35 psig (240 kPa)	80 psig (550 kPa) and 45 psig (310 kPa)
2	8.5	Granule	20 psig (140 kPa)	35 psig (240 kPa)	45 psig (310 kPa)
3	8.6	Surface wash	20 psig (140 kPa)	35 psig (240 kPa)	45 psig (310 kPa)
4	8.7	Mixed media	20 psig (140 kPa)	35 psig (240 kPa)	45 psig (310 kPa)
5	8.8	Transport	20 psig (140 kPa)	35 psig (240 kPa)	45 psig (310 kPa)

GENERAL NOTES:
(a) Where a higher minimum operating pressure is required for a fixture by a manufacturer, that minimum pressure shall be substituted for the minimum test pressure indicated above. This minimum operating pressure shall be required to be placed on the product literature and product packaging.
(b) Gravity and flushometer-tank water closets shall include siphonic, pressure-assist (other than flushometer-valve models), and washdown bowl types.

NOTE:
(1) All tests shall be performed in the order listed in this Table. Adjustments to sink trim components shall be permitted only when changes to test pressures are indicated. No adjustments shall be allowed between tests employing like pressures. For water closets with staintube materials in traps, the Auger test (para. 7.5) shall be conducted prior to conducting the tests in this Table.

5.1.2 Trap Seal Restoration. Water closets shall restore a residual trap seal of not less than 2 in. (50 mm) minimum when tested in accordance with para. 8.3.

This test will be more difficult at lower flush volumes.

5.1.3 Water Consumption. Water closets shall have an average maximum consumption of 1.6 gpf (6 Lpf) for low-consumption water closets or 3.5 gpf (13.2 Lpf) for blowout water closets, when tested in accordance with para. 8.4.

As flow volumes are reduced, drainline transport will be reduced and drainline blockages will increase exponentially.

5.1.4 Granule and Ball Test. In order to comply with this standard, not more than 125 polyethylene granules and not more than five 1/4 in. (6.4 mm) diameter balls shall be visible after each of three initial flushes when the water closet is tested in accordance with para. 8.5.

5.1.5 Surface Wash Test. For the line drawn at 1 in. (25 mm) below the rim holes, the total length of ink line segments remaining on the flushing surface after each flush shall not exceed 2 in. (50 mm) as averaged over three test runs. No individual segment shall be longer than 1/2 in. (13 mm) based on the average of three test runs when tested in accordance with para. 8.6.

During a recent ASME meeting in San Diego it was noted that this test will become extremely difficult to pass with the ultra low flow water closets, and it is likely that these water closets will require toilet brushes to assist in

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cleaning the bowl.

5.1.6 Mixed Media. All water closets shall discharge 22 mixed media (any combination of sponges and/or paper balls) based on the average of three of the four test runs when tested in accordance with para. 8.7.

5.1.7 Drainline Transport Characterization. The average carry distance shall be a minimum of 40 ft (12.2 m) when tested in accordance with para. 8.8.

At the ASME meeting it was noted that will be more difficult for many models of water closets to pass this requirement. The simple physics of using less water reduces the hydraulic depth of flow and, without reducing pipe sizes, will likely lead to an exponential increase in drainline stoppages. Pete Demarco queried the task group, and it was agreed that drainline transport will be an important issue as flows are reduced by government mandates.

I expressed concerns about health and sanitary issues from sewage backups related to drainline blockages. I cited an example of a hospital where some existing public water closets were replaced with low flow models, which experienced drainline transport problems. When hospital maintenance staff removed the floor cleanouts (which was done about every two weeks), the raw sewage flowed all over the MRI unit, creating an unsanitary mess and exposing patients and staff to a cocktail of bacteria and stench. If water closet flushing rates are reduced further, without research into the full effects and studies of drainline transport, expect this scenario to be commonplace. I feel that research would define certain design parameters that should be avoided for ultra low flow fixtures (long horizontal runs with no additional fixture to aid in flushing the lines).

5.1.8 Adequacy of Overflow Device in Gravity Tanks. The overflow device in gravity tanks shall be capable of fully discharging the full open flow of the fill valve when tested in accordance with para. 8.9. This provision shall become effective 18 months after publication of the Standard.

5.1.9 Operating Pressures. For safe and efficient operation, static pressures of water distribution systems at plumbing fixtures shall be not less than 20 psig (140 kPa gauge) for low-consumption gravity and flushometer tank closets and not less than 35 psig (240 kPa gauge) for low-consumption flushometer valve activated closets, or not less than 45 psig (310 kPa gauge) for blowout-type water saver flushometer valve activated closets.

5.1.10 Maximum Safe Operating Pressure. Manufacturer's specifications shall be followed for all water closets. Maximum water pressure shall be no more than 80 psig (550 kPa gauge) static. Higher pressures could result in unsafe conditions.

Manufacturers learned that the water closet trapway needed to be slightly smaller to be more efficient, yet not so small that it caused constant clogging. Eventually, the trapways were a smooth design and were glazed internally to aid in flushing performance. Manufacturers have, for the

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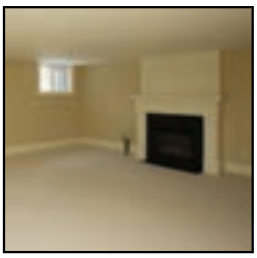

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most part, redesigned their products to perform well and to flush the contents out of the bowl and down the drain, at least the minimum 40 feet required by the standard. At one point during the 1990s, manufacturers wanted to remove the 40-foot distance requirement from the standard, because some of them were having trouble meeting the requirement with older models. Many in the industry, including the American Society of Plumbing Engineers (ASPE), voiced their concerns about removing the 40-foot requirement.

The poor flushing performance created a need for super flushing performance with very little water. Bruce Martin stepped up with his patented invention of the pressure-assist toilet. He was with a company called Water Control International, which was bought out by Sloan Valve Company. The product eventually became known as the Sloan "Flushmate" pressure-assist flushing system.

Martin went on to design a new version of a pressure-assist flushing unit that was called "P/S-2 Powerflush." The product was a hit, and it was soon purchased by Masco Corporation. Martin, who was a member of the ASME A112.19.2 committee on *Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals*, had an uphill battle in keeping the performance requirements for drainline transport in the standard. The 40-foot distance remains in the standard, in large part due to Martin's raising awareness of efforts to remove it. Some people even question whether the 40-foot distance is long enough; there are those who would like to see a more realistic distance for drainline transport. I personally feel that 100 feet would be a more realistic distance, because the vast majority of building drains exceed 40 feet and are closer to, or exceed, 100 feet, from the fixture outlet to the public sewer.

I just returned from Frankfurt, Germany, where I attended the ISH show and the Dry Drains Forum, at which speakers from around the world discussed the issues they are having with drainline transport. It became apparent that we are all dealing with the same types of issues.

Each of these speakers addressed the issues they have been dealing with related to a phenomenon known as "dry drains," related to low flow fixtures. Dry drains is a relatively new phenomenon, as it has only started to become a problem since the advent of global water conservation efforts, and it seems to be more than just a drainline transport issue.

Dry drains are a result of continual efforts to conserve water in many ways. Newer technologies, such as non-water using urinals and high efficiency urinals (HEUs), lower flow rate faucets, and increasingly-efficient water consuming appliances reduce the amount of water discharged into sanitary waste systems. To compound the issue, greywater reuse systems that collect discharged water from lavatory basins, clothes washers, bathtubs and shower fixtures for reuse are taking water away from sanitary drainage systems. The wastewater flow must be maintained at a level that keeps the hydraulic depth of flow sufficient for proper water velocities and drainline transport.

Recently, the LEED points system has driven water use reductions to levels that are becoming unsustainable. The arbitrary points system that the LEED program has is completely out of balance with reality. The arbitrary 10 percent increment reductions in water usage have no scientific basis. Research is needed to address the minimum water flow required for proper drainline transport.

There are unique and dangerous hazards involved in arbitrarily reducing water consumption in plumbing fixtures without considering the consequences. For example: reducing a 1.6 gpf water closet 20 percent to 1.28 gpf for a LEED point and another reduction to 30 percent to gain another LEED point (1.12 gpf) will most likely be a challenge for larger horizontal buildings. In high-rise vertical buildings, it should be relatively easy to load a stack and have enough additional uses of water in the stack to provide sufficient drainline transport. In a remote restroom in a large horizontal building there will likely be drainline transport problems and an increase in drainline blockages.

The cost of cleaning the drainlines and cleaning up the spilled sewage from drainline blockages and the increased

Q&A with Ron George

Ron,

How is it that the low-flow showerheads sometimes increase scalding risk?

Regards,
Matt

Matt,

The low-flow showerheads increase the risk of scalding by restricting the flow of water out of the showerhead. This makes other fixtures without flow restrictors, water closets, clothes washers, dish washers, etc. the fixture with the largest demand. When a shower without a pressure or temperature compensating element built into the shower valve is flowing, and another nearby fixture on the cold water (CW) system turns on, the water flows to the path of least resistance. When an old two-handle or non-compensating type single-handle faucet is flowing hot and cold water into the same mixing chamber or pipe between the two valves, and a nearby CW fixture is opened, the cold water pressure will drop and then the hot water (HW) pressure is higher than the CW pressure. This condition causes hot water to temporarily cross over in the mixing faucet with the flow restrictor and flow toward the open CW fixture. The HW flowing through the faucet causes either a sudden burst of nothing but HW or a sudden rise in temperature if it does not cross over completely. The result will be thermal shock, which can lead to a slip and fall injury or if the hot water temperature is high enough, it can lead to a scalding incident. This is why I recommend storing hot water at 140°F to minimize Legionella growth in the tank and delivering HW to the HW system at a maximum of 120 F through an ASSE 1017 thermostatic mixing valve at the heater. At the shower valves there should be an ASSE 1016 control valve to minimize the chances of thermal shock. In order to eliminate thermal shock, the older style mixing valves must be replaced with mixing valves that meet the requirements of ASSE 1016 or CSA B125 requirements for individual showers. At the very least, any organization handing out free low-flow shower valves also should hand out temperature-actuated flow-reduction valves that conform to ASSE 1062 to minimize the risk of scalding with non-compensating-type valves.

Ron George

health risks associated with the spread of bacteria and mold from drainline blockages needs to be weighed against the few gallons of water that are saved. I do not know what the final outcome will be, but I do know that we need to research the issues and make sound decisions, instead of arbitrarily picking percentages of water reductions.

During the Dry Drains Forum, Dr. Lynne Jack discussed many of the water conservation efforts that are leading to the dry drain phenomenon. Dr. Jack pointed out that the proliferation of greywater systems is robbing the drainage system of much needed water to assist in drainline transport of solids. She also pointed out that the addition of non-water using urinals is further contributing to the problem.

I found some of the discussions on drainline flow research interesting, especially one of the Australian studies done by Jeff Clark, Les Barnard and Dr. Steve Cummings. Their research addressed the fact that when drainline branches are connected horizontally they allow waste to divert or back up into each branch, which lowers the hydraulic depth of flow in the main. This illustrated the need to consider code requirements to roll up branches on a 45 fitting to prevent the waste from entering the branches and reducing the drainline transport for ultra low flow fixtures.

The research also confirmed that waste should not drop from directly overhead into a horizontal drain. Waste should usually be directed upstream from a vertical stack dropping into a horizontal drain. This allows solids to settle in the horizontal pipe upstream of the connection and reduces the hydraulic depth of flow because of the diversion of waste. The stack should use a 45- and a Y-fitting to allow a rolled up 45 degree entry into the horizontal drain.

We need to be more aware of using directional drainage pattern fittings as water closet flow rates are further reduced. An interesting thing to note is that the minimum slope in Australia is 1.67 percent and in the U.S. the minimum slope is 1.0104 percent (1/8 inch per foot)

Another interesting presentation was made by Professor Mete Demiriz, the research leader for Building Services Engineering at Gelsenkirchen University in Germany. His discussion covered waterless urinals and urinal scale build-up. Les Barnard, from Australia, discussed a research project on waterless urinal installations that used glass piping on the other side of the toilet wall for observations. One toilet room was maintained and had sinks upstream flush the drain line; the other installation had no fixtures upstream and was specifically not maintained for observation purposes. They found that, after 39 months, the pipes became completely blocked by urine salts and mineral build-up. The non-water using urinals with proper maintenance and with lavatories upstream performed well.

Another issue related to low flow fixtures is that, when there is no compensating-type shower valve installed, low flow showerheads increase the risk of scalding. The installation of a low flow showerhead causes other fixtures without flow restrictors, such as water closets, clothes washers, dishwashers, etc., to have the largest demand in the system. Most homes built before the 1970s or 1980s were built without compensating-type shower valves, because these valves were not required by the codes. Based on the age of the housing stock in the United States, it is estimated that approximately half of all homes with showers and bathtubs do not have compensating-type shower control valves.

When a two-handled or non-compensating single-handle faucet flows hot and cold water into the same mixing chamber or pipe between the two valves and when a nearby cold water fixture is turned on, the cold water pressure will drop and the hot water pressure will be higher than the cold water pressure. A flow-restrictor type showerhead causes hot water to temporarily cross over in the mixing faucet. Hot water flows toward the open cold water fixture. The resulting drop in cold water pressure and the increase in hot water pressure allow hot water to flow through the mixing faucet and up to the low flow showerhead. This causes either a sudden burst of hot water or, if it simply changes the mix ratio and does not cross over completely, a sudden rise in temperature. The result will be thermal shock, which can lead to a slip and fall injury.

If the hot water temperature is high enough, it can lead to a scalding incident. To prevent scalding and to minimize Legionella bacteria growth in the water heater tank, I recommend storing hot water at 140 F. I also recommend delivering hot water to the hot water piping system at a maximum of 120 F through an ASSE 1017 or CSA B-125 thermostatic mixing valve at the heater.

To minimize the chances of thermal shock, the Model Plumbing Codes require a new shower valve to be an ASSE 1016 or CSA B-125 control valve. Mixing valves that meet the requirements of the code must be pressure-balancing, thermostatic or combination pressure-balancing/thermostatic shower valves designed for individual showers and at the flow rate of the showerhead. At the very least, any water utility or organization handing out free low flow shower valves should also offer to replace the older style shower valves. They should also hand out warning literature and consider temperature-actuated flow reduction valves that conform to ASSE 1062. The ASSE 1062 devices shut off the flow of water to a trickle when the temperature exceeds about 115 to 117 F. It should be noted that, although the ASSE 1062 device minimizes the risk of scalding with non-compensating type valves, it will not prevent thermal shock.

To sum up, the Frankfurt "Experience the Product" show was 10 times the size of any show I have ever attended. It was like ASHRAE and ASPE on steroids: It was pretty incredible. The Dry Drains Forum was an unqualified success, and I hope you will get a chance to view the photos and videos online in the near future. Until next time, keep looking for ways to save water. ■

Ron George *is president of Ron George Design & Consulting Services. He is the former Chairman of the International Residential Plumbing & Mechanical Code Committee and he serves on the International Association of Plumbing & Mechanical Officials (IAPMO) Code interpretation Answers and Analysis Committee and the IAPMO Standards Council. He is active in Plumbing Code and Plumbing Product Standard development and consulting. His company specializes in plumbing, piping, fire protection and HVAC system design. He also provides plumbing and mechanical code consulting, plumbing product standard consulting and forensic investigations and litigation support for plumbing and mechanical system failures. E-mail: rgdc@rongeorgedesign.com. Web site: www.rongeorgedesign.com.*

Fire Protection

Richard Schulte, Schulte & Associates, Evanston, Ill.

The collapse of WTC 7: The NIST recommendations, Part 1

The Executive Summary of the National Institute of Standards and Technology (NIST) Final Report (November 2008) on its investigation into the collapse of the WTC 7 Building begins with the following paragraph:

"WTC 7 was a 47-story office building located immediately to the north of the main WTC Complex. It had been built on top of an existing Consolidated Edison of New York electric power substation, which was located on land owned by The Port Authority of New York and New Jersey. On September 11, 2001, WTC 7 endured fires for almost seven hours, from the time of the collapse of the north WTC tower (WTC 1) at 10:28:22 a.m. until 5:20:52 p.m., when it collapsed. This was the first known instance of the total collapse of a tall building primarily due to fires."

Given the last statement in the paragraph above, the report on the collapse of WTC 7 should be of considerable interest to both structural engineers and fire protection professionals. The two-part column that appeared in the February and March 2008 issues of *Plumbing Engineer* included excerpts from the NIST report and critiqued the entire report. This column will focus entirely on Chapter 5 of the report. Chapter 5 is titled "Recommendations." The following are excerpts from Chapter 5:

"In its final report on the collapse of the World Trade Center towers (NIST NCSTAR 1), NIST made 30 recommendations for improving the safety of buildings, occupants, and emergency responders. These encompass increased structural integrity, enhanced fire endurance for structures, new methods for fire resistant design of structures, improved active fire protection, improved building evacuation, improved emergency response, improved procedures and practices, and education and training." (page 63)

"The urgency of the prior recommendations is substantially reinforced by their pertinence to the collapse of WTC 7, a tall building that is based on a structural system design which is in widespread use. A few of the prior recommendations have been modified to reflect the finding of this Investigation." (page 63)

"The partial or total collapse of a building due to fires is an infrequent event. This is particularly true for buildings with a reliably operating active fire protection system such as an automatic fire sprinkler system. A properly designed and operating automatic sprinkler system will contain fires while they are small and, in most instances, prevent them from growing and spreading to threaten structural integrity. Fires that have spread and grown can also be extinguished by fire fighters when they are smaller than 10,000 sq ft." (page 63)

"The intent of current practice, based upon prescriptive standards and codes, is to achieve life safety, not collapse prevention. However, the key premise of NIST's recommendations is that buildings should not collapse in infrequent fires that may occur when active fire protection systems are rendered ineffective, e.g., when sprinklers do not exist, are not functional, or are overwhelmed by the fire." (pages 63 and 64)

"Fire scenarios for structural design based upon a single compartment or single floor fires are not appropriate representations of infrequent event fires. Such events have occurred in several tall buildings, resulting in unexpected substantial losses. Instead, historical data suggests that infrequent fires which should be considered in structural design involve: ordinary combustibles and combustible load levels, local fire origin on any given floor, no widespread use of accelerants, consecutive fire spread from combustible to combustible, fire-induced window breakage providing ventilation for continued fire spread and accelerated fire growth, concurrent fires on multiple floors, and active fire protection systems rendered ineffective. The fires in WTC 7 involved all of these." (page 64)

"The scope of the WTC Investigation does not include supporting analyses of the recommendations, such as alternative factors or design options." (page 64)

*"**Recommendation A (NIST NCSTAR Recommendation 1).** NIST recommends that: (1) progressive collapse be prevented in buildings through the development and nationwide adoption of consensus standards and code provisions, along with the tools and guidelines needed for their use in practice; and (2) a standard methodology be developed - supported by analytical design tools and practical design guidance - to reliably predict the potential for complex failures in structural systems subjected to multiple hazards.*

Relevance to WTC 7: Had contemporaneous standards and practices been available to expressly design WTC 7 for prevention of fire-induced progressive collapse, it would have been sufficiently robust to withstand local failure due to fires without suffering total collapse." (page 64)

*"**Recommendation B (New).** NIST recommends that buildings be explicitly evaluated to ensure the adequate performance of the structural system under maximum credible (infrequent) design fires with any active fire protection system rendered ineffective. Of particular concern are the effects of thermal expansion in buildings with one or more of the following features: (1) long-span floor systems which experience significant thermal expansion and sagging effects, (2) connection designs (especially shear connections) that cannot accommodate thermal effects, (3) floor framing that introduces asymmetric thermally-induced (i.e., net lateral) forces on girders, (4) shear studs that could fail due to differential thermal expansion in composite floor systems, and (5) lack of shear studs on*

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girders. Careful consideration should also be given to the possibility of other design features that may adversely affect the performance of the structural systems under fire conditions." (page 65)

"Building owners, operators, and designers are strongly urged to act upon this recommendation. Engineers should be able to design cost-effective fixes to address any areas of concern that are identified by these evaluations. Several existing, emerging or even anticipated capabilities could have helped prevent the collapse of WTC 7. The degree to which these capabilities improve performance remains to be evaluated. Possible options for developing cost-effective fixes include:

** More robust connections and framing systems to better resist the effects of thermal expansion on the structural system.*

** Structural systems expressly designed to prevent progressive collapse. The current model building codes do not require that buildings be designed to resist progressive collapse.*

** Better thermal insulation (i.e., reduced conductivity and/or increased thickness) to limit heating of structural steel and to minimize both thermal expansion and weakening effects. Currently, insulation is used to protect steel strength, but it could be used to maintain a lower temperature in steel framing to limit thermal expansion.*

** Improved compartmentation in tenant areas to limit the spread of fires.*

** Thermally resistant window assemblies which limit breakage, reduce air supply, and retard fire growth.*

Industry should partner with the research community to fill critical gaps in knowledge about how structures perform in real fires, particularly considering: the effects of fire on the entire structural system; the interactions between subsystems, elements, and connections; and scaling of fire test results to full-scale structures, especially structures with long span floor systems.

Relevance to WTC 7: The effects of restraint of free thermal expansion on the steel framing systems, especially for the long spans on the east side of WTC 7, were not considered in the structural design and led to the initiation of the building collapse."

(pages 65 and 66)

*"**Recommendation C (NIST NCSTAR 1 Recommendation 4)** NIST recommends evaluating, and, where needed, improving the technical basis for determining appropriate construction classification and fire rating requirements (especially for tall buildings) - and making related*

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code changes now as much as possible - by explicitly considering factors including:

** timely access by emergency responders and full evacuation of occupants, or the time required for burnout without partial collapse;*

** the extent to which redundancy in active fire protection (sprinkler and standpipe, fire alarm, and smoke management) systems should be credited for occupant life safety;*

** the need for redundancy in fire protection systems that are critical to structural integrity;*

** the ability of the structure and local floor systems to withstand a maximum credible fire scenario without collapse, recognizing that sprinklers could be compromised, not operational, or non-existent;*

** compartmentation requirements (e.g., 12,000 ft2) to protect the structure, including fire rated doors and automatic enclosures, and limiting the air supply (e.g., thermally resistant window assemblies) to retard fire spread in buildings with large, open floor plans;*

**the effect of spaces containing unusually large fuel concentrations for the expected occupancy of the building; and*

** the extent to which fire control systems, including suppression by automatic or manual means, should be credited as part of the prevention of fire spread.*

*"**Footnote 3.** The construction classification and fire rating requirements should be risk-consistent with respect to the design-basis hazards and the consequences of those hazards. The fire rating requirements, which were originally developed based on experience with buildings fewer than 20 stories in height, have generally decreased over the past 80 years since historical fire data for buildings suggests considerable conservatism in those requirements. For tall buildings, the likely consequences of a given threat to an occupant on the upper floors are more severe than the consequences to an occupant on the first floor or the lower floors. For example, with non-functioning elevators, both the time requirements are much greater for full building evacuation from upper floors and emergency responder access to those floors. The current height and area tables in building codes do not provide the technical basis for the progressively increasing risk to an occupant on the upper floors of tall buildings that are much greater than 20 stories in height."*

"Relevance to WTC 7: The floor systems in WTC 7 failed because thermal effects within the structural system, especially thermal expansion, were not considered in setting the fire rating requirements in the construction classification, which are determined using the ASTM E119 or equivalent testing standard. Such evaluation is not required under current codes and standards." (pages 66 and 67)

*"**Recommendation D (NIST NCSTAR 1 Recommendation 5).** NIST recommends that the technical basis for the century-old standard for fire resistance testing of components, assemblies, and systems be improved through a national effort. Necessary guidance also should be developed for extrapolating the results of tested assemblies to prototypical building systems. A key step in fulfilling this recommendation is to establish a capability for studying and testing the components, assemblies and systems under realistic fire and load conditions.*

Of particular concern is that the Standard Fire Resistance Test does not adequately capture important thermally-induced interactions between structural sub-systems, elements, and connections that are critical to structural integrity. System-level interactions, especially due to thermal expansion, are not considered in the standard test method since columns, girders, and floor assemblies are tested separately. Also, the performance of connections under both gravity and thermal effects is not considered. The United States cur-

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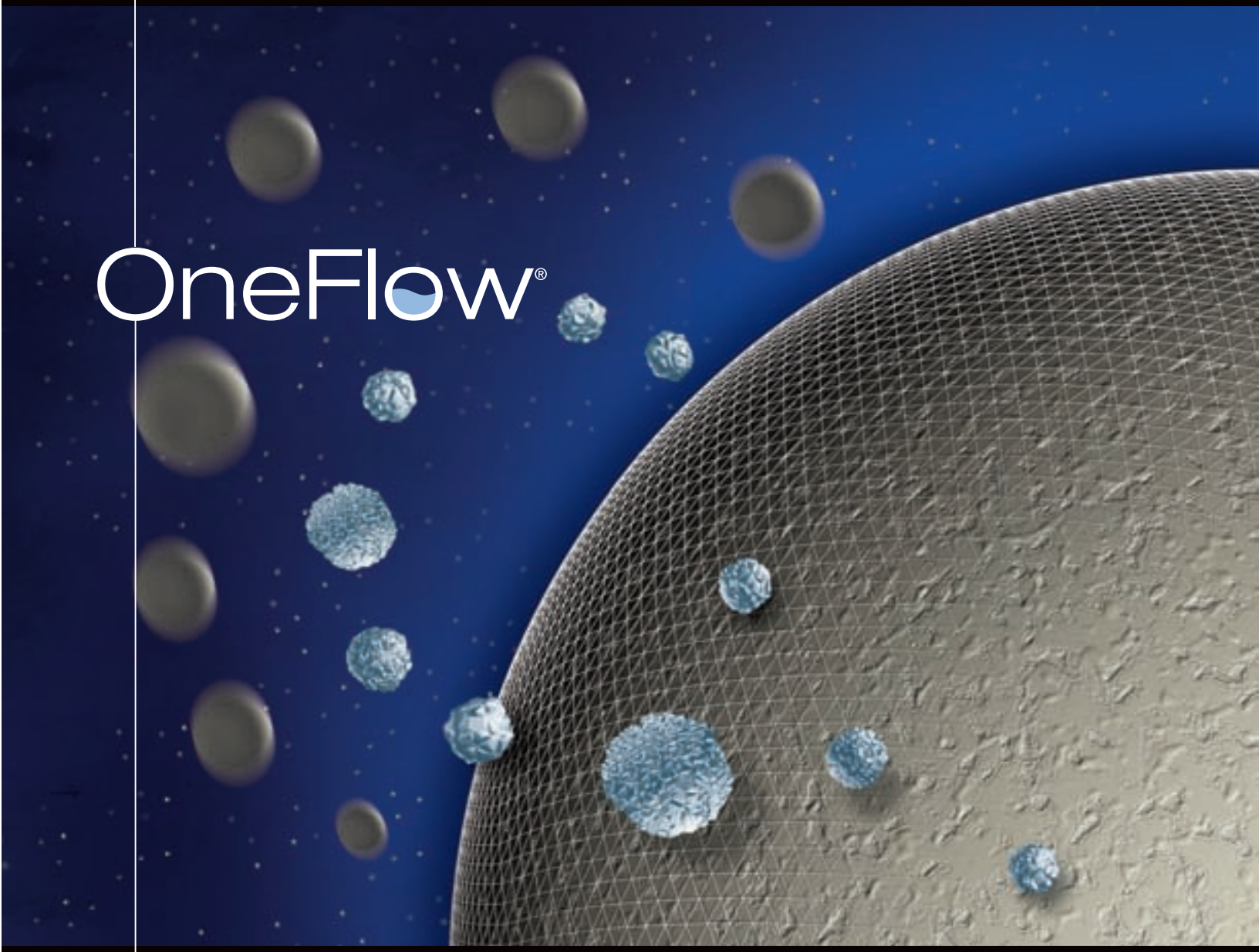

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rently does not have the capability for studying and testing these important fire-induced phenomena critical to structural safety.

Relevance to WTC 7: The floor systems failed in WTC 7 at shorter fire exposure times than the specified fire rating (two hours) and at temperatures lower than the endpoint temperature (593° C, 1100° F) because thermal effects within the structural system, especially thermal expansion, were not considered in setting the endpoint criteria when using the ASTM E119 or equivalent testing standard. The structural breakdowns that led to the initiating event and the eventual collapse of WTC 7 occurred at temperatures that were hundreds of degrees below the criteria that determines structural fire resistance ratings." (page 67)

*"**Recommendation E (NIST NCSTAR 1 Recommendation 7).** NIST recommends the adoption and use of the "structural frame" approach to fire resistance ratings. This approach requires all members that comprise the primary structural frame (such as columns, girders, beams, trusses, and spandrels) be fire protected to the higher fire resistance rating required for the columns. The definition of the primary structural frame should be expanded to include bracing members that are essential to the vertical stability of the primary structural frame under gravity loading (e.g. girders, diagonal bracing, composite floor systems that provide lateral bracing to the girders) whether or not the bracing members carry gravity loads. Some of these bracing members may not have direct connections to the columns, but provide stability to those members directly connected to the columns. ...This recommendation ensures consistency in the fire protection provided to all structural elements that contribute to overall stability. State and local jurisdictions should adopt and enforce this requirement.*

Relevance to WTC 7: Thermally-induced breakdown of the floor system in WTC 7 was a determining step in causing collapse initiation and progression. Therefore, the floor system should be considered as an integral part of the primary structural frame." (pages 67 and 68)

*"**Recommendation F ([NIST] NCSTAR [1] Recommendation 8).** NIST recommends that the fire resistance of structures be enhanced by requiring a performance objective that uncontrolled building fires result in burnout without partial or global (total) collapse. Such a provision should recognize that sprinklers could be compromised, non-operational, or nonexistent. Current methods for determining the fire resistance of structural assemblies do not explicitly specify a performance objective. The rating resulting from current test methods indicates that the assembly (component or subsystem) continued to support its superimposed load (simulating a maximum*

load condition) during the test exposure without collapse.

Model Building Codes: This recommendation should be included in the national model codes as an objective and adopted as an integral part of fire resistance design for structures. The issue of non-operational sprinklers could be addressed using the existing concept of Design Scenario 8 of NFPA 5000, where such compromise is assumed and the result is required to be acceptable to the Authority Having Jurisdiction.

Relevance to WTC 7: Large, uncontrolled fires led to failure of a critical column and consequently the complete collapse of WTC 7. In the region of the collapse initiation (i.e., on the east side of Floor 13), the fire had not consumed the combustible building contents, yet collapse occurred." (page 68)

*"**Recommendation G (NIST NCSTAR 1 Recommendation 9).** NIST recommends the development of: (1) performance-based standards and code provisions, as an alternative to current prescriptive design methods, to enable the design and retrofit of structures to resist real building fire conditions, including their ability to achieve the performance objective of burnout without structural or local floor collapse:[;] and (2) the tools, guidelines, and test methods necessary to evaluate the fire performance of the structure as a whole system. ... This performance-based capability should include the development of, but not be limited to:*

a. Standard methodology, supported by performance criteria, analytical design tools, and practical design guidance; related building standards and codes for fire resistance design and retrofit of structures, working through the consensus process for nationwide adoption; comprehensive design rules and guidelines; methodology for evaluating thermostructural performance of structures; and computational models and analysis procedures for use in routine design practice.

b. Standard methodology for specifying multi-compartment, multi-floor fire scenarios for use in design and analysis of structures to resist fires, accounting for building-specific conditions such as geometry, compartmentation, fuel load (e.g., building contents and any flammable fuels such as oil and gas), fire spread, and ventilation; and methodology for rating the fire resistance of structural systems and barriers under realistic design-basis scenarios.

c. Publicly available computational software to predict the effects of fires in buildings - developed, validated, and maintained through a national effort - for use in the design of fire protection systems and the analysis of building response to fires. Improvements should include the fire behavior and contribution of real combustibles; the per-

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formance of openings, including door openings and window breakage, that controls the amount of oxygen available to support the growth and spread of fires and whether the fire is fuel-controlled or ventilation-controlled; the floor-to-floor flame spread; the temperature rise in both insulated and uninsulated structural members and fire barriers; and the structural response of components, subsystems, and the total building system due to fire.

d. Temperature-dependent thermal and mechanical property data for conventional and innovative construction materials[.]

e. New test methods, together with associated conformance assessment criteria, to support the performance-based methods for fire resistance design and retrofit of structures. The performance objective of burnout without collapse will require the development of standard fire exposures that differ from those currently used.

Relevance to WTC 7: A performance-based assessment of the effects of fire on WTC 7, had it considered all of the relevant thermal effects (e.g., thermal expansion effects that occur at lower temperatures), would have identified the vulnerability of the building to fire-induced collapse and allowed alternative designs for the structural system." (pages 68 and 69)

*"**Recommendation H (NIST NCSTAR 1 Recommendation 12).** NIST recommends that the performance and possibly the redundancy and reliability of active fire protection systems (sprinklers, standpipe/hoses, fire alarms, and smoke management systems) in buildings be enhanced to accommodate the greater risks associated with increasing building height and population, increased use of open spaces, high-risk building activities, fire department response limits, transient fuel loads, and higher threat profile.*

Reliability is affected by (a) the redundancy such that when one water supply is out of service (usually for maintenance) the other interconnected water supply can continue to protect the building and its occupants, (b) automatic operation of water systems (not only for starting fire pumps but also for testing and tank replenishment with appropriate remote alarms to the fire department and local alarms for notifying emergency personnel), (c) the use of suitable equipment and techniques to regulate unusual pressure considerations.

Relevance to WTC 7: No water was available for the automatic suppression system on the lower 20 stories of WTC 7 once water from street-level was disrupted. This lack of reliability in the source of the primary and secondary water supplies allowed the growth and spread of fires that ultimately resulted in the collapse of the building." (page 70)

*"**Recommendation I (NIST NCSTAR 1 Recommendation 24).** NIST recommends the establishment and implementation of codes and protocols for ensuring effective and uninterrupted operation of the command and control system for large-scale building emergencies.*

a. State, local, and federal jurisdictions should implement the National Incident Management System (NIMS). The jurisdictions should work with the Department of Homeland Security to review, test, evaluate, and implement an effective unified command and control system. NIMS addresses interagency coordination and establishes a response matrix - assigning lead agency responsibilities for different types of emergencies and functions. At a minimum, each supporting agency should assign an individual to provide coordination with the lead agency at each incident command post.

b. State, local, and federal emergency operation centers (EOCs) should be located, designed, built, and operated with security and operational integrity as a key consideration.

c. Command posts should be established outside the potential collapse footprint of any building which shows evidence of large multi-floor fires or has serious structural damage. A continual assessment of building stability and safety should be made in such emergencies to guide ongoing operations and enhance emergency responder safety. The information necessary to make these assessments should be made available to those assigned the responsibility. ...

d. An effective command system should be established and operating before a large number of emergency responders and apparatus are dispatched and deployed. Through training and drills, emergency responders and ambulances should be required to await dispatch requests from the incident command system and not to self-dispatch in large-scale emergencies.

e. Actions should be taken via training and drills to ensure a coordinated and effective emergency response at all levels of the incident command chain by requiring all emergency responders that are given an assignment to immediately adopt and execute the assignment objectives.

f. Command post information and incident operations data should be managed and broadcast to command and control centers at remote locations so that information is secure and accessible by all personnel needing the information. Methods should be developed and implemented so that any information that is available at an interior information center is transmitted to an emergency responder vehicle or command post outside the building.

Relevance to the WTC 7: (1) The New York City Office of Emergency Management (OEM) was located in WTC 7 and was evacuated early in the day before key fire ground decisions had to be made. The location of OEM in WTC 7 contributed to the loss of robust interagency command and control on September 11, 2001. (2) Due to the collapse of the WTC towers and the loss of responders and fire control resources, there was an evolving site leadership during the morning and the afternoon. Key decisions (e.g., decisions not to fight the fire in WTC 7 and to turn off the power to the Con Edison substation) were reasonable and would not have changed the outcome on September 11, 2001, but were not made promptly. Under different circumstances (e.g., if WTC 7 had collapsed sooner and fire fighters were still evaluating the building condition), the outcome could have been very different." (pages 70 and 71)

*"**Recommendation J (NIST NCSTAR 1 Recommendation 27).** NIST recommends that building*

codes incorporate a provision that requires building owners retain documents, including supporting calculations and test data, related to building design, construction, maintenance and modifications over the life of the building. Means should be developed for offsite storage and maintenance of the documents. In addition, NIST recommends that relevant building information be made available in suitably designed hard copy or electronic format for use by emergency responders. Such information should be easily accessible by responders during emergencies.

Relevance to WTC 7: The efforts required in locating and acquiring drawings, specifications, tenant layouts, and material certifications, and especially shop fabrication drawings, significantly lengthened the investigation into the collapse of WTC 7." (page 72)

*"**Recommendation K (NIST NCSTAR 1 Recommendation 28).** NIST recommends that the role of the "Design Professional in Responsible Charge" be clarified to ensure that: (1) all appropriate design professionals (including, e.g., the fire protection engineer) are part of the design team providing the standard of care when designing buildings employing innovative or unusual fire safety systems, and (2) all appropriate design professionals (including, e.g., the structural engineer and the fire protection engineer) are part of the design team providing the standard of care when designing the structure to resist fires, in buildings that employ innovative or unusual structural and fire safety systems.*

Relevance to WTC 7: Following typical practice, none of the design professionals in charge of the WTC 7 project (i.e., architect, structural engineer, and fire protection engineer) was assigned the responsibility to explicitly evaluate the fire performance of the structural system. Holistic consideration of thermal and structural factors during the design or review stage could have identified the potential for the failure and might have prevented the collapse of the building." (page 72)

*"**Recommendation L (NIST NCSTAR 1 Recommendation 29).** NIST recommends that continuing education curricula be developed and programs be implemented for (1) training fire protection engineers and architects in structural engineering principles and design, and (2) training structural engineers, architects, fire protection engineers, and code enforcement officials in modern fire protection principles and technologies, including fire-resistant design of structures, and (3) training building regulatory and fire service personnel to upgrade their understanding and skills to conduct the review, inspection and approval tasks for which they are responsible. The outcome would further the integration of the disciplines in effective fire-safe design of buildings.*

Relevance to WTC 7: Discerning the fire-structure interactions that led to the collapse of WTC 7 required research professionals with expertise in both disciplines. Assuring the safety of future buildings will require that participants in the design and review processes possess a combined knowledge of fire science, materials science, heat transfer, and structural engineering and design." (pages 72 and 73)

*"**Recommendation M (NIST NCSTAR 1 Recommendation 30).** NIST recommends that academic, professional short-course, and web-based training materials in the use of computational fire dynamics and thermostructural analysis tools be developed and delivered to strengthen the base of available technical capabilities and human resources.*

Relevance to WTC 7: NIST stretched the state-of-the-art in the computational tools needed to reconstruct a fire-induced building collapse. This enabled identification of the critical processes that led to that collapse. Making these expanded tools and derivative, validated, and simplified modeling approaches usable by practitioners could prevent future disasters." (page 73)

Discussion

With one exception (Recommendation B), the recommendations for improving the level of safety in buildings excerpted above were contained in the NIST Final Report on the investigation into the collapse of the WTC 1 and WTC 2 towers issued in the fall of 2005. Hence, these recommendations have already been discussed and debated and have spawned proposals in the code change processes conducted by the International Code Council (ICC) and the National Fire Protection Association (NFPA). Many of these proposals have already been incorporated into the model building codes developed by these two organizations.

Nonetheless, a discussion of the NIST recommendations should still be of interest because of the significant adverse impact that the implementation of these recommendations will have on the construction of new high-rise buildings and the cost of upgrading existing high-rise buildings to comply with the NIST recommendations.

Prior to beginning the discussion of the NIST recommendations, let's take a look back at the origins of the NIST investigations into the collapse of the WTC towers and WTC 7 in order to gain a perspective on the original purpose and goals of the investigations.

Congressional hearings on the collapse of the World Trade Center towers began roughly six months after September 11. The first hearing, held on March 6, 2002, opened with a statement from the chairman of the committee, Congressman Sherwood Boehlert (R-N.Y.), followed by testimony from five witnesses. Congressman Boehlert's opening statement included the following excerpts:

"The Committee decided to move forward for two fundamental reasons. First, we believe that we owe it to the victims and their families to learn everything possible about what happened in those horrifying first hours of September 11- not just to satisfy their immediate needs and yearnings, but to ensure that such a catastrophic building failure, and the resulting loss of life, never happen again."

"Another significant lesson of the Trade Center collapse is that we need to understand a lot more about the behavior of skyscrapers and about fire, if we are going to prevent future tragedies."

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"But this hearing is not so much about the past, as it is about ensuring that we protect lives in the future."

The final witness before the committee was Dr. Bement, the director of NIST. Dr. Bement's testimony included the following:

"The tragedy that the United States experienced on September 11, 2001, was unprecedented when compared with any prior accident, natural disaster or terrorist/ war attack. The collapse of the twin World Trade Center towers was the worst building disaster in human history. ..."

"The implementation of the results of such an investigation would be critical to restore public confidence in the safety of tall buildings nationwide, enhance the safety of fire and emergency responders and better protect people and property in the future. To cite one example, the February 4 issue of *Crain's New York Business* reports that an increasing number of tenants are leaving the Empire State Building, which is again the tallest building in New York City, because of fears of another terrorist attack. Anecdotal evidence also suggests that building vacancy rates have doubled in Manhattan, despite the 15 million square feet of space that was lost on September 11."

"The Building and Fire Research Laboratory is the foremost fire research laboratory in the United States, and, through the National Earthquake Hazards Reduction Program (NEHRP), NIST is the principal agency for research and development to improve building codes and standards. ... "

"Fourth, to study procedures and practices used to provide adequate structural reserve capacity to resist abnormal loads (e.g. blast, explosion, impact due to aircraft or flying debris from tornadoes, accidental fires and faulty design and construction), especially those that can be anticipated prior to construction (e.g. impact of a Boeing 707) ... "

"This broader program would address critically and urgently needed improvements to national building and fire standards, codes and practices that have begun to be recognized in recent years. The events of September 11 have brought even more focus and priority to this already important issue."

"The goal of this broader program would be to produce cost-effective retrofit and design measures and operational guidance for building owners and emergency responders."

"Current building design practice does not consider fire as a design condition. Instead, structural fire endurance ratings are prescribed in building codes using standard tests on individual components. The current testing standards are based on work carried out at NIST in the 1920s. They do not represent real fire hazards in modern buildings. They also do not consider the fire performance of structural connections or of the structural system as a whole, or the multiple performance demands on fireproofing materials."

"In short, NIST would provide the technical basis and guidance for fire safety design and retrofit of structures, the predictive tools and test methods for fire resistance determination and the performance criteria for fireproofing materials. In addition, NIST proposes to develop guidance and retrofit technologies to enhance building egress in emergencies, practical tools and guidance to enhance the safety and effectiveness of fire and emergency responders and improved models of occupant behavior and response to enhance evacuation and communication in emergencies."

"Yet, the United States has not developed standards, codes, and practices to assess and reduce this vulnerability. Adding to the problem for modern structures is their smaller margin of safety - and the reserve capacity to accommodate abnormal loads - due to increased efficiency in the use of building materials and refinements in analysis techniques ... "

"The overwhelming majority of buildings in public use today are vulnerable to terrorist attack on a number of fronts ... "

"The final program element supports a construction-industry-led road mapping effort to reflect changed priorities for development and deployment of safety and security standards, technology and practices."

"The effort would complement and support parallel efforts of technical organizations to improve standards, codes and practices."

"In conclusion, I believe it is imperative for the U.S. to learn from the worst-ever building disasters in human history and to take aggressive remedial action to minimize future losses."

"In the wake of September 11, the private sector's willingness to take necessary corrective action to strengthen building codes and standards is extraordinarily strong."

Following the March 6 hearings, members of the Science Committee issued a press release containing some of the members' reactions to the testimony that the committee heard. The reaction of one committee member, Representative Connie Morella (R-Md.) was as follows:

"The importance of this work can't be overstated. Research into this disaster is the only way we have any chance of preventing the next one and Congress needs to move swiftly to formalize the way we evaluate catastrophic building collapse. Fortunately, we have an advanced federal laboratory dedicated to such research. The National Institute of Standards and Technology is uniquely position[ed] to conduct extensive investigations into the structural failures of the World Trade Center and to suggest appropriate new standards and potential retrofits ..."

Now that the NIST investigation reports on the collapse of the WTC towers and WTC 7 building have been completed, and NIST's final recommendations on making buildings "safer" have been published, we can begin to evaluate whether or not NIST's investigations have actually fulfilled the promises NIST made to Congress and the American public and also our progress in preventing "the next one".

Interestingly enough, NIST's recommendations contained in its final investigation reports do not address the issue of terrorism and "the overwhelming majority of buildings in public use today" still remain "vulnerable to

terrorist attack on a number of fronts. ... " Also of interest is that "the next one" has been prevented in the 7+ years since September 11, without even implementing NIST's recommendations. In other words, the United States has been able to prevent future disasters by preventing terrorist activity in this country (and by simply enforcing our existing building codes). Given this, it seems fair to ask: Is the implementation of the NIST recommendations for "critically and urgently needed improvements to national building and fire standards, codes and practices " really all that critical, or even necessary at all?

In my opinion, it is simply not economically feasible to make our buildings "terrorist-proof" or even "terrorist-resistant" and that the generation of codes and standards in use in the early part of this decade (i.e., 2000 and 2003 editions of the International Building Code) provide more than adequate safety for both building occupants and emergency responders. One only has to look at the fire safety statistics for high-rise buildings protected by a sprinkler system to see that the increase in the level of safety provided by the implementation of the NIST recommendations will be minuscule, at best. Given the current economic climate in the United States, do we really want to make the development and construction of new high-rise buildings more difficult, costly and, in many cases, simply impractical, when the safety record of high-rise buildings is already outstanding and the increase in the level of safety provided by the implementation of the NIST recommendations is so minuscule?

Quite frankly, the implementation of the NIST recommendations will provide little "bang" in the way of building safety for the billions of dollars that will be required to comply with these recommendations. Again, in my opinion, we could save hundreds of thousands of more lives in the next few decades by taking the resources invested in compliance with more restrictive provisions for high-rise buildings and investing these resources in highway safety.

Common sense should tell us that saving the lives of hundreds of thousands of Americans by reducing the number of traffic fatalities over the next few decades ought to be a far higher priority than, at most, saving the lives of a few thousand or, perhaps, as few as a handful, of Americans, by implementing the NIST recommendations. Saving hundreds of thousands of lives versus saving thousands of lives, at most, over the next few decades: I would hope that most safety professionals, including the engineers and scientists at NIST, would agree that the choice is obvious.

In a time when our economic resources are limited, public officials need to invest the public's money wisely. (Building codes are a means of allocating our resources, which must be invested in building safety.) The implementation of the NIST recommendations is simply not a wise use of our dollars invested in public safety.

Part 2 of this article will provide an in-depth discussion of the NIST recommendations. ■

Richard Schulte is a graduate of the Fire Protection Engineering Program at the Illinois Institute of Technology. He formed Schulte & Assoc. in 1988. His consulting experience includes work on the Sears Tower and many other notable structures. He also has acted as an expert witness in the litigation involving the fire at the New Orleans Distribution Center.

Modern Hydronics

By Paul Rohrs, Radiant Expert, Biggerstaff Radiant Solutions, Lincoln, Neb.

An Olympic caliber relay, Part 2

Last month we talked about relays: what they are, how they work, how best to utilize them. This month I would like to build on that by looking at how industry professionals from coast to coast are using relays in practical and creative applications.

Rocky Pavey is the owner/operator of Rocky's Heating Service in Fairbanks, Alaska. Rocky uses relays with his Energy Kinetics System 2000 boiler installs. Rocky states, "The EK boiler has a 'digital manager' that provides power to the thermostats. It also provides power to the zone valves. Closing the zone valve kills power to the zone contacts, relying on a 'spring return' style zone valve to pull itself closed. If we come across a system using White Rogers 1311 or 1361 zone valves where they are 'power open/ power close,' then we have to leave their 24-volt transformers connected. This presents possible conflict between the System 2000 digital manager's transformer and the zone valves transformer.

"We use the RIB brand, single-pole single-throw (SPST) relay to connect to the tail switch contacts of White Rogers 1311 and 1361 series zone valves. Then the output side of the RIB becomes my thermostatic demand to the digital manager, preventing any butting heads of transformer power. It keeps us from having to replace some perfectly good zone valves when using the System 2000 boiler controls."

Brad White is a highly respected engineer from Boston. White says, "I am partial to Veris Hawkeye current sensing relays. They are roughly sixty bucks and can be panel mounted or in a junction box. Some uses I have in play include: interlocking combustion air fans with a clothes dryer; make-up air fan with a cooking range hood fan; lock-out or enabling of pumps and/or fan coils (not running a fan until water flow is established) to prevent freeze-stat lockout. This allows the return temperature sensor to be satisfied in series too. These are just a few of its many applications. Also the #735 can detect amperage spikes indicating a fan belt break or sheared pump coupling."

A lot of snowmelt systems use circulators with high amp draws. I use relays to isolate and protect circuits in the system when these circulators have the potential to trip breakers and blow fuses. Figure 1 illustrates a two-zone snowmelt system with one heat source. Figure 2 shows the electrical schematic of the controls and boilers that are controlling this system. We can refer to Figure 1 for piping and visual references and to Figure 2 for the bulk of our discussion about how relays 1 to 3 are used and what their functions are.

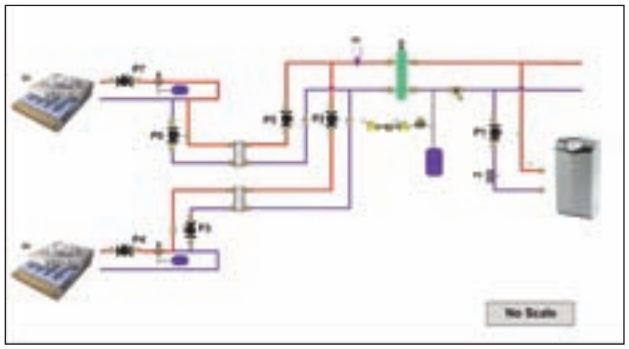

Figure 1. An illustration used for piping and visual references.

The Tekmar 665's featured slab sensors (S5 and S6), when coupled with the outdoor sensors (S3 and S2), will activate the system and start melting snow through terminals 11 and 12. When the snowmelting call for heat begins, 120V is switched through terminals 11 and 12. We use this circuit to power the coil on our relays on terminals 7 and 2 on relays R2 and R3. With the coil now closed, we can highlight two functions on each relay. First, upon energizing the coil, the NO (normally open) terminals 1 and 3 close and allow it to complete the circuit back to our boiler TT of our Lochinvar Knight boiler. This signals the call for heat, and the boiler initiates its firing sequence to inject heat into the system. Secondly, when the coil is energized, relays R2 and R3 allow terminals 8 and 6 to switch 120V(ac) power to complete our circuit to the P6 and P3 circulators.

Now let's look at our Knight boilers control board. With the Knight boiler, anytime there is a call for heat via the room stat or end switch terminals, the system pump contacts are engaged. Even if the domestic hot water (DHW) circulator is used and the boiler pump drops off, the system pump contacts remain engaged until the call for heat ends. This feature is used to our advantage by driving the circulators that provide heat to the heat exchangers. The Knight boiler system pump contacts will allow up to a 1.8 amp draw, but our P2 and P5 circulators are going to draw 3.0 amps each, so use the R1 relay to protect our system pump contacts.

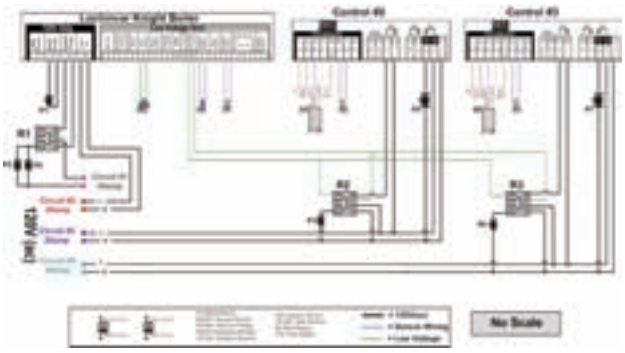

Figure 2. Illustrates how relays 1 to 3 are used and what their functions are.

As said earlier, the system pump contacts remain

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Modern Hydronics

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engaged constantly during a call for heat, so we are going to use those contacts to close the 120V(ac) coil of our R1 relay to switch a dedicated and appropriately sized circuit (Circuit #1) to our P2 and P5 circulators. When the system pump contacts engage, it powers the coil on terminals 7 and 2 and allows our NO contacts to close so that terminals 8 and 6 safely feed the necessary power and amperage to our circulators.

With the use of three DPDT relays on this job, we safely switched the necessary voltage and required amp draw to our P2 and P5 circulators, switched power to our P3 and P6 circulators and completed the low voltage circuit to signal a call for heat to the boiler. As with any heating or snowmelt system, proper programming and selection of controls is essential to proper operation. Hopefully, relays and their proper wiring will be second nature to you, and heating contractors across the country will be using these handy and inexpensive devices to enhance their heating systems. ■

Paul Rohrs welcomes your comments. Contact Paul at paul@biggerstaffradiantsolutions.com.

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Solar Solutions

Bristol Stickney, technical director, Cedar Mountain Solar Systems, Santa Fe, N.M.

Bristol's six principles of good solar hydronic design

Collector efficiency and the SRCC

I have said many times that if you don't get the first five principles right, the last one does not matter. Yes, I am speaking of the E-word, *Efficiency*.

Many people use this term in casual conversation, without understanding what it means. It is really a simple relationship between the total energy (fuel) available and the useful portion of it that is put to good use. Divide the useful energy delivered by the energy available and you get Efficiency, expressed as a fraction or as a percent. It is often abbreviated using the Greek letter Nu (η). The confusion starts when people are not clear about what is available or how much is useful. Even worse is when they confuse Effectiveness with Efficiency, such as the fellow that recently told me that his flat plate solar collectors get boiling hot, so they must be really efficient.

To add to the confusion, the thermal efficiency of a solar heat collector is not static: It changes as the operational conditions change. This can make a fair comparison of one collector to another really difficult, since panels come in different sizes, are made of different materials and can be used in countless different climates and temperature applications. Clearly there is a need for a standard way of testing and comparing solar heat collectors and, in the United States, that standard is maintained by the Solar Rating and Certification Corporation (SRCC). Let's take a closer look at collector efficiency and the vast repository of solar collector data that is the SRCC.

The SRCC

The Solar Rating and Certification Corporation (SRCC) is our national solar heating test facility. It was founded in 1980 as a non-profit organization whose primary purpose is development and implementation of certification programs and national rating standards for solar energy equipment. They administer a certification, rating and labeling program for solar collectors and a similar program for complete solar water heating systems. (We will cover complete systems in a future article.) The rating and labeling has become more important to installers and owners in recent years, since this is now required for the solar equipment to qualify for solar tax credits in the U.S. The labels themselves can be useful when making an energy performance comparison, since they show a standard performance rating similar to those found on appliances and cars.

The SRCC database is the one place where all these ratings can be found side by side for an easy and useful comparison. This information is free on the SRCC website at www.solar-rating.org and includes a complete list of all the test results for all the collector manufacturers available on the U.S. market. New products entering the U.S. market must submit to SRCC testing, or they will not qualify for most solar subsidy programs. The list is regularly updated; new products are listed as their testing is completed. The SRCC website does a good job of explaining themselves and their programs, so feel free to check it out.

Free publications are available for download on this website. The ones that cover solar collector ratings from A to Z in PDF format are:

1. *Summary of SRCC Certified Solar Collector and Water Heating System Ratings,* a 50-page publication listing the performance ratings for solar collectors and systems;

2. *Directory of SRCC Certified Solar Collector Ratings,* a 279-page publication that includes construction and rating information on certified solar collectors.

There is also a lot of information on solar water heater system ratings, which I hope to cover in more detail in the future.

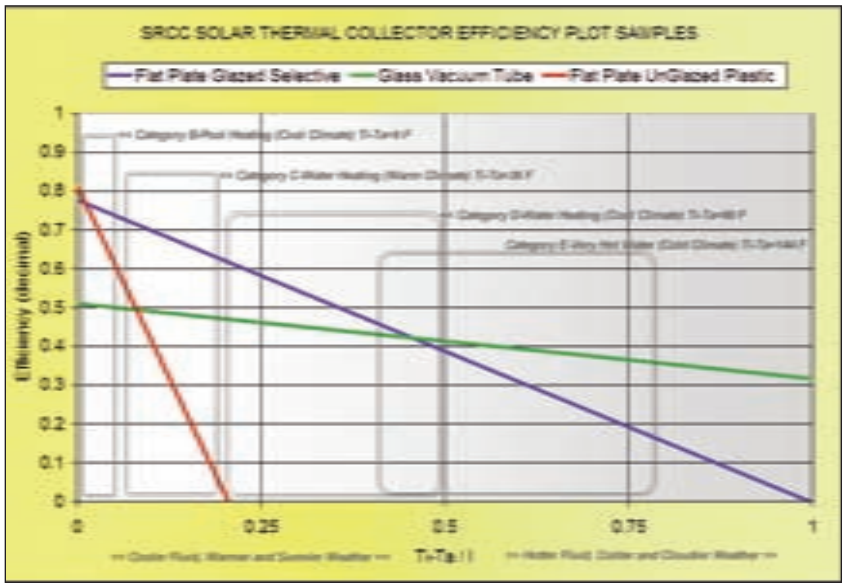

Figure 1. For most of the common solar heating categories, the flat plate glazed collector performs better than the glass vacuum tube collector, with a higher collector efficiency.

Efficiency vs. Effectiveness

Effectiveness has more to do with user satisfaction and with how well the equipment does its job. This includes everything that the owner needs in order to feel satisfied with the equipment, including the cost-effectiveness and comfort temperatures. When we succeed in providing solar heating components that are effective, the owners have little to complain about. Be aware, however, that the owner's perception may be mistaken, as in the example I mentioned earlier. The fellow that commented how

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Figure 2

COLLECTOR THERMAL PERFORMANCE RATING

Megajoules Per Panel Per Day				Thousands of Btu Per Panel Per Day			
CATEGORY (Ti-Ta)	CLEAR DAY 23 MJ/m²·d	MILDLY CLOUDY 17 MJ/m²·d	CLOUDY DAY 11 MJ/m²·d	CATEGORY (Ti-Ta)	CLEAR DAY 2000 Btu/ft²·d	MILDLY CLOUDY 1500 Btu/ft²·d	CLOUDY DAY 1000 Btu/ft²·d
A (-5°C)	31	23	16	A (-9°F)	29	22	15
B (5°C)	30	22	14	B (9°F)	28	21	14
C (20°C)	28	20	13	C (36°F)	26	19	12
D (50°C)	25	17	10	D (90°F)	23	16	9
E (80°C)	21	13	6	E (144°F)	20	13	6

A-Pool Heating (Warm Climate) B-Pool Heating (Cool Climate) C-Water Heating (Warm Climate) D-Water Heating (Cool Climate) E-Air Conditioning

"efficient" his collectors must be, because they got boiling hot, was actually being fooled by an impressively high temperature that he thought should be very effective. On the contrary, the general rule is that a cool collector is an efficient collector. When the collector stays cool on a sunny day, it means that the solar heat is being carried away by the coolant and is not building up in the collector. In fact, extremely hot collectors quite often indicate a coolant pump failure, with a corresponding collector efficiency of zero.

Efficiency is calculated by dividing the "useful energy out" by the "energy available." In the case of the solar heat collector, the energy available is the solar radiation that arrives at the collector aperture. This can change from moment to moment, with passing clouds and other shading conditions. The useful energy out is the net thermal energy embodied in the hot fluid (coolant) leaving the collector outlet pipe. A cold outdoor air temperature surrounding the collector tends to draw more heat out of it, so cold ambient temperatures can lower the useful energy delivered.

When this situation is boiled down mathematically, it turns out that there are only three things you need to know to evaluate the collector efficiency for any heating application:

How hot is the fluid you want to heat? (**Ti**),
How cold is it outdoors? (**Ta**),
How sunny is it (**I**)?

So the Collector Efficiency (η) is directly linked to these three values, which can be combined as follows:

(Ti - Ta)/I [a.k.a. **(P)/I**, as seen on the SRCC ratings pages]

Ti is inlet fluid temperature,
Ta is ambient temperature, and
I is solar radiation at the collector surface. [**I** stands for solar *Insolation*.]

The SRCC publications provide collector test results in publications 1 and 2 (above), which include the slope and the intercept data for each collector tested. The slope and the intercept allow you to draw a straight line on a graph that defines the collector efficiency for any conditions of **(Ti - Ta)/I**. I have done this in Figure 1 for three collectors I found listed in the January 2009 Directory; a flat plate glazed, a flat plate unglazed and a glass vacuum tube collector. The intercept is the point found on the vertical axis and the slope is the (negative) Rise over Run of the line as it runs downhill to the right.

Please note that this only describes the collector thermal efficiency, which is the solar collector by itself. This is not to be confused with the system thermal efficiency, which is complicated by pump and control "parasitic" energy consumption, heat loss from piping, heat exchanger efficiencies, heat storage losses, etc., etc. This article is limited to the solar collector. We hope to cover more system efficiency issues in the future.

Making sense of SRCC collector ratings

The SRCC requires each solar collector to be tested using a standard series of procedures known as the OG100 test. (Not to be confused with the OG300 test for solar water heaters systems.) This includes a torture test that proves that the collector can stand up to high temperature solar stagnation and other harsh conditions. The final results include not only the slope and intercept of the Collector Efficiency graph but also the heat output of the collector under five different standard temperatures and three different solar Insolation conditions. These ratings represent solar heating jobs that range from very easy to very difficult and are presented as categories A, B, C, D and E, respectively.

Category A: Pool Heating (warm climate) Ti-Ta = (-9) F
Category B: Pool Heating (cool climate) Ti-Ta = 9 F
Category C: Water Heating (warm climate) Ti-Ta = 36 F
Category D: Water Heating (cool climate) Ti-Ta = 90 F
Category E: Very Hot Water (cold climate) Ti-Ta = 144 F

Results from each category are presented for standard solar conditions known as:

Clear Day - 2,000 Btu per square foot per day
Mildly Cloudy - 1,500 Btu per square foot per day
Cloudy Day - 1,000 Btu per square foot per day

A collector that is capable of producing heat under all of these standard test conditions will have 15 heat output ratings from which to choose. A sample is shown in Figure 2. These results appear in the SRCC Directory (publication 2 above) as two tables; one metric and one in Btu. In summary information (publication 1 above), only the Clear Day Category C results are shown for comparison.

On Figure 1, you will notice that I have drawn rectangular boxes on the graph that represent where the different solar/temperature categories are. The SRCC lists the solar availability in more than 50 major U.S. cities, and it is inter-

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esting to note that they all fit within each of the gray boxes. For example, if you have a Category C heating job, the collectors seen in this figure will perform to the left side of the Category C box in Albuquerque or Los Angeles and to the right side of the box in Seattle or Boston.

Collector comparison

Whether you use the SRCC Data Tables or Plot the Efficiency Graph, you can see that this data allows a useful comparison between collectors. Keep in mind that while the graph data is normalized per square foot of collector, the table data is not. The tables show the heat output of each whole collector, and some collectors are bigger than others. So, you can divide by the net aperture area to make a comparison per square foot.

The examples shown in Figure 1 present an interesting result. For most of the common solar heating categories, the flat plate glazed collector performs better than the glass vacuum tube collector, with a higher collector efficiency for these models. (Both of these collectors are from the same manufacturer.) So, if the price of the vacuum collector is much higher than the flat plate, the extra expense may not be worth it, unless you are to the right side of Category D or in the Category E area. The SRCC publications include some descriptions of how to use the data to make other useful comparisons. ■

In this series of articles, I have been making the case that the key ingredients for solar/hydronic design and installation can be divided into six categories, listed below, roughly in order of their importance.

1. RELIABILITY
2. EFFECTIVENESS
3. COMPATIBILITY
4. ELEGANCE
5. SERVICEABILITY
6. EFFICIENCY

The success of any solar hydronic home heating installation depends on the often-conflicting balance between any of these six principles. Finding the balance between them defines the art of solar heating design.

Bristol Stickney, partner and technical director at Cedar Mountain Solar Systems in Santa Fe, N.M., has been designing, manufacturing, engineering, repairing and installing solar hydronic heating systems for more than 30 years.

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Engineering Spotlight

AKF Group LLC, New York

Sustainability Proactive

By John Mesenbrink

Sustainable design, load matching and service integration are just some of the topics covered in *Plumbing Engineer*'s new feature segment called "Engineering Spotlight," in which *PE* spotlights an engineering firm that exhibits professionalism and innovative design procedures. To kick off its first Spotlight, *Plumbing Engineer* proudly features New York-based AKF Group LLC, which specializes in HVAC, electrical, plumbing, fire/life safety, controls, central utilities and energy management. The firm has continued to evolve and expand its services and reach throughout the United States and abroad. The staff has continued to grow at a rate of over 15% a year, and AKF Group has been blazing the trail as a LEED™ (Leadership in Energy and Environmental Design) leading engineering firm.

AKF was founded in New York in 1989 by three founding partners and offers a full scope of traditional engineering services. Today, the firm — comprised of 25 partners and 435 staff members — offers a broad range of engineering services with offices in New York, Princeton, N.J.; Arlington, Va.; Boston; Philadelphia; Stamford, Conn.; and Mexico City. With a majority of engineers licensed professionals, AKF has continued to grow and diversify its practice to serve the continually changing needs of its clients. Its services have expanded to embrace AKF Technologies and AKF Analysis & Testing to supplement the broad range of professional engineering services. AKF is organized to allow for continual succession and opportunities for all members of the firm.

As AKF celebrates its 20th anniversary, the partners are very proud of the many accomplishments that brought them to their current position as a leading full-service engineering firm with clients in both the private and public sectors throughout the United States, and the world.

Inside the firm

AKF provides detailed testing and retro-commissioning services. Over the past three years, it has expanded its in-house commissioning group and services to become the only New York City firm to provide complete in-house Critical Systems℠ design and true hands-on commissioning services and preventive maintenance without the need to outsource the services. AKF maintains an inventory of sophisticated testing and monitoring equipment to support its field technicians. Many of its commissioning technicians have come out of the major UPS corporations and provide a greater level of hands-on support.

The commissioning services, vibration analysis, predictive maintenance and start-up testing services are conducted by dedicated specialists within the AKF Group and AKF Analysis & Testing companies. The AKF Group has over 70 dedicated Commissioning and Analysis & Testing

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Engineering Spotlight

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professionals in NYC actively participating within the Association of Energy Engineers (AEE), the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), Building Commissioning Association (BCA) and the American Society for Healthcare Engineers (ASHE) organizations.

AKF also performs all electrical distribution testing and emergency generator testing services and short circuit, coordination and arc flash studies. The Analysis and Testing team provides in-depth vibration monitoring, vibration analysis, acceptance testing, critical speed testing, and motor current waveform analysis.

AKF has highly experienced commissioning engineers, technicians and analysts who have focused their expertise on building operations, chiller plants, and automation systems, serving facility and plant operations directly or in combination with the Owner's A/E project specific design team to provide a fully integrated solution.

The firm has a dedicated Critical Systems design team, which has extensive experience with the design of data centers and other critical facilities. The in-house support

Jake Lawrence (l), PE, and Dave Moreno, PE, partners at AKF, oversee construction of Capital Health System's new replacement hospital located in Hopewell Township, N.J. This 1,000,000-sq.-ft. facility will provide the most comprehensive and state-of-the-art, patient-focused care. AKF has provided complete MEP/FP engineering services at this facility.

available to the commissioning team provides them with insight and assistance into providing a comprehensive and coordinated commissioning plan.

The following is an exclusive Q&A with AKF Group LLC partners Jake Lawrence, PE, Dave Moreno, PE, Rob Diemer, PE, LEED AP, Asif Syed, PE, LEED AP and Joe Ianni, project manager.

PE: What are your initiatives for AKF?

AKF: Our initiatives involve green technology, sustainability, integration of services with our information technology, analysis & testing, commissioning, controls, lighting, etc. —providing our clients the ability to address tomorrow's issues today.

Specific Project Example

AKF provided sustainability engineering services to St. John's University to comply with their "3010 challenge" as part of the U.S. Mayors' climate protection agreement. New York City requested higher educational institutions to reduce their carbon footprint by 30% over 10 years commonly referred to as the "3010 Program" or "3010 challenge."

St. John's has over 2.75 million sq. ft. of buildings at 50,000 tons of carbon dioxide, and a target reduction of 30%, or 15,000 tons. AKF established St. John's footprint baseline carbon for 2006 and St. John's was recently awarded the Energy Gold Star by Mayor Bloomberg "for accelerating its greenhouse gas reduction plan to reach its 30% decrease target by the year 2013."

AKF developed a strategy for 30% reduction achieved with a five-year master plan including:

- Existing buildings on campus retrofitted with green technologies;
- Boiler plants and chiller plant technologies converted to state-of-the-art;
- Building operations improved;
- Campus-wide building management system to reduce waste energy;
- Building systems retro-commissioned; and
- On site generation and cogeneration technologies with existing campus low pressure steam distribution and improved efficiency.

PE: Is your company involved with sustainable design?

AKF: As a large design and full service engineering firm we are involved in more than $3 billion in construction. Our designs can significantly impact sustainability, energy efficiency and the carbon footprint. With this in mind, we have taken an integrated approach to sustainability, LEED Design and energy, along with our MEP designs. We do not consider sustainability to be an appendage to MEP design, but rather seamless and mosaic. We have introduced CFD Analysis and have trained a large portion of our regular engineering design staff in all software available for engineering analysis.

Increased awareness of the principles of sustainable design is changing the way buildings are developed. AKF is a leader in furthering sustainable design and environmental responsibility in our projects. We continue to pay attention to the long-term environmental impact of the systems we engineer, as well as the energy required to operate them. We provide workshops and seminars on sustainable design and green building systems for our clients and staff.

As a benchmarking tool, and to ensure advanced support to our clients, we work closely with the LEED Green Building Rating System, which was developed by the U.S. Green Building Council (USGBC). LEED supports sustainable buildings and its effect on the environment by providing a framework for more efficient, healthier structures that are both good for the planet and the people who live on it, while providing a higher return on investment. AKF is proud to have been an active member in the USGBC since 2001.

AKF became the founding sponsor of the Mexico Green Building Council in 2005 with the World Green Building Council, as well as existing and emerging

Green Building Councils from around the world. The combined councils work to advance the cause for sustainable buildings and building practices — necessary to the welfare of our planet.

Sustainable design capabilities start with our experienced professional staff and collaborative approach to engineering. Our comprehensive in-house training programs continue to yield an increasing number of LEED® Accredited Professionals. The firm goal is not only to meet the current sustainability requirements of our clients and a building's occupants, but also to anticipate and prepare for future needs and developments.

Our sustainable design solutions have included geothermal heat pump systems, photovoltaics, hybrid natural/mechanical ventilation, radiant heating and cooling, thermal storage, heat recovery, energy efficient lighting control systems, graywater storage and treatment systems, cogeneration plants and alternate fuel chillers. AKF has full building energy modeling capabilities utilizing the DOE II based VisualDOE program, as well as the Trane Trace modeling software. AKF provides computation fluid dynamics modeling using Fluent software. We also have assisted our clients in the process of procuring rebates and incentives for energy efficient equipment and systems. AKF Commissioning Group is available to provide basic and enhanced Commissioning Services for LEED projects.

Our services and capabilities including the following:

- Sustainable MEP Design Services
- Building Energy Modeling
- Daylighting Studies
- Renewable Energy Studies
- Computational Fluid Dynamics
- LEED Commissioning Services
- LEED Consulting Services
- Rebate/Incentive Consulting Services

Our philosophy of sustainable design is founded upon three basic principles:

Harvest Free Energy — Maximize the harvesting of available on-site renewable energy by advantageous building orientation and massing, correct placement of fenestration to maximize daylight potential and optimize solar gain, optimal placement of passive ventilation openings and discharge points and other passive strategies. The proper utilization of daylight has a profound impact on building energy use, occupant comfort and health. We are proponents of the use of natural ventilation, passive heating and/or cooling and geothermal energy where appropriate.

Reduce Building Loads — Second, optimize remaining loads that affect building performance. The design of efficient electric lighting systems, realistic plug load allowances, optimized building envelopes and the education of the building owner to alternative indoor environmental control systems and strategies have a major impact on the affordability of sustainable strategies.

Employ Efficient Systems — Finally, once maximum benefit is extracted from available site resources and building imposed loads are reduced to the greatest extent possible, we design efficient mechanical and electrical systems. These systems are "right sized" based on an optimized building, require less capacity and have a lower first cost than systems that are not designed in this manner. The opportunities to apply high performance, low energy systems and strategies are greater because the building systems are asked to do less. We believe our approach results in the realization of the maximum sustainable potential for the project at the lowest bottom line impact.

PE: Can you explain the significance of AKF being carbon neutral?

AKF: We are offsetting our environmental impact and eliminating our contribution to global warming. This is achieved by purchasing certified offsets for our electricity use and carbon emissions associated with our corporate travel and firm member commuting. AKF is committed to helping reduce our dependency on fossil fuels, promoting cleaner air, and fighting global climate change. Our certified annual commitment is similar to planting 32,330 mature trees or not driving 8,016,216 miles each year.

PE: Is green building here to stay or is it just good fodder for campaign speeches?

AKF: Green building has become standard operating procedure in today's fast-paced world, although there are still cost premiums involved for some systems. We believe that designing and building better, healthier, more efficient buildings is the only solution to improving the quality of our environment and, as more people understand and demand these systems, we expect that costs will decline.

Engineers at AKF Group LLC work diligently, addressing tomorrow's issues today.

However, it is important to understand that where we are today is just a step in the evolution of where we need to go in the design of buildings. We need to design buildings that are regenerative and restorative; that generate more energy than they use; that export clean water instead of waste; and that create rather than destroy habitats.

PE: How do you avoid "green" over-saturation? How do you spec products that are sustainable and true to the application?

AKF: There is a proliferation of claims made by manufacturers about the green compliance of their products. It is incumbent on us as engineers to do the comparative due diligence and take the time to educate ourselves about the products we specify. We do that in a number of ways at AKF:

- We have a sustainability group (AKF Green Team) who undertake research studies and share their information with the rest of the firm.

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• We have a program of "lunch and learns," both in-house training and with manufacturers.

• We attend Greenbuild (November 11-13, Phoenix) where we can see the products side by side and can evaluate them.

PE: Anything in the stimulus package that will translate to green building practices and environmental stewardship?

AKF: There has been $151 billion earmarked in the stimulus package nationwide for green building practices and environmental stewardship.

PE: Tackling solar/SDHW, how do you come up with solar designs and software?

AKF: The most critical factor is understanding the owner's goals and objectives. So often solar and SDHW are thought of because they are very visible symbols of an owner's commitment to sustainability. Unfortunately, many owner's balk at the cost of installation once they fully understand them. We try to educate owners on the costs and merits of various systems. We also try to make sure we are applying the systems correctly and in the right applications. It may not make much sense to put SDHW on an office building where the domestic hot water load is such a small factor, but on a residential building it may be another story. Once we decide that a particular building is a good fit, we use a number of generic software programs and refer to manufacturers' literature to determine basic sizing parameters for solar domestic hot water. Oventrop Corp.'s literature, for example, is a great source for us.

PE: For what percentage of the building load would you size a solar system?

AKF: If the space is available and it is economically feasible, then we would size the solar system for 100% of the building's domestic hot water load. We obviously would have other means of generating hot water as a supplement/backup. If the project has certain limiting parameters, such as space, then the system would be maximized up to the limiting parameters.

We are careful to consider solutions that create a balanced system that takes advantage of available solar energy throughout the year while optimizing the cost of the system.

PE: Flat panel vs. evacuated tubes?

AKF: Based on independent studies, the evacuated tubes are more efficient (produce more hot water per area of equipment). Also, the evacuated tubes perform better during lower ambient temperatures. If neither space nor ambient temperature is an issue then we would select panels, since they are more cost effective.

PE: How can engineers/AKF better assist builders in today's economic climate?

AKF: We help our clients by providing them options on solving problems and informing them about alternate cost-effective ways to assure that their facilities meet current regulatory compliance requirements and state-of-the-art operational efficiencies.

PE: Can you explain the delicate balance of engineering in the short term while anticipating for the long term?

AKF: As engineers, we need to help our clients understand how things are changing in the world around us and help educate them about the value of thinking beyond only the expedient options and considering the long term implications of energy usage, carbon footprint, etc, as well. We must recognize that some owners are beginning to value energy use reductions with the resultant reduction in carbon footprint and have specific goals that go beyond the life cycle costs. The old way of looking at engineering options assumed that the main considerations were cost driven. We now have to make sure we are finding the best life cycle cost options that also achieve these other objectives. We must also consider design flexibility in our design solutions that allow the buildings and the systems we design to adapt over time.

PE: Celebrating its 20th year, what are some milestones or highlights of AKF?

AKF: Several major milestones/highlights have led to the successful growth of the firm:

• The core values and culture established by the founding partners have survived and endured over the past 20 years and have allowed us to differentiate our firm from our competitors and maintain strong, long term relationships with our clients.

• We have successfully expanded into new geographic areas and new market sectors by empowering our people to pursue their goals and interests.

• We have accomplished the leadership transition program that will take the firm forward for the next 20 years.

AKF Group LLC's goal is to continue to provide innovative design, quality service and technical leadership by offering services that go beyond traditional engineering and respond to the ever-changing dynamics of the marketplace.

Because AKF is an "open" firm — it purposely has no stratified structure, no titles, no private offices — each engineer on a project has access to all of his or her staff, able to tap into the firm's total pool of knowledge and skills. The spirit of collaboration also embraces its clients. Each client has unfettered access to its AKF team leaders, who in turn serve as their partners on a project, and who are engaged on the front line to answer questions — and ask them — and to solve problems. This atmosphere of respect and candor throughout a project helps to sharpen and speed successful outcomes.

And, as AKF looks forward, it recognizes the effects of the global economy, new technologies, the need for environmental efficiency and other major issues will present new challenges for its clients across all market sectors. Its vision for the future is to foster a firm that will continue to lead, diversify and evolve. ■

AKF Awards

• New York Constructions News — The Best of 2008 Awards
The Best Green Project — Award of Merit
National Audubon Society Home Office, New York

• 2008 Green Building Award
The City of New York and the United States Environmental Protection Agency (EPA) Region 2, Grand Prize Winner
Battery Park City Parks Conservancy, Maintenance Building New York

• 2008 Green Building Award
The City of New York and the United States Environmental Protection Agency (EPA) Region 2, Winner
West Harlem Environmental Action (WEACT), New York

• 2008 American Council of Engineering Companies of New York (ACECNY) — The Gold Award
Weill Cornell Medical College
The Weill Cornell Ambulatory Care Building, New York

• 2008 American Council of Engineering Companies of New York (ACECNY) — The Diamond Award
The Rockefeller University
Dr. Hudspeth, Ear Cell Laboratory, Bronk Building, New York

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Solar Commercial Hot Water Design

By Peter Biondo

In today's revitalization of job creation and emphasis on renewable energy, there is a renaissance of activity within the engineering community for commercial solar hot water systems. Spurred by federal and state tax incentives, utility rebate programs, grant money and prestigious LEED accreditation, this push into solar hot water has engineers venturing into a new aspect of design that had quietly gone away for almost 20 years (since the end of the early stage of solar hot water development in the 1980s).

Many mechanical engineers have had to rethink domestic hot water design and include a solar system for the first time. Using a solar fuel source requires a dynamic approach to design that is very different from using traditional fossil fuel or electric boiler water heaters. The purpose of this article is to help explain sizing criteria, designing for the usage pattern or building occupancy and the importance of the dynamic use of solar hot water storage.

Measuring hot water loads for solar

Commercial hot water system design begins by sizing the hot water load under full occupancy of the building. Electric or fossil fuel boilers and hot water heaters are sized by this requirement. ASHRAE charts help determine the hot water requirement for each fixture so that, at a given design volume of hot water required for the building, the heating source can match with delivery.

This method will not work, however, for sizing solar hot water systems. Why not? To size a solar system, the designer needs to determine the volume of hot water expressed in daily use. The design load cannot establish the hot water volume in gallons per day and, to make it worse for the designer, there are no charts for solar (that I am aware of) that help estimate daily hot water volumes. Also, the load of a hot water recirculation loop should be taken into account for the additional amount of daily energy consumed through the losses of the hot water piping lengths. With these daily loads taken into account — gallons per day at design temp and Btu losses through hot water recirculation — we can express the value of energy used per day in a hot water heating system for solar integration.

For example, let's look at a hotel that uses an estimated average of 2,400 gallons per day and has a 400-foot recirculation hot water loop, timed for 12 hours per day. Incoming water temperature is 55 F and design hot water temperature to achieve is 140 F. To find the daily hot water usage load, calculate 2,400 gallons per day × 8.3 lbs. per gallon × 1 Btu per 1 F temperature rise × 85 F temperature rise. This will equal the total daily usage, which is 1,693,200 Btu per day. Next, estimate the recirculation hot water loop

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heat loss load. In this case, I will use a loss of 8.25 Btu/hr per linear foot of recirculation pipe (assumptions: pipe surface temperature, 125 F; pipe diameter, 3/4 inch; pipe insulation, 1 inch).

To find the daily recirculation hot water loop heat loss load, calculate 12 hours of use per day × 8.25 Btu/hr per foot of pipe × 400 feet of pipe. This will equal the total daily load of 39,600 Btu/day. The total energy (Btu) draw would be the sum of the estimated daily energy load for hot water use and the recirculation pipe loss. This is calculated as 1,693,200 Btu + 39,600 Btu. The total energy use per day is 1,732,800 Btu/day.

This total Btu equivalent would be the estimated daily energy load for hot water. With a good sense of the daily load, the solar designer can build a monthly hot water load profile and then establish solar performance based on solar radiation data and collector sizing for a particular location.

Solar flat plate w/selective absorber DHW Commercial Sizing Calculator

Project Name: Restaurant Date: 3/21/09
Location: Boston

Hot Water Load: number of gallons per day 350

4 x 8 Selective surface absorber flat plate collector

Aperture Area in Ft. Sq.	30
Number of Collectors	6
Design Water Temperature ° F	120

Percent Solar Savings per Month

January	February	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
39%	53%	58%	68%	74%	84%	85%	82%	76%	59%	41%	35%

Annual Solar Savings Fraction 63%

How much solar hot water will contribute to the full hot water load over the course of an average year?

Solar collector sizing options

The solar contribution for hot water heating can be measured in an annual solar savings fraction. In other words, how much solar hot water will contribute to the full hot water load over the course of an average year? In some cases, the solar contribution may be a small fraction of the total

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load (5% or less) where the hot water demand is high and the roof area to mount collectors is limited. The benefit for the small solar hot water system is for the commercial owner who wants to make a "green statement" and is interested in appealing to his or her customer base.

In many cases, for commercial buildings, the limitation of sizing solar for the total load can be imposed by the installation area of the roof facing south or by space in the mechanical room for installing solar storage tanks. Both require space that could set the parameters for solar hot water sizing. Budget also has its constraints. Where limitations are imposed, the solar contribution can be viewed as a technology that increases the efficiency of the hot water heating system rather than as a system that has the ability to carry a significant portion of the hot water load.

Higher solar savings are made by sizing the solar hot water system to result in annual savings of 50% (in some cases up to 65%) of the hot water load. The 50% goal solar is a good rule to apply to a commercial building; this helps to avoid the problem of stagnation in the solar collectors during low load cycles. Solar performance in the summer also needs to be taken into consideration for sizing. Due to high ambient air temperatures, solar radiation increases in the summer, as does efficient solar collection; this can produce more than twice the amount of energy for domestic hot water production than in the winter months.

The problem to avoid in closed loop solar hot water collection is stagnation of the working fluid, propylene glycol, in the solar collectors. If the solar storage tank has reached its high temperature limit, the solar collection loop will stop circulation, stagnate and reach temperatures of 300 F and higher. Propylene glycol can then flash to steam quickly on large collector banks and, if chronic, can significantly decrease the life cycle of the antifreeze and the solar collectors. I have seen large collector banks fail early because of oversized collector arrays or undersized solar storage tanks. Unlike with a conventional fuel source, one cannot turn off the sun, but solar collectors can be sized so that stagnation will not occur. Another way to avoid stagnation is to include a heat dissipater in the design so that the collector loop can continue to cycle throughout the daytime hours when the solar tanks are hot and the hot water load is either low or off.

Designing solar to building occupancy

Understanding how a commercial building is occupied and the type of hot water load needed can help determine the appropriate design and increase the efficiency and life cycle of the solar hot water system. There are four primary types of solar commercial hot water applications: buildings with daytime heating loads, such as hospitals; those with evening and morning loads, such as apartments; those with intermittent

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loads, such as offices that are unoccupied two days per week and schools, which have long periods of inactivity.

Buildings with daytime loads, such as hospitals, nursing homes and laundries can be designed without large solar storage requirements. These buildings have a constant daytime load every day of the week, all year round. In this case, and only in the case of steady hourly daytime hot water loads, solar collector arrays may be thought of as heating plants, not unlike boilers, without the need for large solar storage tanks. Solar storage tanks would still be required but would be designed as buffer tanks or solar heat transfer tanks. As a precaution during periods of servicing the hot water system, these systems would require heat dissipaters.

The second type of application is for apartments and multifamily dwellings. In this case, solar storage should be sized to store the full capacity of hot water produced by the solar collector array. Most of these loads are drawn during early morning hours or late in the day for showers or cooking. Some buildings are mixed use, such as hotels that have daytime laundry loads. The same strategy applies. Solar storage should be sized to store the solar energy collected throughout the day. Typical sizing requirements for solar hot water storage are to include one to two gallons of hot water storage capacity per day for every square foot of collector aperture.

Solar energy is a dynamic fuel, so expect the hottest storage temperatures in the summer and the lowest in the winter months. You should never expect design temperature from a solar tank to be the same all year round. In the winter, or during periods of cloud cover, a solar hot water system should be recognized as a preheating hot water system.

Office buildings are different in that they usually have no hot water load throughout the weekend. In this case, the solar storage volume could be increased and solar tanks staged to save the solar heat during the two days that no load would be accounted for and then used during the occupied cycle. The collector array could also be sized down for a seven-day collection cycle for five days of actual use.

The last application would be for buildings that are intermittently occupied. These include schools, dormitories and seasonal resorts, where the hot water systems serve a building that may not be used for weeks or months at a time. These hot water systems are best served by drainback solar design. Using drainback design, the solar collectors are empty for freeze protection and are filled only when there is solar hot water to collect. All the solar working fluid is drained out of the collectors into a reservoir tank after the collection cycle is complete. Drainback solar systems are appropriate for buildings with intermittent use, because the collectors are empty when solar collection is not in use and, therefore, do not pose the problem of stagnation.

Pay particular attention to drainback design. Not all solar collectors can be drained to slope, so the appropriate collectors must be chosen. Also, all collectors and piping must be sloped to drain and empty to the reservoir when circulation is off. It is important to note that a drainback may not be possible, for example, when collectors are on a ground mount or when the distance from the collectors to the reservoir poses obstacles for slope to drain.

Solar closed loop systems may be the only choice for schools or seasonal resorts. When choosing closed loops for these buildings, find an auxiliary load, such as a pool, during periods of inactivity. If that is not possible, have the solar loop drained during unoccupied cycles. The other option, installing heat dissipaters, such as rooftop fan coils or buried pipe, may be the easiest solution and should be included for closed loop systems on buildings that are regularly unoccupied.

Solar collectors on this commercial building soak in the sun.

Hot water recirculation and solar storage tanks

If there is anything to avoid with hot water recirculation and solar storage it is piping the recirculation hot water loop directly back into the solar storage tank, which uses solar energy to preheat the cold water supply then feeds the heated water to the thermostat-controlled hot water heater. Solar tank temperatures are very dynamic and can fluctuate widely throughout the day. Directing return recirculation piping into the solar tank is a mistake. When this happens, the hot water feed from the water heater through the recirculation hot water loop raises the temperature of the solar tank to the thermostat setting in the water heater. This must be avoided so that the solar collector can do all the work in its designated tank to raise the temperature of the cold water supply.

Hot water recirculation can only be diverted into the solar tank with the addition of a three-way valve and a differential control. This allows recirculation into the solar tank only as the water in the tank increases in temperature over the returning hot water, adding temperature to the recirculation hot water loop with solar. Without this control, pipe recirculation hot water loops into the back-up hot water heater.

I hope that this article provides additional perspective on solar design considerations for commercial hot water applications. One thing is certain: Solar hot water technology requires a different approach to designing hot water systems. The primary difference is the emphasis on "collecting" hot water. Once the concept is understood, the principles of design will fall into place. The sun's energy is not concentrated fuel stored in a gallon or a therm of energy, ready for hot water heating at any time. Instead, solar energy is very consistent and reliable and can be creatively delivered into our job market and the U.S. renewable energy infrastructure. ■

Peter Biondo is the technical sales coordinator for Oventrop Corp.

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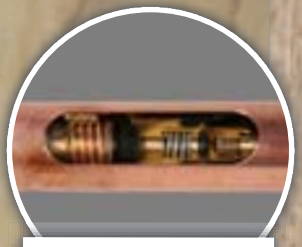

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Rainwater Harvesting

More Than Just A Drop in the Bucket

By Sarah Lawson

Rainwater harvesting is an ancient and effective water conservation practice. Unfortunately, in modern times "rainwater harvesting" has often become associated with a mosquito-laden barrel in the backyard, lined with last year's leaves and a resident frog or two.

The potential of rainwater harvesting systems is so much more. With proper design, these systems can transform a waste product (stormwater) into a valuable resource. Bringing rainwater harvesting into the commercial and residential mainstream will require increasing awareness of possible uses of rainwater, improved regulatory guidance and a greater understanding of all the potential environmental benefits of stormwater management. Rainwater harvesting systems are also a perfect opportunity for coordination of services and design among the civil engineer, the plumbing engineer and the mechanical engineer (the butcher, the baker and the candlestick maker).

Harvested rainwater is often thought of only as an irrigation supply, but it can also be used indoors to meet non-potable water demands (and is approved in some localities for potable use). According to the Alliance for Water Efficiency, restrooms, landscape and cooling and heating account for 87% of the water use in schools and 89% of the water use in office buildings (domestic use is included with restrooms in the reported figures for office buildings). Even if half of the restroom/domestic use requires potable water (handwashing, etc), the majority of water use at schools and office buildings is non-potable. The EPA's guidance document, "Managing Wet Weather with Green Infrastructure: Municipal Handbook: Rainwater Harvesting Policies," identifies non-potable indoor water uses as toilets, urinals, laundry and cooling towers.

Using harvested rainwater for water closets and urinals will be only part of the story at the Wellmark Blue Cross-Blue Shield headquarters now under construction in Des Moines, Iowa. Cisterns at this site will collect rainwater and condensate from the HVAC system to supply toilets and urinals and to be used for irrigation. During warmer months, when the demand for irrigation is highest, the water supply from the HVAC system condensate will also be highest. The cisterns are integrated into the site stormwater management plan, which offsets a portion of the initial cost of rainwater harvesting. This project is a prime example of the benefits of collaborative design. Imagine the potential waste if the plumbing engineer designed a rainwater harvesting system, the civil engineer designed an underground detention system and the HVAC engineer designed a system to handle condensate.

In an article entitled, "President's Viewpoint - the Need for Green Schools" in *NEA Today*, National Education Association president Dennis Van Roekel stated, "Green schools are also a great teaching tool. If we want children to learn that human beings have a responsibility to be good stewards of natural resources, we have to teach them by example."

At Burton School in Grand Rapids, Mich., rainwater from 11,000 square feet of roof is filtered and directed to a 10,000-gallon belowground storage tank, then used to flush 12 water closets. A water meter in the corridor lets students see how much water the system has saved. Based on daily rainfall data from Grand Rapids, if the school was used year round, this system could supply approximately 150,000 gallons of water per year.

Paula Leatherman, CPD from ProgressiveAE, who designed the rainwater harvesting system at Burton School, describes the process, saying, "Grand Rapids Public Schools

A high capacity vortex filter in action during construction of the Burton School. This pre-tank filter diverts the "first flush" and prevents debris from entering the tank. A single filter can treat roof areas up to 33,000 square feet. (Photo courtesy of Paula Leatherman.)

has made a commitment to sustainability for its facilities, and their last several projects have earned LEED® certification. During the Burton Elementary School project planning stage, administrators and designers discussed the different elements that would be appropriate for LEED points for this project. One way to acquire additional points for LEED is to use a non-potable water source to satisfy the building water needs. The concept of a rainwater harvesting system was researched. The district's director of facilities expressed a deep interest in an educational approach to the aspect of rainwater harvesting, and so the groundwork was set for the system.

"Not only does the system help recognize a 52% total building water savings (according to LEED templates) but it also provides an educational tool that involves the students in the importance of preserving our natural resources. The design integrated a visual metering system located in a corridor display case where the kids are able to track the water savings. This was one of the first rainwater harvesting systems in the city of Grand Rapids, and the first to utilize the system as an educational tool. Reusing rainwater for building needs is a viable direction in the construction industry, and we are exploring opportunities to implement similar systems in a variety of building types."

At Western Virginia Regional Jail in Salem, Va., which opened on March 9, 2009, a look at the whole site led to innovative design and increased energy efficiency. Water demands inside the facility outweigh the available rainwater supply, so harvested rainwater is used only for laundry. Because the laundry use is localized in one section of the building, the pumping and piping demands are decreased. However, the real energy savings occur with pre-heating of the rainwater for laundry. Water used to cool the pumps from the vacuum-assisted waste system enters a heat exchanger and pre-heats rainwater before it is pumped to the laundry. This 264,000-square-foot facility will be the first LEED-certified jail in the region.

Rainwater harvesting is often used just to earn LEED points through irrigation but can be a part of stormwater management and innovative design, in addition to water efficiency.

The potential impact of rainwater harvesting is staggering. According to the U.S. Census, the United States had almost 12 million more housing units in 2007 than in 2000. Assuming an average footprint of 1,500 square feet for each of these housing units and an average of 30 inches per year of precipitation, if all of these new housing units had rainwater harvesting systems, they could collect about 234 billion gallons of water per year, more than enough water to supply the entire city of Los Angeles. These rainwater harvesting systems would also mean that there would be 234 billion gallons less of runoff into lakes, rivers and streams or into stormwater treatment facilities. Based on information from the Stormwater Manager's Resource Center, 234 billion gallons of residential runoff will carry about 390 tons of phosphorus, 2,150 tons of nitrogen and 97,770 tons of sediment. While these nutrients and sediment are crucial for plant growth on land, they can wreak havoc in lakes and estuaries, causing algal blooms and fish kills.

The environmental benefits of rainwater harvesting even extend to energy use. According to the EPA, approximately 3% of energy use in the U.S. goes to drinking water and wastewater treatment. By using non-potable water, which requires less treatment, for non-potable uses and by greatly decreasing the distance that water is transported, rainwater harvesting provides an energy-efficient alternative to traditional water systems. Rainwater harvesting even reduces strain on an aging water supply infrastructure.

These calculations are only for new residential development. Imagine how much greater the impact could be if commercial development was included. While rainwater harvesting is an old technology, the opportunities for innovation are by no means exhausted. Starting with a basic, established, system design to preserve the quality of the rainwater, the possibilities of producing a green solution are vast. Rainwater harvesting should continue advancing far beyond the leaf-filled barrel to becoming an integral part of whole-site water management. ■

Rainwater storage at the Western Virginia Regional Jail is stored in four 30,000-gallon belowground fiberglass storage tanks. Storage tank selection can be tailored to the site.

Sarah Lawson is a water specialist for Rainwater Management Solutions, Salem, Va.

GeoExchange system is Harris Companies' Rx in down economy

In a time of tight budgets and soaring energy costs, the St. Cloud Municipal Athletic Center (MAC) has found a way to go green and to save taxpayer dollars in the process. With the installation of a new GeoExchange system, the MAC uses the earth to maintain the arena ice and heat their facility. Installing this sustainable technology will save enough electricity to power more than 30 homes and enough gas to heat more than 80 homes. It will reduce greenhouse gas emissions by an amount equal to the removal of more than 100 cars from the road each year.

This project originated after the Fall 2007 Minnesota Ice Arena Managers' Association (MIAMA) meeting, at which Harris Companies presented information on improving energy efficiency in ice arenas. Following that presentation, Todd Bissett, St. Cloud MAC arena manager, asked for a follow-up visit.

The MAC has two arenas; Torrey Arena was original to the facility and was installed in 1972 , Ritsche Arena was part of a 1997 addition. The 1972 arena was in poor condition, needed repair and was not operating efficiently. The original arena floor had been built using galvanized piping that circulated brine through the floor, causing severe degradation in heat transfer and effectiveness. The MAC staff felt that they could justify a chiller replacement with energy savings but, due to budget constraints, did not think the floor could be replaced.

Harris Companies met with the arena staff and conducted a preliminary review of the facility. They found that the project, including the new floor, would be feasible. The final contract was approved by the City Council and signed in early June 2008. The new floor was installed and skating resumed in late September 2008, while the remainder of the project was completed in November 2008.

The MAC has a new floor in the Torrey Arena, a high efficiency TRAK International GeoExchange ground source heat pump (GSHP) "chiller plant," a new web-enabled and integrated building automation system (BAS) installed by Harris Controls and improved system operation. The MAC team, the City of St. Cloud, and the citizens of St. Cloud now have a high-performance green arena that will reduce gas usage by 95% and electric usage by 30%. Nearly 4 million gallons of water usage will be eliminated, along with the yearly elimination of 300,000 pounds of greenhouse gases.

The first phase of the project involved the demolition of the Torrey arena floor, the chiller room, pumps and evaporative condenser. The new rink was designed using a state-of-the-art floor design that maximizes heat transfer to create a high quality skating surface, while using substantially less energy. The new floor utilizes a below-grade thermal storage buffer to create thermal storage capacity, sustain consistent glycol temperatures and minimize the risk of ice loss related to a loss of cooling.

The floor contains three circuits to provide only the amount of flow needed to maintain ice quality, saving cooling capacity and pump energy. It is constructed using high-density polyethylene (HDPE) piping that was installed using fusion welding to create a seamless piping assembly that is resistant to leaks and friction loss and contains more than 19 miles of 1" HDPE and more than 600' of 6" HDPE pipe. Added insulation under the thermal storage buffer, around the header and along the sideboards prevents loss of capacity to the surrounding areas.

The heart of the new installation is the TRAK International GeoExchange Ground Source Heat Pump System. The system has four 60-ton heat pumps dedicated to the Source Loop, providing 12 - 15 degree chilled glycol for the arena floors

The engine that drives the MAC installation is the TRAK International GeoExchange Ground Source Heat Pump System. The system has four 60-ton heat pumps dedicated to the Source Loop, and two 60-ton heat pumps dedicated to the load loop, providing 145 F hot water.

and two 60-ton heat pumps dedicated to the load loop, providing 145 F hot water that is integrated into the existing hot water and domestic hot water systems.

The system was custom designed by TRAK to meet the needs of both ice rinks. The Vilter flooded chiller system at the Ritsche Arena (1997) was left in place but tied into the new TRAK system, so that it could remain as a back-up system and provide additional capacity, if needed, during peak load conditions.

The TRAK heat pumps were custom built by Midwest Fabrication and Supply of Zumbrota, Minn., for this application. The heat pumps are high-efficiency industrial grade heat pumps that are designed for the specific facility where they will be installed. They include on-board direct digital controls and electronic expansion valves.

The well field was installed under the existing parking lot and consists of more than 6,500 feet of vertical boreholes.

The circulating pumps were installed with variable frequency drives to allow reduced flow through the circulating loops. A fluid cooler was added to the system to allow for additional heat rejection and free cooling during cold winter months, when it is possible to circulate chilled glycol through the fluid cooler and to eliminate the need for mechanical cooling.

The existing dehumidification unit for Torrey Arena was retrofitted in the field to convert the existing refrigerant and hot water coils to chilled water and hot water coils. In addition, a new high efficiency motor and variable frequency drive were installed. The unit uses excess cooling from the rink floor supply and waste heat to efficiently maintain rink humidity levels.

The Ritsche Arena used a Fresh Air Systems (FAS) dehumidification unit that contained a desiccant wheel that was recharged by heat generated from a 750,000 Btu natural gas hot water boiler in the unit. The hot loop piping was extended to this unit in order to use waste heat generated from maintaining the ice to recharge the desiccant wheel.

A heat recovery air handling unit for the Torrey Arena that had used hot refrigerant gas from the chiller was converted to use hot water that is heated with waste heat from the TRAK heat pump plant.

The Torrey Arena was built in 1972 with pneumatic controls for the temperature control system. Several years ago, the pneumatic control system was abandoned and replaced with stand-alone electric controls. Most of the valves and actuators were retrofitted in some way, but several were left without any control and remained that way until this project was completed. Ritsche Arena was built in 1997 and used electro-mechanical controls for the Vilter Chiller plant and KMC Controls Direct Digital Controls (DDC) for the arena temperature control.

This project replaces all of the stand-alone controls in the Torrey Arena, integrates both the existing KMC controls in the Ritsche Arena and the new KMC controls for the TRAK heat pump plant and Vilter Plant into one system. The project also included the addition of CO2 sensors for the Torrey Arena make-up air units so that they only operate and ventilate when the building occupancy requires additional outdoor air.

The BAS uses a web-enabled graphical user interface to allow the arena staff to monitor the system, adjust schedules

The arena used a dehumidification unit that contained a desiccant wheel that was recharged by heat generated from a 750,000 Btu natural gas hot water boiler. The hot loop piping was extended to this unit in order to use waste heat generated from maintaining the ice to recharge the desiccant wheel.

and operate the building from anywhere Internet access is available. It also includes energy management functions to monitor and control the arenas' energy use in the facility. ■

Product News

Bariatric wall-hung water closet

A complete system, including a Z1203-XB carrier and Z5690 bariatric toilet, will withstand loadings of up to 1,000 pounds. Bariatric toilet is provided with an open front, elongated, anti-microbial polypropylene seat for enhanced patient comfort. The unit is fabricated from type 304 stainless steel and is available with an anti-microbial powder coating. **Zurn Industries, LLC.**

www.zurn.com

Grinder pump

E810 Progressing Cavity Grinder Pump retrofit readily adapts to existing progressing cavity grinder pump systems. The system contains a quick-disconnect coupling for easy use, installation and adaptation. The pump's finned class 30 cast iron construction reduces heat, an arch-enemy to any electric motor. **Zoeller Pump Co.**

www.zoeller.com

Fire sprinkler piping guide

Company has published a new comprehensive 72-page CPVC Fire Sprinkler Piping Installation Guide to provide the fire sprinkler industry with its most comprehensive printed resource for technical data on installing CPVC fire sprinkler systems. **Harvel Plastics, Inc.**

www.harvel.com

Premium bathroom collection

Reminiscent of the classic architecture of Oxford, the geometric lines of the Oxford Suite evoke a sense of being among England's ornate towers and steeples. Boasting a bold and stately design, the refined, distinct look of the Oxford Suite is appropriate for a range of décor options from traditional to contemporary. **Symmons.**

www.symmons.com

Oil smart water pump controller

The "original" and "only" stand-alone pump controller with the ability to differentiate between hydrocarbons and water. Unlike costly conductive systems, the capacitive pump control requires no control panel, will operate any pump by itself up to 1 hp or 16 amps, and it's performance cannot be altered by oil. If a layer of oil attaches itself to the sensors, the switch will detect a field of water and pump the water from under the oil. Once the long sensor sees no more water (oil or air), the pump will turn off immediately. **See Water Inc.**

www.seewaterinc.com

Brochure on TMVs & controls

A newly revised 16-page color brochure describing the company's extensive line of thermostatic water mixing valves and water temperature controls is now available. The revised brochure highlights the revisions to the Megatron system, photo mixing systems, remote shower control systems and thermostatic shower valves. **Leonard Valve Co.**

www.leonardvalve.com

Oil detective systems

Three new "Oil Detective" Sump Systems are job-ready and are designed to detect/alert the presence of oil in various applications. System comes complete with: durable cast iron or cast iron/stainless steel pump; pump controller; audible alarms; visual display lights; preset on/off, 20' piggy-back switch cord; UL508 approved switch; and complete easy-to-install instructions. **Blue Angel Pumps.**

www.blueangelpumps.com

H_2Okinetic showerhead

Award-winning water efficient showerheads with H2Okinetic Technology. The showerheads flow at an efficient 1.5 gallons per minute (gpm) at 60 pounds per square inch (psi), yet deliver a warm, drenching shower — offering consumers a smarter way to conserve water without compromising comfort. **Delta Faucet Co.**

www.deltafaucet.com

Sensor-operated faucets

New 16-page, 4-color brochure titled "The Universe of Electronic Faucets," covers company's hardwire, battery-powered and solar-powered faucets for all types of commercial, industrial and institutional applications. The brochure highlights select models within each faucet category and gives an overview of available options. Faucets include both deck- and wall-mount models for installation flexibility. **Sloan Valve Co.**

www.sloanvalve.com

Commercial products catalog

New Commercial Products Catalog introduced, as the Division expands its presence in the commercial marketplace. The easy-to-use guide gives builders, architects and engineers a high-level review of the kitchen and bath products available to meet their standards for durability, accessibility, safety and conservation. Products are created to address the specific needs of the building owner and the end-user. **Moen Commercial.**

www.moen.com

ECAST faucets & fixtures

ECAST line provides a complete offering of durable, high quality brass faucets and fixtures, including deck mounted and wall mounted faucets, metering faucets, stop valves, specialty fittings and bubblers. The line was developed specifically to meet the AB1953 standard requiring faucets intended to dispense water for human consumption must not exceed a total weighted average of 0.25% maximum lead content. **Chicago Faucets.**

www.chicagofaucets.com

See contact information on page 69

Challenge met at 1,000,000-square-foot covert government facility

DALLAS — In a recent address to the nation, President Obama announced his plan for reviving the weakened U.S. economy. One of the plan's primary focuses is on energy efficiency; by investing in the greening of homes and lifestyles, America can reduce waste and spur innovative opportunities.

The speech was well received; many people saw the trend even before President Obama announced it. One example of this forward thinking is the partnership between United Mechanical in Dallas, a private design and build contractor with more than 60 years of experience in specialized skill projects, and a 1 million-square-foot government facility that had an antiquated boiler system serving its modern hot water needs.

The facility (its identity undisclosed due to security) features an onsite commercial kitchen, showers, numerous lavatories and a salon. There are four food preparation sinks, five hand sinks, one commercial dishwasher, two pot sinks, 30 dishwashers throughout the offices, 131 restroom lavatories and more.

Three pairs of Eternal Hybrid Water Heaters serve three different zones of the facility. The units are on a header system, allowing for easy swap-out and recirculation to provide quick hot water delivery. Six 200 K Btu heaters can closely match the output of the original 2M Btu boilers.

Mike Edenstrom, head installer who built the system at the government project, readies for another day at the job site.

Two 1-million Btu gas fired-boilers, along with a 2,000-gallon storage tank that took up 200 square feet, had been serving the entire compound for decades. When the new administration made its green intentions known, the facility contacted United Mechanical for advice and help.

Gary Scoggins, design engineer, tackled the challenge of sizing a system that can handle the facility's demands, reduce energy consumption and ensure reliable operations. By traditional means of Btu sizing, the new equipment should match the original equipment's two million Btu input. Btu input rating is often misleading, however, as output is the key to satisfying demand. For example, with a 60% thermal efficiency rating, the original equipment is capable of a 1.2 M Btu output. With high efficiency modulating equipment such as Eternal Hybrid, six 200 K Btu heaters can closely match the output of the original 2M Btu boilers.

By closely monitoring usage patterns, Gary discovered that, while the commercial dishwasher required 12 gallons of water per minute, it filled in just 45 seconds. Knowing this, he chose Eternal for its ability to leverage built-in storage for short burst demands. Otherwise, he would have had to use a 380 K Btu tankless to achieve the required flow rate.

The end result is a system with three pairs of Eternals serving three different zones of the facility. The units are on a header system, allowing for easy swap-out and recirculation to provide quick hot water delivery. The facility is very pleased with the result, and the maintenance crew is happy that the new system takes up just over 10 square feet of space. ■

Advertiser Index

Classified Ads

AHRI announces CEO's retirement, staff restructuring

ARLINGTON, VA. — The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) has restructured its staff responsibilities and made the following announcements:

• CEO Jack Klimp will be retiring as of June 1, 2009.

• Stephen R. Yurek will continue to serve as the association's president.

• Joe Mattingly continues as general counsel and corporate secretary.

• Stephanie Murphy is responsible for finance, membership and office operations.

• Bill Tritsis is responsible for certification programs.

• Henry Hwong is responsible for standards, product section services and statistical programs.

• Francis Dietz is responsible for public affairs, meetings and education.

• David Calabrese will have overall responsibility for government, regulatory and international affairs, assisted by Karim Amrane with regard to regulatory activities, Don Davis with regard to government affairs and Jim Walters with regard to international affairs.

The senior staff positions of executive vice president and senior vice president, public affairs, were eliminated in the restructuring.

ASHRAE honors Tampa engineer as new Fellow

CHICAGO — The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) elevated Warren G. Hahn, P.E., CEO, Hahn Engineering, Tampa, Fla., to the grade of Fellow at the Society's 2009 Winter Conference. Fellow ASHRAE is a membership grade that recognizes distinction in the arts and sciences of heating, ventilating, air conditioning or refrigeration and is earned through achievement as a researcher, designer, educator or engineering executive. Approximately 500 of ASHRAE's 50,000 members are Fellows.

Webstone appoints Western regional sales manager

WORCESTER, MASS. — Webstone Company Inc. has appointed Grant Dow Western regional sales manager. Grant will be responsible for all western United States and the western provinces of Canada. His duties will include sales enhancement, training, new product launches and representative management. He has extensive industry experience in sales management and is a licensed plumbing contractor, as well as a member of IAPMO.

Bradley names Western regional sales manager

MENOMONEE FALLS, WIS. — Bradley Corp. announced the appointment of Steve Henry as the company's new Western regional sales manager for Division 10 products.

See contact information on page 69

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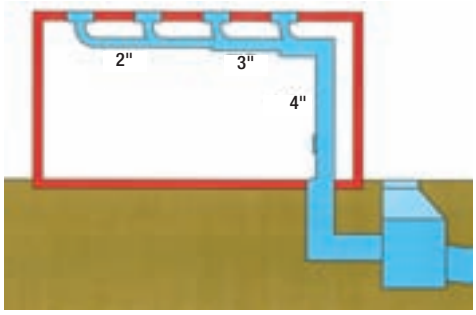
Siphonic Drain … the Future

Have you considered a Zurn Siphonic Roof Drainage System for use on your next project? ***Here's why you should …***

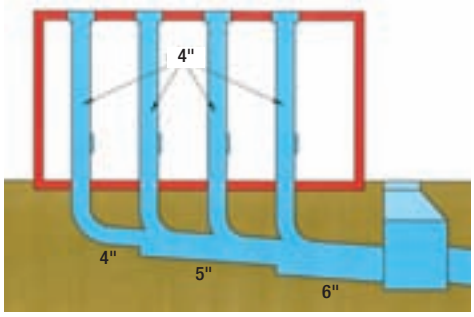
- No pitch required in piping to induce flow … ***more usable interior space.***
- Smaller pipe diameter for flow rates equal to gravity … ***cost savings.***
- Reduced underground large diameter drainage due to vertical stack placement flexibility … ***cost savings, more free interior space.***
- Higher flow velocities help to clean pipes – no cleanouts required … ***cost savings.***
- Green benefits for siphonic construction.

Siphonic Roof Drain Systems Versus Gravity Roof Drain Systems

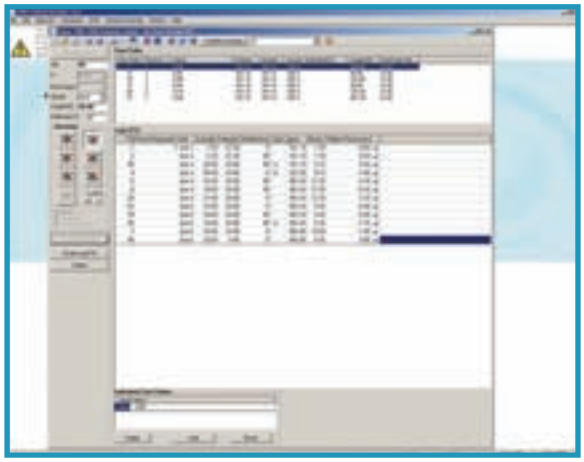
Siphonic



Gravity



Easy To Use Zurn Siphonic Software



Please contact your Zurn representative for more details.

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