THE NEW VALVE MAGAZINE CELEBRATES 25 YEARS!

VALVE MAGAZINE

SUMMER 2013
VOL. 25, NO. 3

The Debate and Opportunities Surrounding LNG

- VALVES IN HYDROGEN SERVICE
- SHUTDOWN VALVES IN SHALE
- ADVANCED SEALING TECH-NOLOGIES
- FLOWMETER SELECTION

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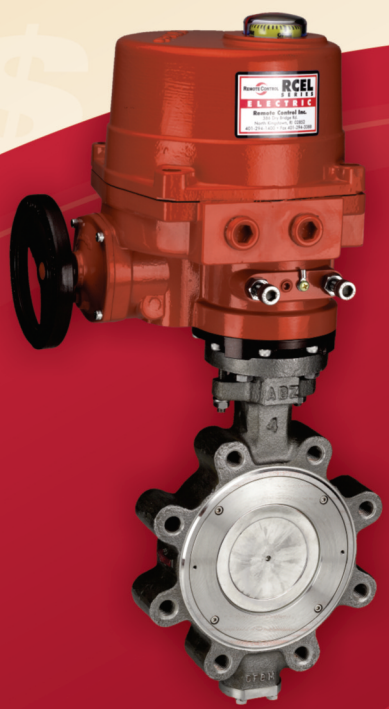

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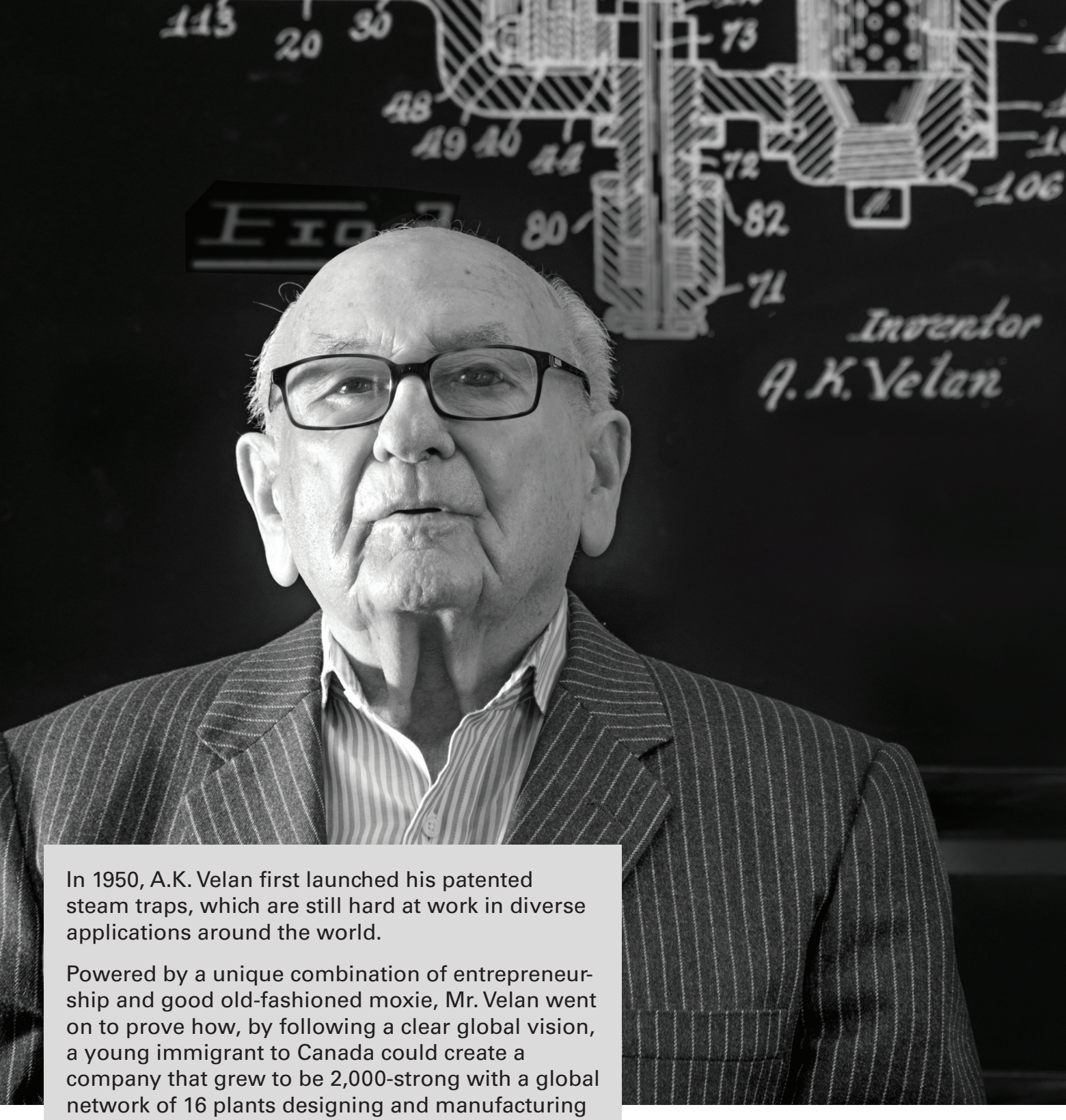

In 1950, A.K. Velan first launched his patented steam traps, which are still hard at work in diverse applications around the world.

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What you might not know about A.K. Velan is that this 95-year-old is a true renaissance man. Not only is he an inventor, he's also written books on cosmology, and is widely known for his many philanthropic efforts over the years. And he still likes to come into the office every day.

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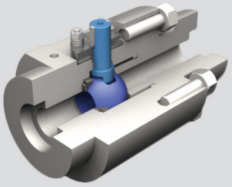

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www.VALVEmagazine.com

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VMA 75 YEARS
VALVE MANUFACTURERS ASSOCIATION OF AMERICA
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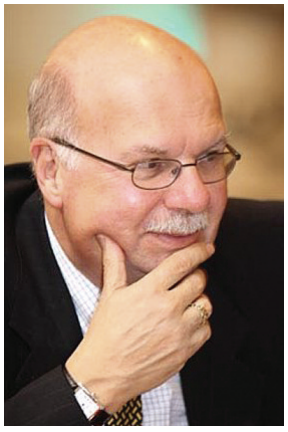
Designing for Growth



No trip is too far a distance to travel if you come back from it with something you've learned. In my case, I recently returned from a trip that was almost 4,000 miles: from Washington, DC to Ghent, Belgium. I was traveling May 24-25 for the annual CEIR Congress. CEIR is the umbrella trade association representing the European national sanitary and industrial valve trade associations. This year attendees included over 50 delegates from 10 different European nations plus representatives from Plumbing Manufacturers International and VMA in the U.S. I traveled there with our current Chairman Mark Cordell of Cameron Valves & Measurement.

Professor Miguel Meuleman of Vlerick Business School in Ghent, Belgium, gave the presentation I think made the trip most worthwhile. His talk was called *Designing for Growth*. Professor Meuleman started by categorizing two sources of new business growth, namely, new business models and customer-focused learning. He then described the business model as the rationale of how an organization creates, delivers and captures value, and gave examples from companies such as Google, Amazon, Zipcar and Dropbox, which have seen tremendous growth because they came up with new types of models.

I want to share with you a segment of his presentation I felt could be adapted for any company in the valve industry. He gave these nine building blocks of a business model and what they address:

- Customer segments—Which customers and users are you serving? Which jobs do they really want to get done?
- Value propositions—What are you offering them? What is what you're offering getting done for them? Do they care?
- Channels—How does each customer segment want to be reached? Through which interaction points?
- Customer relationships—What relationships are you establishing with each segment? Personal? Automated? Acquisitive? Retentive?
- Revenue streams—What are customers really willing to pay for? How? Are you generating transactional or recurring revenues?
- Key resources—Which resources do you need to realize your value proposition? Which assets are essential?
- Key activities—Which activities do you need to realize your value proposition? What is crucial?
- Key partners—Which partners and suppliers leverage your model? Who do you need to rely on?
- Cost structure—What is the resulting cost structure? Which key elements drive your costs?

To me, these nine points give us a good quick analysis of what we should look for when developing a model. They prove my point that whether you travel 4 feet or 4,000 miles, there is always something to learn. VM

Bill Sandler
President
Valve Manufacturers Association of America

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NEW FACILITIES

Emerson Process Management Has New Houston Facilities

Emerson Process Management opened its new $30 million Americas headquarters for valve automation technologies and a new, highly automated and sophisticated manufacturing facility in Houston to expand its services for the oil and gas and petrochemical industries. The new valve automation complex encompasses 215,000 square feet of office and manufacturing space.

Metso Opens New Service Center in The Netherlands

In May Metso launched a new service center in Waddinxveen, The Netherlands, near the Rotterdam-Antwerp industrial area. The new service center supports the company's strategy to grow its valve and field device service business globally and strengthens the company's service capabilities within the Benelux region for major petrochemical, energy, oil and gas, and pulp and paper companies.

The new facility brings the total number of Metso's automation service centers to 34 and automation service hubs to 87.

Pentair Valves & Controls Sets up Australian Assembly and Configuration Center

Pentair Valves & Controls is initiating a new Biffi piston actuator assembly and configuration center in Australia to focus on customers in the Pacific market.

"With our facility in Wangara, Eagle Farm, and now in Nowra, Pentair Valves & Controls Australia is well prepared to serve the demanding Australian market with a range of local products and services," Pentair development manager Alberto Provini told *Manufacturer's Monthly*.

In April, customers and agents were invited to see the workshops and product presentations by the Rotork Middle East team at the company's new Dubai facility.

Rotork Middle East Inaugurates Dubai Facility

Rotork Middle East opened a new purpose-built factory in Dubai to provide increased local support for business in flow control markets throughout the Middle East. Located in the Jebel Ali Free Zone, the facility contains offices and workshops for 15 sales and technical staff, with plans for further expansion.

In addition to stocking products and spares, the new facility provides a range of valve adaptation, retrofitting, site service and asset management activity for electric and fluid power actuators and associated equipment.

NEW CONTRACTS

Emerson Supplying World's Largest Semi-Submersible Heavy Transport Vessel

Dockwise has selected Emerson Process Management to supply the control systems that help maintain stability and structural integrity for Dockwise's new semi-submersible heavy transport vessel, the largest of its kind in the world with a loading capacity of up to 110,000 metric tons.

MARKET FOCUS: The Nation's Water Infrastructure Needs

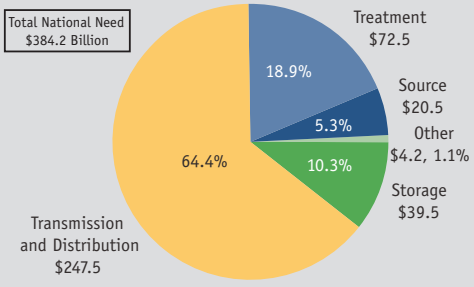
The nation will require $384.2 billion over the next 20 years to take care of public water system infrastructure needs, including almost $73 billion just for treatment, and $4.9 billion to meet new regulatory actions, according to a recent report by the U.S. Environmental Protection Agency (EPA). The agency's fifth annual national water infrastructure study says the funds are necessary for thousands of miles of pipes, as well as for treatment plants, storage tanks and other key assets to ensure public health, security and economic well-being of the nation's communities.

The amounts estimated in the report cover needs from Jan. 1, 2011 to Dec. 31, 2030 to take care of 52,000 community water systems and 21,400 not-for-profit non-community water systems. The projects, some of which are covered by the Drinking Water State Revolving Fund, are for new construction as well as rehabilitation, expansion or replacement of deteriorated or undersized infrastructure.

EPA says that by far the greatest need is for transmission and distribution, which makes up $247.5 billion or almost 65% of the needs. The majority of the money needed here is for replacing or refurbishing aging or deteriorating mains.

Meanwhile treatment makes up almost 19% of needs and EPA reports that about $72.5 billion is needed in this category for construction, expansion and rehabilitation to reduce contamination through various treatment processes (e.g., filtration, disinfection, corrosion control). Almost all of the money needed to meet regulatory needs comes from the treatment category, EPA says.

Total 20-Year Need by Project Type
(in billions of January 2011 dollars)



Note: Numbers may not total due to rounding.


The world's largest semi-submersible structure

Named Dockwise Vanguard, the new vessel is designed for heavy marine transport and offshore dry docking, enabling oil and gas operators to design and build larger and heavier offshore structures.

Metso's Jamesbury Valves Selected for Russian Refinery Expansion

Heurtey Petrochem has selected Metso to supply an upgrade and expansion project at the Tuapse Refinery situated in the Krasnodar region on the Black Sea coast in Russia. Heurtey Petrochem and Metso have been collaborating on a number of projects around the world for several years. The most recent of these are in Serbia and Abu Dhabi.

Commissioned in 1929, the Tuapse Refinery specializes in the production of motor fuel. It is the oldest refinery in the JSC Rosneft Group, the leading refinery in Russia's petroleum industry.

Cameron Awarded $600 Million Order from Petrobras

Cameron has received an order totaling about $600 million for the supply of 47 subsea trees and associated equipment. The deliveries for the equipment, destined for pre-salt and post-salt areas of offshore Brazil, will commence in 2014.

"Cameron welcomes the opportunity to continue to support Petrobras. This order will be supported by the expansion of our manufacturing capabilities in Brazil, completed this quarter," said Jack B. Moore, chairman, president and CEO.

CERTIFICATIONS

Highland Foundry Announces NORSOK-M650 Qualification

Highland Foundry Ltd. has successfully completed the updating of its 22Cr (MDS D46) Duplex and 25Cr (MDS D56) Super Duplex casting Qualification Test Records from Rev.3 to the current Rev.4 for NORSOK M-630 Edition 5 and M-650 Edition 4.

The NORSOK standards were developed by the Norwegian petroleum industry to ensure adequate safety, value adding and cost effectiveness for existing and future petroleum industry developments and operations.

CWFC Gets HAF604 Confirmation from China

Curtiss-Wright Flow Control announced that its Enertech business unit has received confirmation of its registration with Chinas National Nuclear Safety Administration, in accordance with HAF604 regulations. This certification is required for all equipment and components designed and manufactured outside of China.

Enertech currently has contracts with Westinghouse Electric Company to supply Westinghouse AP1000 pressurized water reactors currently under construction in Sanmen and Haiyang, China.

AWARDS & MILESTONES

Allagash International Named SBA Small Business Exporter of the Year

The U.S. Small Business Administration (SBA) announced Allagash International as the winner of its annual Small Business Exporter of the Year Award for 2013. Company founder Terry Ingram and Allagash International was honored at an SBA celebration luncheon on June 4 in Bangor, ME.

"Small businesses are the backbone of our economy, and recognizing those who work so hard to achieve success is truly an honor," said Marilyn Geroux, SBA district director for Maine.

Spirax Sarco Wins Two Product of the Year Awards

Spirax Sarco's VLM10 Inline Vortex Mass Flowmeter and Steam DesignPro 6.1 software have been selected as winners in the 2012 Plant Engineering Product of the Year Contest. This is the 25th year the publication has offered the contest for the best new products that improve productivity and safety in manufacturing operations. *Plant Engineering* announced the winners in the April 2013 edition of the magazine.

2013

AUGUST

8-9
VMA Market Outlook Workshop*
San Diego
www.vma.org

SEPTEMBER

25-26
ChemInnovations Conference & Expo
Galveston, TX
www.cpievent.com

OCTOBER

3-5
VMA/VRC Annual Meeting*
Palm Beach, FL
www.vma.org

5-9
WEFTEC
Chicago
www.weftec.org

NOVEMBER

6-7
VMA Valve Basics Seminar & Exhibits
New Orleans
www.vma.org

12-14
Power-Gen International
Orlando, FL
www.power-gen.com

DECEMBER

10-12
The 2013 Chem Show
New York City
www.chemshow.com

2014

MARCH

4-7
VMA Technical Seminar & Exhibition: Fugitive Emissions
Las Vegas
www.vma.org

25-26
VMA Valve Basics Seminar & Exhibits
Kansas City
www.vma.org

**Open only to VMA/VRC members.*

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ARTICLE SUBMISSIONS
VALVE Magazine welcomes articles, proposals, manuscripts, photographs and ideas from our readers. For a copy of the magazine's Author's Guidelines, contact Genilee Parente, managing editor, at gparente@vma.org.

MERGERS & JOINT VENTURES

Metso's Board Approves Plan to Divide into Two Companies

Metso's Board has approved a demerger plan to transfer all the assets, debts and liabilities of Metso' s pulp and paper and power businesses to a newly formed company that will be named Valmet Corporation. Metso's mining and construction and automation businesses would remain in the current company, which would continue to operate under the Metso name. Valmet would initially have the same ownership structure as Metso and would be totally independent without any cross-ownership between Metso and Valmet.

Allagash International Announces Joint Venture with Caspian Energy

Allagash International Inc. President and CEO Terry J. Ingram has announced a formal joint venture with Caspian Energy, an oil and gas exploration company operating in Almaty, Kazakhstan.

Caspian's primary focus is supplying product solutions to the oil and gas sectors. Allagash has created this joint venture to increase exports to the region, which is one of the fastest growing areas in the Asian market. The plan is to create an assembly and technician center in Kazakhstan to service the emerging oil and gas industries.

Flowserve Obtains Full Ownership of Indian Manufacturing Facility

Flowserve has announced the completion of a series of transactions related to the company' s former Audco India, Limited (AIL) joint venture with Larsen & Toubro, Limited (L&T). As a result, Flowserve obtains full ownership of the joint venture's Maraimalai Nagar manufacturing facility in Chennai, India, and retains the key Serck AUDCO brand lubricated valve products and technology. L&T will retain the remaining AIL entity and its other operations.

PEOPLE IN THE NEWS

CURTISS-WRIGHT... announced that **David J. Linton** resigned as president of Curtiss-Wright Flow Control (CWFC) effective May 6, 2013, in order to pursue other opportunities. By mutual agreement, he is stepping down as part of the reorganization of the operational management structure as announced in October 2012. President and COO **David C. Adams** will assume day-to-day management of CWFC until a permanent replacement is named. As COO, Adams has responsibility for CWFC as well as the company's other two operating segments, Controls and Surface Technologies.

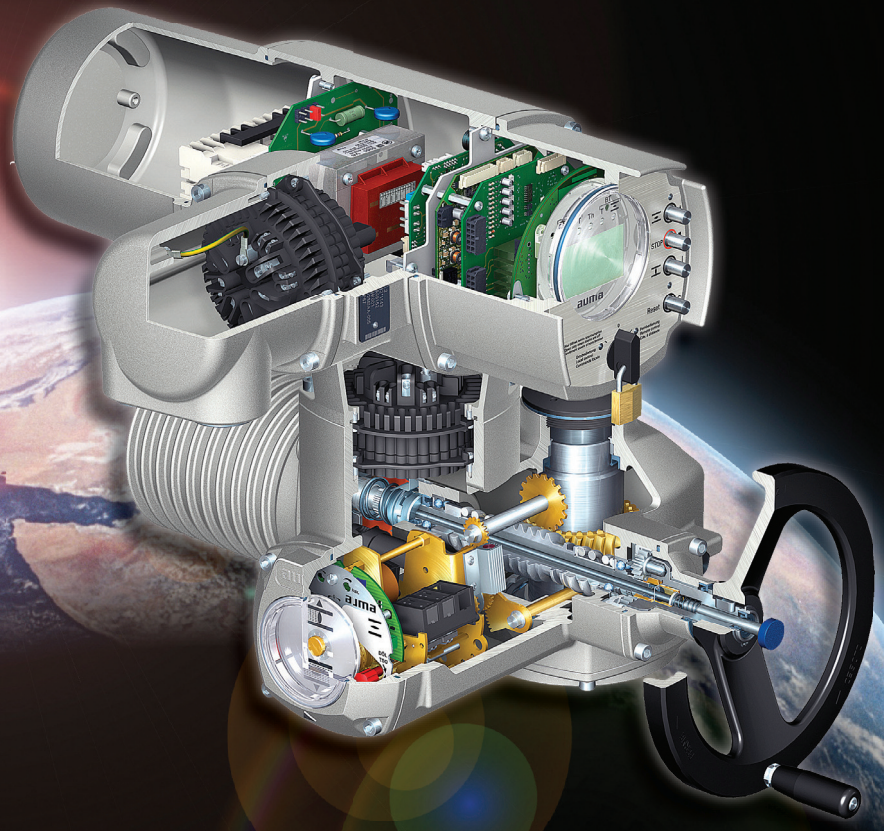
CRANE CO... CEO **Eric Fast** will retire from Crane Co. in January 2014. Fast joined Crane in 1999 as president and chief operating officer and was promoted to chief executive officer in January 2001. He will be succeeded by former VMA Chairman **Max Mitchell,** currently president and COO. Mitchell joined Crane in 2004 as vice president of operational excellence, was promoted to president, Fluid Handling, in 2005, became executive vice president and COO in May 2011, and was appointed president of Crane Co. in January 2013.

In other Crane news, the VMA Board of Directors has approved the appointment of **Louis Pinkham** to fill a vacancy on the board. Pinkham joined Crane Co. in October 2012 as group president, Fluid Handling. Before joining Crane, he was senior vice president and general manager of the Critical Power Solutions Division, Electrical Group at Eaton Corporation. Prior to Eaton, Pinkham held engineering and quality manager positions at ITT Sherotec, a division of ITT Engineered Valves.

VALVTECHNOLOGIES... has named **Edward Ferris** as vice president of human resources, company president Kevin Hunt announced in May. Ferris previously served as senior vice president of corporate and organization development at Del Global Technologies Corporation. Additionally, he has held executive human resource positions at ABB, General Signal Corporation and British Telecom. His roles included human resource management of locations in more than 44 countries on six continents.

A Step Beyond

Enjoy tomorrow's breathtaking technology today with AUMA innovative solutions for electric valve actuators and controls. Customers worldwide can choose precisely the right combination for optimum results.



Valve Actuators with AC

Actuators may be non-intrusive with position and torque sensed by encoders or conventional with limit and torque switches. AC controls provide extensive control and reporting features for interface with the Distributed Control System (DCS).

Valve Actuators with AM

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VMA's 75th Anniversary: The Celebration Moves Full Steam Ahead

To commemorate its long and rich history, the Valve Manufacturers Association (VMA) is celebrating its 75th anniversary with a series of events and activities that highlight the industry's legacy and future.

Many member volunteers are working to make the year memorable, including the VMA Communications Committee chaired by Mike Rooney of Emerson Process Management–Valve Actuation.

"Our intent is to capture and share the many reasons the association is proud to be the voice of the U.S. and Canadian flow control industry and represent many of the world's finest valve, actuator and control manufacturers," Rooney says.

To spread the message about the high-quality products engineered by its members, VMA is working with trade press on developing articles and exchanging ads, as well as hosting members of the press at a briefing at the VMA 75th Annual Meeting (Oct. 3-5 at The Breakers in Palm Beach, FL). The association will also release new data at the meeting to help quantify the industry's economic footprint. Also under development is a new multi-media presentation that features members talking about the association, its positive effect on their careers and their companies, and why end users worldwide benefit by seeking VMA member companies for their flow control projects.

THE PAST

VMA's history is tied to several early associations, which were born to address issues facing the valve industry, including standardization. Among them were the National Association of Fittings Manufacturers and the Valve Institute—both founded in the early 1900s—that merged in 1933 to create the Valve and Fittings Institute (VFI). As valves and actuators became increasingly specialized, they became viewed as products within the product and were manufactured separately. In response to this trend, 14 valve companies broke away from VFI and in 1938 formed VMA to better represent this growing and increasingly specialized industry.

Today, membership in VMA is recognized as the "seal of approval" since members must be voted in based on a number of criteria that assure they follow certain quality procedures and that their engineering know-how originates from operations in the U.S. and Canada.

A special section of VMA's website (www.VMA.org/?75 home) has been created to capture this rich history. Included are articles on the fascinating history of valves as well as significant milestones in the industry and the association, interviews with valve industry icons, a pictorial history of images from the last century and an Anniversary Press Room. More features will be added in coming months.

THE PRESENT

Currently, VMA exclusively represents nearly 100 North American manufacturers of valves, actuators and controls, which account for about 80% of total industrial valve shipments out of U.S. and Canadian facilities, as well as suppliers to the industry and distributors/channel partners.

VMA President William Sandler explains that: "Valve manufacturing is an industry that dates back centuries, but the industrial age spurred its growth and importance and led to VMA's formation. As a voice for this multi-billion-dollar industry, we are proud of our 75-year partnership that has helped keep this flagship industry growing and competitive."

"We are using our anniversary to showcase our industry, which is the backbone for many others," he says.

The Fall 2013 issue of VALVE Magazine, which will be released on Oct. 1, will feature extensive editorial on the history of VMA and the valve industry—past, present and future. VM

VMA AND VRC WELCOME NEW MEMBERS

The Valve Manufacturers Association has added three more members, bringing to eight the total number of new members so far in 2013. In addition, the Valve Repair Council welcomes a new member.

Total Valve Systems (www.totalvalve.com), Broken Arrow, OK, offers valve and gauge application solutions for on-site and in-house service for all brands of pressure relief and all types of process line valves. Total Valve Systems has a full line of in-house manufactured custom valves, including excess flow valves, isolation valves and check valves.

Joining as associate (supplier) members are:

AVK Carbo-Bond/BI-TORQ Valve Automation (www.bitorq.com), LaFox, IL, is a family-owned business serving industrial, commercial and municipal accounts since 1981. The company's experience with a wide variety of valve and actuator manufacturers allows them to provide valve automation components for virtually any application.

Houston Plating & Coatings (www.houstonplating.com), South Houston, TX, provides electroless nickel, spray coating and other corrosion protection services to petroleum equipment and other manufacturers since 1988.

New to the Valve Repair Council is **NWS Technologies, LLC**, Spartanburg, SC; the company provides safety valve testing for the nuclear industry.

If your company would like to join VMA, visit VMA.org > Members to see if you qualify and to learn about the benefits of membership.

WEFTEC – The Largest Water Quality Event

The Water Environment Federation's Annual Technical Exhibition and Conference is the largest water quality event in North America, offering water and wastewater professionals the latest information, education and training.

More than 17,000 professionals from both the private and public industries are expected to gather at the McCormick Place, Chicago for the Oct. 5-9 event. There, they will attend close to 150 technical sessions as well as workshops, local facility tours, and general sessions divided by areas of expertise. Those areas include collections and distribution, energy production, facility operations, research, utility management, water reclamation, water supply and much more.

The exhibition itself is the largest water quality showcase in the world offering products from close to 1,000 vendors on hundreds of thousands of square feet of exhibit hall. These products help keep water clean and wastewater facilities running smoothly. This year's exhibit hall will be open Monday to Wednesday, Oct. 7-9 from 9 a.m. to 5 p.m. and private demonstrations will be given until 6 p.m. the first two days. For information go to www.weftec.org.

ChemInnovations 2013 is in Galveston

About 1,500 plant management and operations personnel will gather Sept. 24-26 at the Moody Gardens Convention Center, Galveston, TX for ChemInnovations 2013, a conference that addresses issues in the workplace.

The event is designed to provide practical advice, networking opportunities and product showcasing to engineers in the chemical processing industry. Eight tracks that range from water management to maintenance to new technologies will guide the technical program and a series of half-day preconference workshops on Sept. 24 offer basic information on the industry.

Shale gas leads off as a topic for the general sessions, and the exhibit hall features 100 companies displaying innovations and services. For information, go to www.cpievent.com.

Valves & Actuators 101: Continued Growth Shows Need for Basic Education

"At every turn we see evidence of the importance of entry-level valve education," says Greg Johnson, chairman of the VMA Education & Training Committee, and president of United Valve. "You can't go to a conference or read a business or trade publication without discussion of this topic: How are we going to replace the graying workforce, and where will the next generation of workers learn their craft?"

VMA's Valve Ed program was born out of this concern and continues to go strong four years after the association unveiled its first program, held in Houston, Oct. 29, 2009 to a packed room of nearly 200 attendees. In its early stages, the Valves & Actuators 101 course lasted one day, "but it became clear that participants needed to have opportunities to examine products in a more intimate setting, so we expanded the program to one-and-a-half days and added a 'valve petting zoo,'" Johnson explains.

Prior to the start of the Valve World Americas Expo & Conference, VMA presented a one-day version of its Valves & Actuators 101 course. More than 120 people from all facets of the industry attended and gave the course high ratings.

With so much information to convey and products to demonstrate, the Valve Basics Seminar & Exhibits, Nov. 6-7 in New Orleans, has been expanded to two full days. New lessons on solenoids, positioners and other accessories have been added to the curriculum, along with more time for the hands-on portion of the program. Attendees will receive 12 credit hours for participating in the two-day course, as well as a VMA-awarded Certificate of Completion.

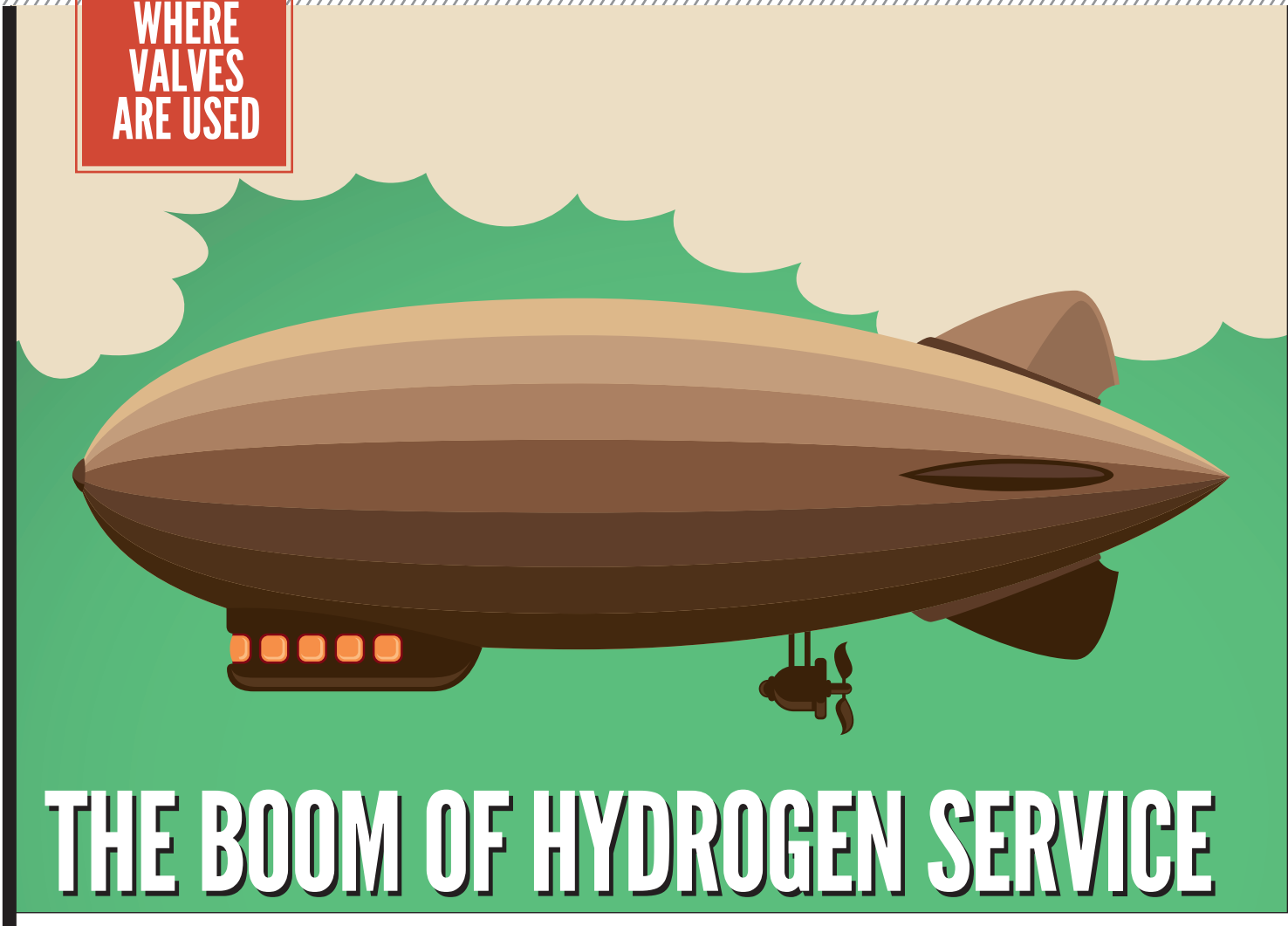
The course is designed to provide an entry-level overview of valves, actuators and controls, and is most appropriate for those who are newly graduated or in the early stages of their careers. Past attendees have included individuals who specify, purchase, use, maintain/repair/service, sell, distribute and manufacture valves, actuators, controls and related products.

The fee for the two-day course, which includes a manual, CD, entrance to the table-top exhibits, breakfasts, lunches and beverage/snack breaks, is $665 for the first person registering from a company, and $635 for subsequent registrants from the same location. After Aug. 31, the rates will go up to $700 and $670, respectively. Additional information and online registration is available at www.VMA.org/?Basics.

A limited number of spaces are available for exhibitors. Please read the Exhibitor Prospectus for details on the types of companies that qualify (go to www.VMA.org/?Basics and click on the appropriate link).

In 2014, the Valve Basics Seminar & Exhibits will be held in two locations: March 25-26 at the Hotel Sorella/Country Club Plaza in Kansas City and Oct. 30-31 at Planet Hollywood in Las Vegas.

WHERE VALVES ARE USED



THE BOOM OF HYDROGEN SERVICE

BY GREG JOHNSON

If someone used the word "hydrogen" while playing a word association game, the first word that would probably come to mind would be "bomb."

There's a good reason: This high-energy gas holds a great deal of danger. Perhaps one of the most graphic demonstrations of its potential was the huge Hindenburg dirigible that exploded into flames over Lakehurst, NJ, May 6, 1937.

Hydrogen is very reactive and highly explosive, as well as being composed of the smallest molecules known to man.

The attributes of this gas that make it dangerous must be kept in mind when considering valves for applications that use hydrogen.

THE CHALLENGES OF ENERGY

With the potential energy that hydrogen possesses, as well as its small molecule size, hydrogen service presents many challenges to the valve designer. For this reason, valves for hydrogen use should be of the best materials, highest quality castings and tightest machining tolerances.

Hydrogen service piping has three basic environments. The first is ambient temperature pipelines that transport pure hydrogen from where it's manufactured to its ultimate point of consumption. The second, and sometimes the toughest environment, is low-temperature applications in refineries where hydrogen only makes up part of the total chemistry of the fluid in the line. The third is high-temperature hydrogen applications, where hydrogen again is only one part of the fluid line chemistry. From the standpoint of corrosion, the second and third environments are by far the toughest.

Executive Summary

Subject: Because of its explosive nature, hydrogen presents a unique set of challenges to the equipment that helps it flow.

Key concepts:

- Why hydrogen is a challenge
- What systems are used
- Standards and testing that apply
- New uses for hydrogen

Take-away: Because hydrogen is one of the cleanest types of fuel available, the future for hydrogen use and for the valves designed for the industry is rosy.

Most valve types work well in hydrogen service, as long as they have excellent closure capabilities. This requirement can mean that valve seating surfaces may need additional grinding or lapping to improve sealability. If no high temperatures are involved, elastomeric seats, seals or seating inserts can be employed to help effect a tighter seal. The one type of valve that is least popular in hydrogen service is the swing check valve with its less-than-ideal seating mechanism that does not work effectively for sealing gas, especially hydrogen gas.

CASTINGS REQUIRE EXTRA SCRUTINY

Since many valves are made of pressure-containing castings, those castings require higher than normal scrutiny to ensure they contain the small molecules of hydrogen. Casting evaluation is performed by using four primary nondestructive examination techniques. The first is visual examination, which at a minimum invokes the requirements of the Manufacturers Standardization Society (MSS), SP-55, Quality Standard for Steel Castings for Valves, Flanges, Fittings and Other Piping Components Visual Method for Evaluating Surface Irregularities. The acceptance criteria listed in SP-55 is considered a starting point when evaluating the visual appearance of castings. Oftentimes, end-user specifications will be much more severe in surface finish evaluations for hydrogen service, especially interior areas of valve castings that are exposed to process fluid.

Magnetic particle (MT) examination is used to detect surface and slightly subsurface casting irregularities. This testing is performed in accordance with various American Society of Mechanical Engineers (ASME) and MSS standards. Because it relies on magnetizing the surface to be examined, MT examinations can only be performed on ferrous alloys.

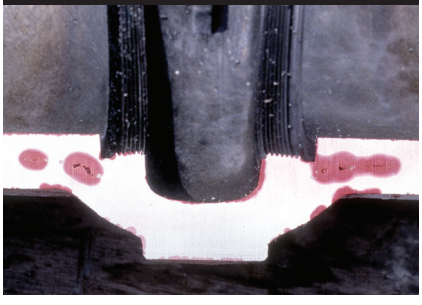
Dye-penetrant (PT) examination is also performed in accordance with ASME and/or MSS standards. The PT examination is versatile because it can be used on all materials, not just ferrous alloys. PT relies on the bleed-out of a highly visible dye after it has been allowed to set on the casting surface for a prescribed minimum period of time. The size of the ink indications are in relative proportion to the size and depth of the defect.

The most important casting evaluation method is radiography. This can be performed with electrically charged x-ray machines or radioactive isotopes. The radiography technique is performed in accordance with ASME and/or MSS standards. Radiography is considered a volumetric examination because it evaluates the sub-surface mass or volume of the castings. Radiographers use comparative radiographs to evaluate the defects that they see as dark areas on the film. These can be linear or rounded indications. By analyzing the defect and comparing what is visible to the specific graded reference radiograph, potential casting voids or defects can be determined.

The reference radiographs contain varying degrees of defect severity from one to five, with one the best and five the worst. Many end users specify certain maximum severity levels, depending upon the parameters of the application. Some users would routinely accept levels 3-4 for most applications, while severe service applications such as nuclear installations would require virtually zero defect castings.

Hydrogen service acceptance criteria usually lie roughly between standard acceptance criteria (levels 3-4) and the highest quality nuclear applications (level 1). A common acceptance criterion for many defect types in hydrogen service is level 2. This level requires specially manufactured and inspected castings or castings that have been upgraded as required via examination and weld repair.

□ Voids in castings are especially undesirable for valves in hydrogen service. Depending upon operating temperature, these voids can be the cause of strength-compromising defects.



CORROSION ISSUES IN REFINERY SERVICE

Hydrogen is a popular raw material for key refining processes, including several that are focused on producing low-sulphur fuels. Popular refining processes such as hydrocracking, hydroprocessing and hydrotreating all require a steady supply of hydrogen. Other refinery processes produce hydrogen as a by-product as well.

□ Oil refineries are the biggest users of hydrogen. It is a key raw material for several important refining processes, including some that are used to create low-sulfur fuels.

High temperature and pressure are two parameters in refinery processes that call for the utmost scrutiny. When hydrogen is the process fluid, the concern for safety and integrity becomes even greater. High-temperature, high-pressure hydrogen can cause a failure mode known as hydrogen attack, which is when carbon and alloy steels are exposed to hydrogen under these conditions. Hydrogen enters the steel and reacts with the carbon to form methane (CH_4). This can result in the formation of cracks and fissures when the operating temperature is above 392°F (200°C).

Another failure mode associated with hydrogen service occurs predominately in low-strength alloys when atomic hydrogen diffuses into internal defects such as voids or laminations, then precipitates as molecular hydrogen. The internal pressure created by this phenomenon is so strong that if it occurs near the metal's surface, blisters are created.

Yet as damaging as blisters in metal seems, probably the most insidious form of refinery hydrogen damage is called hydrogen embrittlement. This generally occurs at near-ambient temperatures when the hardness of the metal is 22 HRC (Rockwell hardness scale of C) or greater. It can cause a

brittle fracture of normally ductile steels under a sustained load and in the presence of hydrogen at levels of less than 100 parts per million.

Because of the hydrogen permeability of steel, it is important that every step be taken to ensure the base material of the valve is of the highest homogeneity. This is why high-quality, near-defect-free castings are desired. It is also why forged materials are highly valued, since their structure is much more compact, dense and free of internal defects.

PROPER WELDING PROCEDURES

In valve manufacturing, welding processes are often employed. If the ultimate service fluid is hydrogen, then special precautions must be taken and procedures followed to ensure sound metal that is not susceptible to any hydrogen damage. It is always good practice to make sure that hydrogen-causing moisture does not enter a weldment, either through the filler material or the welding environment. For example, electrodes should be kept in a heated container until needed so they are dry. Also, the parts to be welded should be free of hydrocarbons such as grease and oil. Welding in a high-humidity environment also can be a source of damaging hydrogen. Proper heat treatment following welding or hot-forming can protect against tramp hydrogen left in the metal. However, it is critical that the weldment and heat-affected-zone is not cooled too fast during the post-weld-heat-treatment process or additional damage could occur.

HYDROGEN PIPELINES

Because refineries are using more and more hydrogen, the need for adequate distribution of the gas has become paramount. To this end, hydrogen gas producers have been laying networks of pipelines to connect production plants to refinery users. These pipelines, because of the hazards of their cargo, must meet strict design and safety guidelines. There are several networks of these hydrogen pipelines, with the longest and most complex situated on the Gulf Coast running between Texas City, TX and Pascagoula, MS.

In 2009, ASME developed B16.12, Hydrogen Piping and Pipelines, a standard that covers design, fabrication, inspection and installation. In addition to specifying pipeline requirements, this document also covers the requirements for industrial hydrogen piping. Because transmission pipelines convey pure hydrogen at ambient temperatures, the concerns over hydrogen damage are not as great. However, these pipelines weave around and through populated areas, so extreme care must be taken to ensure integrity. B16.12 is very strict about casting integrity, requiring radiography acceptance criteria of level 2 for most defect types.

□ The design and installation of hydrogen pipelines is covered under ASME B31.12, Hydrogen Piping & Pipelines. The standard also prescribes additional testing requirements for API 6D valves in this service.

All API 6D valves in hydrogen pipeline service are required to be pressure tested with helium in accordance with API 6D, Annex C, Para. C4. Non-6D valves must meet the test criteria of API 598, also with helium as the test medium.

Another concern with valves in hydrogen service is the possibility of stem and gasket leaks. High-temperature hydrogen seals are difficult to achieve and require the highest quality graphitic packing along with exacting tolerances in the stem and stuffing box. Sometimes this is not enough and bellows seal valves are required.

Gaskets also must be carefully chosen and installed. The best solution for a 100% effective gasket is no gasket at all, which is why welded bonnet valves are well suited for hydrogen service. The best choice to eliminate all potential hydrogen leak paths is a socket-weld or buttweld-end, bellows-seal, welded-bonnet valve. However, this configuration is usually limited to sizes NPS 2 and smaller.

□ Hydrogen's growth may be tied to its usefulness as a clean transportation fuel.

A PROMISING FUTURE

Today, valves in hydrogen service are used in many applications in the refining industry and the pipelines that feed them. However, tomorrow could see a huge increase in the hydrogen use, which would be accompanied by a much bigger demand for these special service valves. This is partly because hydrogen is a much cleaner fuel source for vehicles, and we are now on the cusp of great growth in the field of hydrogen-powered transport. The creation of hundreds or thousands of hydrogen refueling facilities will require a huge amount of high-integrity hydrogen service valves.

Also looming just over the horizon is the promise of the hydrogen fuel cell. If this technology is commercially and economically realized, it could make hydrogen the primary source of the world's energy.

Because of all this, the future for hydrogen is very bright, as is the future of the pipes, valves and fittings industry sector that will support it. As long as we remember lessons such as the Hindenburg disaster at Lakehurst, NJ, and keep in mind the safety requirements for handling this unique and powerful fuel source, the future for valves, like the gas itself, could be explosive. VM

Greg Johnson is president of United Valve (www.unitedvalve.com), Houston, and is a contributing editor to VALVE Magazine. He serves as chairman of VMA's Education & Training Committee, is a member of the VMA Communications Committee and is president of the Manufacturers Standardization Society. Reach him at greg1950@unitedvalve.com.

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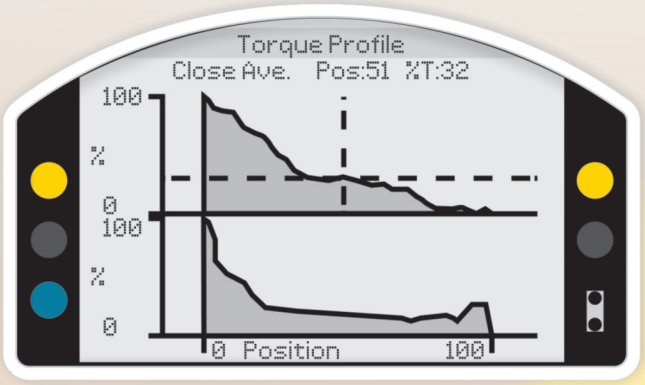

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Redefining Flow Control

Opportunities and challenges in the LNG process

BY MARK TILLEY AND FREDERIC BLANQUET

Liquefied Natural Gas (LNG) is exactly what it says: the liquid form of natural gas. The process of liquefying is performed to reduce the volume for purposes of transporting the fuel: LNG reduces volume by 600 times, making it much more economical to transport by sea aboard LNG carrier ships to destinations all over the world.

The temperature required to liquefy natural gas is -260°F (-162°C). As a result, most pipe, valves and fittings will be specified to meet cryogenic temperatures of -270°F (-168°C) to 325°F (-198°C). The development, transportation and receiving of LNG require a step-by-step process that has grown very rapidly over the last several decades. In the past, each step was treated as a different market. However, with the global economy and market for LNG expanding rapidly, the challenge of many manufacturers of pipe, valves and fittings is to expand their product ranges to cover all three areas. Valves are a critical component at each stage, and they need to be constructed of quality cast and forged materials. Valve performance and reliability are vital to the whole process, and these strengths can only be achieved through critical design, manufacturing and material selection.

LIQUEFACTION FACILITIES

LNG facilities are constructed in various places in the world where an overabundance of natural gas can be converted to its liquefied state for use elsewhere. A few different facility designs have been developed for reaching the cryogenic temperatures needed. Valve design and specification may be slightly different from facility to facility, but the

Executive Summary

SUBJECT: The U.S. recently became the world's top producer of natural gas, and the nation is now looking at selling it to other places in the world that need the fuel. The result is a growing market for liquefied natural gas (LNG) and the equipment needed for that field, as well as a debate on whether exporting that LNG is good for the country.

KEY CONCEPTS:

- Valves used in LNG
- Standards and testing
- The pros and cons of exporting LNG
- Current legislative thinking

TAKE-AWAY: Although the field is competitive, the growth presents new opportunities.

An LNG tanker offloads at an island-based receiving terminal.

end result is the same: The volume ratio of 600 to 1 (gas to liquid) is loaded onto specially equipped carriers to be shipped to receiving terminals.

Some of the valves used in the facilities include:

Butterfly valves. Most butterfly valves for this use are 4 inches and larger. Some control valves will be this type, but the majority of butterfly valves are manual, on/off automated and emergency shutdown. While many of these valves are used throughout the facility, most types will be cryogenic to meet the extreme cold requirements. Most of these valves are in the 150-pound, 300-pound and 600-pound classes with flanged ends. The valves will require live loading on the packing to ensure a constant load on the packing chamber. They also will have stem extensions that are calculated in length to maintain a vapor barrier at the upper end of the extension. There are also some higher pressure valves needed that are in the 900-pound class and are cryogenic butterfly valves.

Ball valves. The majority of ball valves for LNG are 6 inches and smaller with pressure classes typically the same as butterfly valves. Like butterfly valves, ball valves are used for many applications and most are cryogenic. The body is typically a butt weld, three-piece design with a cryogenic extension and live loading on the packing chamber. There are many applications where a cryogenic top entry, one-piece body is preferred because of thermal cycling conditions in the process.

Gate, globe and check valves. These valves are also used in many areas of the facility in both cryogenic and ambient applications. The majority of cryogenic valves are going to be butterfly and ball valves, however, depending on the process design.

LNG CARRIERS

These vessels are specially designed to transport LNG from the liquefaction facility to the receiving or regasification terminal. The world's need for natural gas means the LNG carrier market is booming. Because of the gas to liquid ratio, these carriers can transport enormous amounts of LNG to those areas of the world that have the demand. There also are many new innovations for floating LNG regasification terminals and liquefaction facilities, including carriers with regasification facilities on board. This means that in areas where the construction of a receiving terminal does not make sense, such as small ports, natural gas can go right from the ship to feed power plants.

Butterfly valves. As with facilities, the majority of butterfly valves on carriers are 4 inches and larger; some control valves are butterfly, but the majority will be manual, on/off automated and emergency shutdown. While there are many butterfly valves designed for

"America's energy abundance is creating employment opportunities and growth at a time when little else in the economy is going as well– and that alone is enough reason to support domestic energy production. But while this energy abundance is a source of jobs at home, it can also be a force for good around the world."

Representative Ed Whitfield (R-KY)
Chairman of the Energy and Power Subcommittee of the House Committee on Energy and Commerce, May 7, 2013

use by utilities or designed for ambient gas, most are cryogenic to meet temperature requirements. Most of these valves are in the 150-pound class with butt weld ends and a side entry port for maintenance. Minimizing flanged connections is important in most areas of the vessel, but they cannot be avoided completely because of space concerns on ships. These valves also will have stem extensions that are calculated in length to maintain a vapor barrier at the upper end of the extension.

Ball valves. As with facilities, most ball valves on carriers are 6 inches and smaller with pressure classes typically the same as for butterfly valves. Also, most will be cryogenic and the body is typically a butt weld top entry design with a cryogenic extension with live loading on the packing chamber.

Gate, globe and check valves. These are used in many areas on the vessel in both cryogenic and ambient applications, though most of the cryogenic valves on ships are butterfly or ball valves.

RECEIVING OR REGASIFICATION TERMINALS

These facilities receive LNG from the carriers and are usually constructed in populated areas of the world where there is a great need for natural gas. The LNG is off loaded into massive insulated tanks on shore before the process of converting LNG to a gas begins. The facilities then introduce the natural gas into area pipelines for use.

Butterfly valves. Again, most butterfly valves for these terminals are 4 inches and larger; some control valves are butterfly valves, but most control valves are manual, on/off automated and emergency shutdown. While many butterfly valves are used throughout the terminals, most are cryogenic, in the 150-pound class with butt weld end and a side entry port for maintenance.

□ With new techniques such as hydraulic fracturing and horizontal drilling, the U.S. has become the world's largest natural gas producer.

Y. BLOND

The Pros and Cons of LNG Exporting

BY WAYNE D'ANGELO

Thanks to widespread use of techniques such as hydraulic fracturing and horizontal drilling, the United States has become the world's largest producer of natural gas. These technological advances in hydrocarbon extraction currently support over 1.7 million jobs, and IHS, Inc. estimates the U.S. energy boom will directly or indirectly support 3.5 million American jobs by 2035.

Apart from job creation, this revolution in U.S. unconventional oil and gas production has bolstered a flagging domestic manufacturing industry, set the U.S. on a path toward energy independence and increased U.S. geostrategic opportunities. The fact the United States has turned from an importer of natural gas to a potentially powerful exporter in only a few short years is seen by many as a powerful geopolitical tool—one that can strengthen strategic alliances while undermining the grip that countries like Russia and Iran have on regional energy supplies.

Critics worry that exporting natural gas would frustrate a resurgence in manufacturing and undermine the benefits that cheap energy offers to U.S. industry and to consumers. Concern also exists that a surge in global demand could trigger a price increase and raise costs for domestic industry and consumers, and that granting exports to countries without a formal U.S. Free Trade Agreement (FTA) would weaken U.S. leverage in international trade negotiations.

Still, America appears to be sitting on a significant amount of natural gas, and the debate over whether, and how, to export it has been simmering, with recent attention turning toward getting answers through Congress, the President and the newly appointed Secretary of Energy, Ernest J. Moniz.

THE DEPARTMENT OF ENERGY AND LNG EXPORTS

The Natural Gas Act (NGA) requires the Department of Energy (DOE) to review all applications for exporting natural gas to countries that have an FTA with the United States. However, a 1992 amendment to the act required that trade in natural gas be "deemed to be consistent with the public interest" and "granted without modification or delay," which removed DOE's discretion over exports of natural gas to such countries. It should be noted, however, that the market for export to these countries is limited, with only South Korea, Singapore, Chile and the Dominican Republic currently importing natural gas.

For non-FTA countries, such as Japan and India, the NGA authorizes DOE to grant applications for export authorizations unless the proposed exports would "not be consistent with the public interest." On May 17, 2013 DOE granted approval to the Freeport LNG Expansion and FLNG Liquefaction LLC's application to export LNG to non-FTA nations, including Japan, the world's largest LNG importer. This comes a year after DOE granted the first approval to the Sabine Pass liquefaction terminal in Louisiana for the export of liquefied natu-

Minimizing flanged connections is also important in most areas of these terminals. The valves must have "live loading" on the packing to ensure a constant load on the packing chamber. They also will have stem extensions calculated in length to maintain a vapor barrier at the upper end of the extension. This is another area where higher pressure, 900-pound cryogenic butterfly valves used with butt weld side entry design are used. Very few manufacturers currently make this type and pressure class of valves.

Ball valves. Most are 6 inches and smaller with pressure classes that are the same as butterfly valves. Again, many types are used, but most are cryogenic. The body is typically a butt weld three-piece design with a cryogenic extension and live loading on the packing chamber. Also, there are many applications where a cryogenic top entry one-piece body is preferred because of thermal cycling conditions in the process.

Gate, globe and check valves. These are used throughout the facility in both cryogenic and ambient applications, though most of the cryogenic valves are butterfly and ball valves depending on the process design used. There may be check valves of a special design used for loading and unloading LNG. These valves can be operated in reverse flow in which case the disc is mechanically overriden to lock open for reverse flow.

BODY MATERIALS

For LNG service, the body material is typically austenitic 316 stainless steel to maintain body strength at cryogenic temperatures. Non-cryogenic valves can be WCB-grade, stainless or high nickel alloys that are suitable for that particular service as well as for the offshore environment.

ral gas for a 20-year period to FTA and non-FTA nations. DOE is currently reviewing 20 similar applications.

In evaluating these applications, the "public interest" provision creates a rebuttable presumption that the designated export is in the public interest. DOE must grant the application unless opponents can refute that presumption. DOE's public interest analysis focuses on the domestic need for the natural gas proposed to be exported. It also focuses on whether the export is consistent with DOE's policy of promoting competition by allowing commercial parties to negotiate freely their own trade arrangements, whether a threat exists to domestic security supply, and on other factors shown in the public interest, including environmental impacts.

On Dec. 5, 2012, the DOE's Office of Fossil Energy posted the long-awaited results of a third-party study on the potential macroeconomic impacts of LNG exports.

STUDY RESULTS

The study's broad conclusions bolster arguments in support of LNG exports. Across all analyzed scenarios, projections were that the U.S. would gain economic benefits from allowing LNG exports according to the metrics of welfare, gross domestic product, aggregate consumption and trade balance. Moreover, the net benefits across all scenarios were examined, and those benefits were found to become larger as the amount of exports increased.

Opponents of LNG exports, however, point to higher domestic LNG prices as a major reason DOE should withhold authorizations. The study noted that increases in domestic LNG prices could hurt trade-sensitive industries, the electricity sector and other energy-intensive industries. Opponents are likely to highlight higher operating costs in these sectors, costs that will shift to consumers in the form of high prices for goods being produced, and onto suppliers, whose workers and owners may experience losses.

WHAT NOW?

Since the study's December release, DOE has been in the process of considering more than 188,000 comments submitted by individuals, companies, trade associations, environmental groups, members of Congress and others.

Within that docket, natural gas-using stakeholders, such as Dow Chemical, alleged analytical flaws in the report and contended that domestic resources should be retained for domestic use. They were joined by certain environmental groups that oppose all hydraulic fracturing as well as LNG export that would provide a market for hydraulically-fractured natural gas.

Other constituencies argued that LNG export to non-FTA companies will not cause massive price increases or spikes, an argument backed up by findings in the DOE study as well as studies by Deloitte and the Brookings Institute. Oil and gas companies argued that artificially low natural gas prices make it uneconomical for companies to produce natural gas, and that, without adequate additional markets, the domestic energy industry will contract. Finally, free-trade constituencies argued that protectionist treatment of natural gas undermines U.S. efforts to stop such practices in China and elsewhere in the world and could cause significant compliance issues for the U.S. at the World Trade Organization.

If DOE's review of the study and the public comments comes out in favor of LNG exports, the agency likely will begin to make decisions on the 20 pending export applications. Determining how those applications will be reviewed, whether approvals will continue to be staggered or whether limits will be imposed on export capacity also rests with DOE. As Maggie Clarke notes on page 22 of this magazine, these issues are under hot debate in both chambers of the U.S. Congress as lawmakers also await a decision. However, one fact in this debate is clear—no decision will have a more profound impact on U.S. energy policy than DOE's ruling on LNG exports.

The issues and legislation regarding export of LNG are ongoing matters. Be sure to check VALVEMagazine.com for updates.

Wayne D'Angelo is special counsel for Environmental and Energy issues at Kelley Drye & Warren. He previously served as an advisor at the U.S. Environmental Protection Agency and in the U.S. House of Representatives. He also served as counsel to the American Petroleum Institute. Reach him at wdangelo@kelleydrye.com or through his blog, www.frackinginsider.com.

TESTING, CERTIFICATIONS AND APPROVALS

All valves will typically need to meet API 598 or equivalent leakage testing as a minimum. Cryogenic valves will have to meet BS 6364, which is tested with helium at -270°F (-168°C) to -325°F (198°C). While this test is an industry standard for liquefaction, receiving or regasification terminal applications, many receiving terminals will require much better leakage rates during cryogenic testing. This testing is usually random on 10% of valves or at least one of every size and class. LNG carriers are usually more critical in regards to seat leakage rates.

More specifically, testing includes:

- For BS 6364, liquefaction facility requirement is a leakage rate maximum 150 cubic centimeters (cm^3) per minute per inch size of valve (cm/minute/inch).
- With the MW Kellogg spec test, most receiving or regasification terminals have a leakage rate maximum of 15 cm^3/minute/inch. This test can be very challenging for metal-seated valves, and triple offset valves typically cannot meet this test because of the torque-seated design.
- LNG carrier leakage testing requirements typically have to meet a maximum of 10 cm^3/minute/inch.
- Process valves typically have to meet fire-safe specifications BS 6755, API607 and API6FA.
- Most specifications will require valve body x-ray testing and die-penetrate testing for random valve body and parts.

□ Manual cryogenic gate valve installation

□ Cryogenic butterfly valve with pneumatic actuator going into the -325°F cryogenic tank

- LNG carrier valves also typically have to meet one or more of many ship or carrier approval certifications such as the Bureau Veritas, DNV or ABS.

SUMMARY

While many of the valve requirements in the receiving terminals, liquefaction facilities and LNG carriers are redundant, there are important differences in pressure class, end connections, certifications and testing.

With the LNG market growing, other markets for the product are poised to grow very quickly. For example, the transportation industry has discovered the benefits of the LNG volume ratio to natural gas: tanker trucks, service vehicles and automobiles can go much greater distances. LNG filling stations also benefit from the volume-saving advantage.

The challenge for pipe, valves and fitting manufacturers as well as other equipment designers and makers, will be public safety and perception. While LNG is not explosive in its liquid state, once it reaches a vapor form and gets between 5-15% of natural gas in air, it

CONTINUED ON P. 23

Exporting LNG: A Legislative Update

BY MAGGIE CLARKE

□ An LNG tanker is maneuvered into place at a receiving terminal.

The energy boom taking place across the country from North Dakota to Texas to Pennsylvania has generated an intense policy debate in Congress early in this 113th Congress with LNG exports a major focus.

Notably, during the comment period on DOE's study, over 100 members of the U.S. House of Representatives sent a letter to then-DOE Secretary Steven Chu urging quick approval of pending LNG export applications, and a bipartisan group of Senators followed suit. On the other side of the debate, however, there are members of Congress who contend that domestic natural gas consumers would see prices rise from increased exports. Some of these congressional colleagues have simply expressed concern and urged caution while others have introduced legislation addressing the issue.

Reps. Ed Markey (D-MA) and Rush Holt (D-NJ), both senior members of the House Committee on Natural Resources, have introduced a trio of bills aimed at restricting energy exports, two of which are aimed at natural gas. The two natural gas bills are:

- H.R. 1191, the *Keep American Natural Gas Here Act*, would prohibit the Interior Department from accepting bids on new leases of Federal lands unless the bidders certify that all gas produced would be sold solely in the United States. Additionally, the bill would prevent granting of any natural gas pipeline right-of-way unless the natural gas transported via the pipeline is sold exclusively in the United States.
- H.R. 1189, the *American Natural Gas Security and Consumer Protection Act* would amend the Natural Gas Act to reform the current permitting process for LNG exports. Specifically, the legislation would require DOE approval of all natural gas exportation (DOE authorization is currently only required for exports to countries with which the U.S. does not have an FTA). The bill would also modify the existing "public interest" provision to eliminate the "rebuttable presumption." That would mean that before granting approval, DOE would have to ensure that the proposed exportation is consistent with the public interest. The bill includes a list of factors DOE would have to consider in that evaluation—ranging from the economic impact on natural gas consumers, to the country's energy security, to the country's ability to reduce greenhouse gas emissions.

It is unlikely that either proposal will advance in the Republican-controlled House, particularly when there is bipartisan support in the chamber for LNG exports. While a few members have expressed general opposition to these exports, many more are either supportive or are instead seeking a so-called "sweet spot"—hoping the market will set a price that allows greater exports to both reduce our trade deficit and boost the economy, while, at the same time, continuing to provide a competitive advantage for domestic energy consumers.

Along those lines, legislation is also pending in both chambers to facilitate additional LNG exports by building upon the existing procedure for exports to FTA countries, whereby exports are deemed "consistent with the public interest" and do not need to go through the DOE approval process. Specifically, Rep. Mike Turner (R-OH) and Sen. John Barrasso (R-WY) have introduced the *Expedited LNG for American Allies Act* (H.R. 580/S. 192), which would provide the same treatment to NATO countries, Japan and any other foreign country if exportation to that country "would promote the national security interests of the United States."

For now, however, Congress appears to be taking a "wait and see" approach in lieu of legislating. That said, the debate continues in committee rooms on both sides of the Capitol, with several hearings already held to debate the merits of LNG export. VM

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Cryogenic butterfly valve with pneumatic cooling after a cryogenic test

CONTINUED FROM P. 21

can ignite. (Below 5%, there is not enough natural gas to become flammable; above 15%, there is not enough oxygen in the air to be flammable.)

LNG carriers as well as loading docks around water have other risks as well. If LNG is exposed to water at a very fast rate, for example, a rapid phase transition (RTP) can occur. RTP can result in a physical explosion that can release a great amount of energy. While this is not a combustion type of explosion, the energy released can be hazardous. Because of this, valve manufacturers, as well as makers of other products for the LNG market, conduct critical research, development and production of their products to meet safety concerns and industry requirements.

What many valve manufacturers are considering is that there has been an overabundance of LNG projects in North America and around the world. In the late 1990s to mid-2000s, North America had many permit applications for receiving terminals. However, there were only a few regasification terminals actually constructed, several of which never moved much LNG into the pipelines.

Still, because of the plentiful supply of natural gas from the shale gas finds in the U.S. and Canada, North America has many projects planned for liquefaction facilities. In fact, many of the receiving terminals are now building liquefaction facilities on the same site.

At the same time, there already are too many new valve manufacturers in the market producing cryogenic valves and others with plans for developing similar products on the horizon. A major challenge current valve manufacturers, as well as foundries and forge masters, face is to remain competitive in this growing market, while maintaining and improving quality and performance. VM

Cryogenic butterfly valve with hydraulic actuator after installation

Mark Tilley is regional sales manager of Velan (www.Velan.com). Reach him at marktilley@velan.com. **Frederic Blanquet** is sales manager, cryogenic valves at Velan France. Reach him at fblanquet@velan.fr.

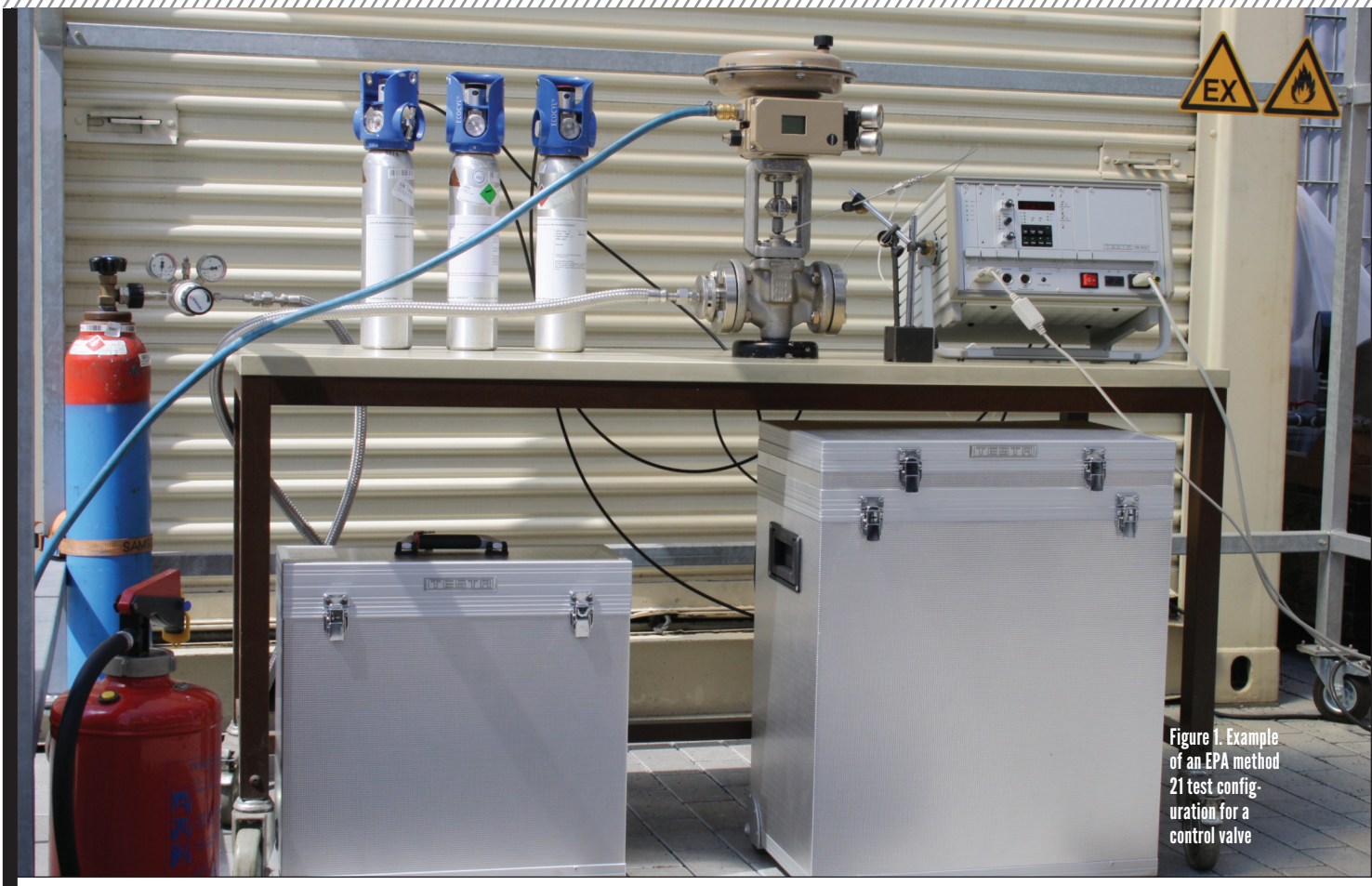


Figure 1. Example of an EPA method 21 test configuration for a control valve

Using Advanced Sealing Technologies to Prevent Fugitive Emissions

BY JOSEPH DUFRESNE AND CALVIN GILLIS

Regulators' monitoring of emissions has forced industries to either implement proactive programs of leak detection and repair (LDAR) or deal with implications of non-compliance, which include fines and consent decrees. In either case, advanced sealing technology can help: It allows an entity to avoid noncompliance or adhere to the low-emission consent decrees.

EMISSION LEVELS

Low emission consent decrees are often specified at less than 100 parts per million (ppm).[1] However, local regulations, plant-specific regulatory action and potential long-term lowering of governmental agency acceptable limits mean that in the near future, sealing technology resulting in valve emissions at levels below 500 ppm will not be adequate. With valves accounting for 60% of all non-compliance, conventional valve packing will not be an acceptable emissions solution by itself moving forward.[2]

Executive Summary

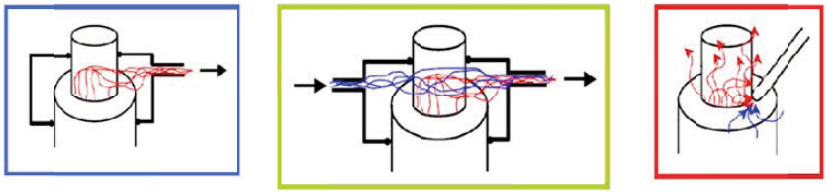
SUBJECT: Because of tightened restrictions, the process industries increasingly rely upon applied technology, including advanced sealing technology, to bring emissions levels into compliance.

KEY CONCEPTS:

- Emissions issues and consent decrees
- Testing methods
- Technological innovations
- Advantages of metal bellows

TAKE-AWAY: Metal bellows, while adding cost initially, has emerged as the best available sealing technology.

	EN ISO 15848-1	TA Luft / VDI 2440	ANSI/FCI 91-1-1997	API 622
	International standard	**National standard**	**National standard**	**National standard**
Title	Industrial valves - measurement, test and qualification procedures for fugitive emissions Part 1: Classification system and qualification Procedures for type testing of valves	Technische Anleitung zur Reinhaltung der Luft Emission control mineral oil refineries	Standard for qualification of control valve stem seals	Type Testing of Process Valve Packing for Fugitive Emissions a) Fugitive emissions b) Corrosion c) Packing material
	For use under laboratory conditions		For use in the field	For use under laboratory conditions
Test medium	Helium or Methane (VOC)	Helium	Methane (VOC)	Methane (VOC)
Test method	Vacuum method Flushing method	Vacuum method Flushing method	Sniffing method acc. to EPA Method 21	Sniffing method acc. to EPA Method 21
Unit	mg/(s·m) Mass flow rate	mbar l/(s·m) Mass flow rate	ppm(v) Concentration	ppm(v) Concentration
Limit value	A: ≤ 10^{-6} mg/(s·m) B: ≤ 10^{-4} mg/(s·m) C: ≤ 10^{-2} mg/(s·m)	t < 250 °C: 10^{-4} mbar l/(s·m) t ≥ 250 °C: 10^{-2} mbar l/(s·m)	A1, B1, C1, D1, E1: < 100 ppm A2, B2, C2, D2, E2: < 500 ppm	Acceptance criteria shall be mutual agreement between the valve manufacturer and purchaser.



□ Figure 2. Fugitive emissions testing methods. Vacuum (blue box), flushing (green box) and sniffing (red box)

Meanwhile, emissions are a greater technological challenge when dealing with control valve sealing because control valves are subject to a greater degree of mechanical cycling than manual valves. Even in the most difficult test conditions, manual valves see only a maximum of 5,000 mechanical cycles, and in actual service, a manual valve will undergo reconditioning and repair before it ever reaches that 5,000-cycle mark. Test conditions based upon industry standards for control valves, however, are often 100,000 cycles or more.

The overall effectiveness of the seal for emissions can be determined by industry test criteria such as ANSI/FCI 91-1,[3] TA Luft/VDI 2440 or DIN EN ISO 15848-1.[4] Emissions detecting methods used in testing as well as in enforcing valve sealing methods generally fall into one of two categories, vacuum or sniffing. The vacuum method, which is commonly used in Europe, is a collection method that measures the amount of leakage into a vacuum chamber. This method is used in test procedures VDI 2440 and ISO 15848, and typically uses helium as the test medium (Figures 1 and 2).

Sniffing is used by the U.S. Environmental Protection Agency (EPA) through method 21. It uses an air sampling method to determine concentration of volatile organic compounds. Methane is the common test medium, and this method of testing is used for ANSI 91-1 and API 622.[5]

The reason there are two emissions detection methods is largely because emissions are regulated differently by different national enforcement entities. It is important to note that data collected from the two methods should not be used comparatively for leakage evaluation—there is no direct conversion from one method to the other. Also, the matter is complicated by the fact that the air concentration detection methods typically used in the U.S. can be influenced by environmental and background factors, which is not the case with direct leak collection methods commonly used by European authorities. This difference is complicated even further by the fact that test media have different chemical and physical properties, and the units of measurement used in testing have no direct conversions.

The reason there are two emissions detection methods is largely because emissions are regulated differently by different national enforcement entities.

SNIFFING

From the perspective of the ANSI/FCI 91-1, the test evaluates packing for 100,000 full mechanical cycles with three temperature cycles while under pressure to achieve the highest level of leakage prevention. These methane emissions measurements are made per EPA method 21. While this test is designed for packing, it also can be used for comparing competing products or technologies such as metal bellows seals.

Given the two LDAR certifying means presented by EPA, an equivalent time period to the 100,000 cycles for a process operating under good engineering practices would be five years. The overall success of this test, as with any part of an emissions reduction program, should be reviewed by field monitoring to assure emissions are below required levels. With well-designed metal bellows, the emissions resulting from the bellows seal should measure at a constant 0 ppm.

Packing in valves is intended to seal the area between the stem and the bonnet. Packing materials typically are PTFE, carbon or graphite in different arrangements designed to reduce relaxation and mechanical damage over cycles and time. "Live loading," a term used for the force of some springs, is often implemented as a way to reduce relaxation of the packing set. This is done because relaxation results in packing load loss and increased leakage. A key limitation of over-tightened packing by gland follower or bushing is over-expansion of the packing radially, which increases packing wear and limits stem movement, thereby also limiting emissions reduction.

Besides valve stem-packing systems, a metal bellows seal can be used to mitigate valve stem leakage. While packing has evolved over the years to meet the needs of tight leakage, advanced metal bellows have always represented the ultimate in valve seal-

ing technology. A bellows seal can achieve zero leakage for a lifespan that far exceeds even the most advanced packing. In the past, this zero stem leakage was critical for applications where health and safety were of paramount concern and the higher cost of bellows was justified. In the present, however, metal bellows technology also should be considered for use in any applications with risks to health, safety and the environment sufficient to justify use of the best available technology solution.

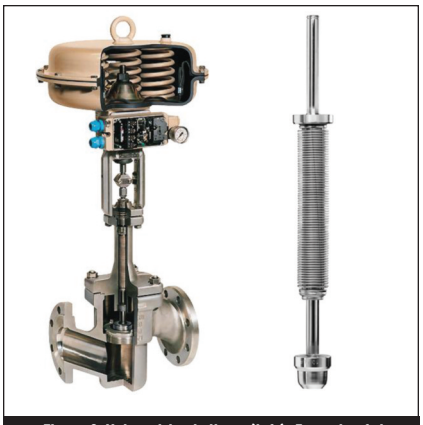
FACTORS TO CONSIDER

The goal of valve manufacturers is to design a tight stem-sealing method that meets emission guidelines. The primary stem-sealing method is standard packing, which meets standard emissions requirements. Most manufacturers also offer a low-emissions packing for more stringent requirements. Still others have designed advanced metal bellows seals capable of achieving a zero leakage rate over the entire service life (Figure 3).

The external factors that might influence the service life would include proper material selection for construction, suitable implementation of the design method, use of superior manufacturing processes, consideration of adversities that the seal will face, and contemplation of what effects the process medium will have on the seal.

Metal bellows are typically constructed of austenitic stainless steel or a similar corrosion-resistant nickel alloy of high strength. Material considerations are process fluid chemical compatibility, design resiliency, fatigue life and temperature resistance. For example, lethal dry chlorine does not exhibit corrosion problems; however, when it comes in contact with normal air humidity, chlorine becomes aggressive and causes damage to stainless steel. For this reason, Hastelloy C bellows are recommended for chlorine applications instead of standard stainless steel.

A suitable method for bellows design is a multilayer wall construction. When combined with use of higher- strength metal alloys, this multilayer design expands the operating range of the metal bellows seal. The bellows manufacturing process can be either a



□ Figure 3. Valve with a bellows (left). Example of the length of a metal bellows seal (right).

forming or welding of the metal to the desired pattern. The formed method can be achieved either hydrostatically or mechanically. The welded type is produced by stacking many individual leaf segments that are welded together at the outer edges. With increased points of failure, the hydrostatically formed and welded type of bellows cannot achieve the design level of the mechanically formed bellows.

Detailed attention to process service conditions during the metal bellows design process will allow for better product construction. Operational pres-

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VALVE {Ed}

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Wednesday, Nov. 6, 2013

7:30 – 8:30 am
Registration / Continental Breakfast

8:30 – 10:00 am
Welcome to Valves & Actuators 101
Greg Johnson, Chairman, VMA Education & Training Committee
LESSON 1: Introduction to the Industry
LESSON 2: Multi-turn Valves
Greg Johnson, President, United Valve, Houston

We begin with a broad overview of the valve industry, the major valve and actuator types, and various end-user applications. Lesson 1 includes valve standards, basic piping information, pressure ratings and classes, as well as application issues that are critical to effective valve specification and usage. The stage is set for more detailed discussions on all the major valve types to give attendees valuable knowledge that can be applied in their daily PVF work. In Lesson 2, multi-turn valve types—gate and globe valves—are explained along with stems and bonnets.

10:00 – 10:15 am
Morning Beverage Break

10:15 – 10:45 am
LESSON 3: Check Valves
PRESENTER: Arie Bregman, Vice President and General Manager, DFT Inc., Exton, PA

Our check valve expert details the unique qualities of check valves, explains how they work and why correct sizing is so essential for this valve type.

10:45 – 11:45 am
LESSON 4: Quarter-turn Valves
PRESENTER: Leon Brooks, Director Sales – Latin America, Distributed Valves Division, Cameron Valves & Measurement, Houston

We progress up the valve chain, and move on to the more complex quarter-turn valve types, including plug, ball and butterfly, as well as the different options among these three broad product types.

11:45 am – 1:15 pm
Lunch / Exhibits Open

Valves, actuators, controls and other products used in the flow control chain will be represented in our tabletop exhibition, providing attendees with the opportunity to ask exhibitors about the products and services they provide.

1:15 – 2:00 pm
LESSON 5: Pressure-relief Valves
PRESENTER: Ernie Dingeldein, Gulf Coast Regional Manager, GE Oil & Gas – Consolidated Products, Alexandria, LA

We learn how pressure-relief valves perform, their critical role in plant safety and important maintenance guidelines.

2.00 – 2.30 pm
LESSON 6: Actuators – Electric
PRESENTER: Ed Holtgraver, CEO, QTRCO, Inc., Tomball, TX

This lesson focuses on pneumatic and hydraulic actuators and includes a description of the various actions, such as linear, rotary, etc., that are used to operate the valve types discussed in earlier lessons. Our presenter then describes the various actuator types that provide these actions. The lesson provides the information attendees require to understand their options, including how each actuator type may apply to their specific needs, and what questions to ask when selecting an actuator.

2.30 – 3.00 pm
Snack Break / Exhibits Open

3.00 – 3.45 pm
LESSON 6: Actuators – Electric *(continued)*

3:45 – 4.30 pm
LESSON 7: Actuators – Electric
PRESENTER: Paul Souza, Training Manager, AUMA Actuators, Inc., Canonsburg, PA

The focus here is on multi-turn and linear electric actuators, their basic designs and common options. The presenter also discusses actuator controls and their requirements, digital controls and their benefits, as well as the benefits of open digital protocols.

4.30 – 5:30 pm
Reception / Exhibits Only

Thursday, Nov. 7, 2013

8:00 – 8:30 am
Continental Breakfast

8.30 – 9.00 am
LESSON 8: Solenoid Valves
PRESENTER: : Representative from ASCO Numatics, Florham Park, NJ

Solenoid valves are defined and explained, along with guidelines on how to make the best selection of a solenoid valve. The presenter also discusses the functions of a solenoid coil, how 2-, 3- and 4-way solenoids operate, and various applications for solenoid valves. In addition, this lesson will also include information about limit switches and proximity switches.

9.00 – 10.00 am
LESSON 9: Positioners, Switch Boxes & Other Accessories
PRESENTER: Representative from Westlock Controls (Pentair), Saddle Brook, NJ

This new lesson features positioners, switch boxes, quick exhaust valves and volume boosters, including how these various products work, possible variations, housing types, linear and rotary use, mounting standards and applications.

10.00 – 10.15 am
Break

10.15 – 11.30 am
LESSON 10: Control Valves
PRESENTER: Bert Evans, Manager, Fisher Valve & Instrument Training, Emerson Process Management, Marshalltown, IA

Our presenter defines control valves, explains what they do and describes typical control valve components, including variations and types. The discussion will briefly touch on linear valves and actuators, as well as sizing and control valve diagnostics.

11.30 am – 12.30 pm
Lunch

12:30 – 4:00 pm (includes two 15-minute breaks)
LESSON 11: Hands-on Instruction at the Valve Petting Zoo

We divide attendees into nine equal groups, with each group having an opportunity to visit tables where the product types covered in each lesson will be displayed. Our industry experts will point out the various components of these products and demonstrate how they work. Attendees are encouraged to pick up and examine the valves and actuators, and ask questions in a small group setting—all designed to help clarify what was learned during the previous lessons.

4:00 pm
Conclusion / Certificates Awarded

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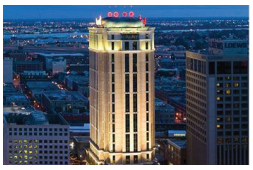

HOTEL INFORMATION

The Valve Basics Seminar & Exhibits will be held at **Harrah's New Orleans** (228 Poydras Street, New Orleans, LA 70130). VMA has negotiated a special rate of just $159, which is available through Friday, Oct. 18, or whenever the room block is filled. Check-in is 4 pm; checkout is 11 am. Free internet access for one device in room, from Nov. 5-8; discounted self parking is $14/day. To make reservations, call 1-800-HARRAHS [427-7247] and mention you are attending the Valve Basics Seminar & Exhibits.

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Attendees completing the 2-day Valves & Actuators 101 course will receive 12 professional development hours as issued by the Valve Manufacturers Association. Certificates of Completion will be given out at the end of the program on Thursday, Nov. 7.

CANCELLATION POLICY

Full refund on registration cancellations received by Tuesday, Oct. 8; 75% refund on cancellations received by Tuesday, Oct. 15. Due to hotel and other meeting guarantees, no refunds thereafter. (Credits will not be given for future meetings.) Substitutions are accepted anytime, but please advise of name changes no later than Wednesday, Oct. 30 so that badges can be prepared and ready to hand out at the event.

ONLINE REGISTRATION

Attendees are strongly encouraged to register for this event online. Just click on the appropriate Calendar listing on the VMA.org home page, or **click here**.

FACSIMILE

If you are unable to register online (preferred), you may fax your completed registration form (with credit card information) to 202.331.0378. (Credit card registration payments will show up on international customer invoices in U.S. dollars.) If paying by check, mail to: Meetings Manager, Valve Manufacturers Association, 1050 17th Street, NW, Suite 280, Washington DC 20036.

QUESTIONS

Contact VMA Director of Education Judy Tibbs (**jtibbs@vma.org** or 804.639.1365) for program information, and contact the VMA Meetings Manager (**meetings@vma.org** or 202.331.8105 x212) for questions about registration.

Here's what past attendees have said about VMA's Valves & Actuators 101 courses:

"The valve petting zoo was outstanding. I learned a great deal by seeing how valves actually function/operate."

"Great introduction to the valve industry! It turns out actuators are quite interesting—it's another career choice for me to consider."

"Whole event/seminar was really informative and helped me to learn more about valves and their applications."

"...provided extremely valuable, real-life applications that aren't found in school."

INTERESTED IN EXHIBITING?

Are you a U.S. or Canadian valve, actuator or controls manufacturer; a U.S. or Canadian distributor or supplier to the valve industry; or an OEM-authorized service and repair facility? If so, you may be eligible to exhibit at the Valve Basics Seminar & Exhibits.

Cost: $575 ($625 after Aug. 31); $475 for VMA/VRC members ($525 after Aug. 31)—Includes 1 tabletop and 2 exhibit personnel; additional personnel - $90 each

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sure must be considered in light of the need to assure the integrity of the device when extreme forces are applied. By testing a multi-wall metal bellows to application pressures, the bellows is pressure-rated greater than the valve body rating without danger of collapsing.

REDUCING STRESSES

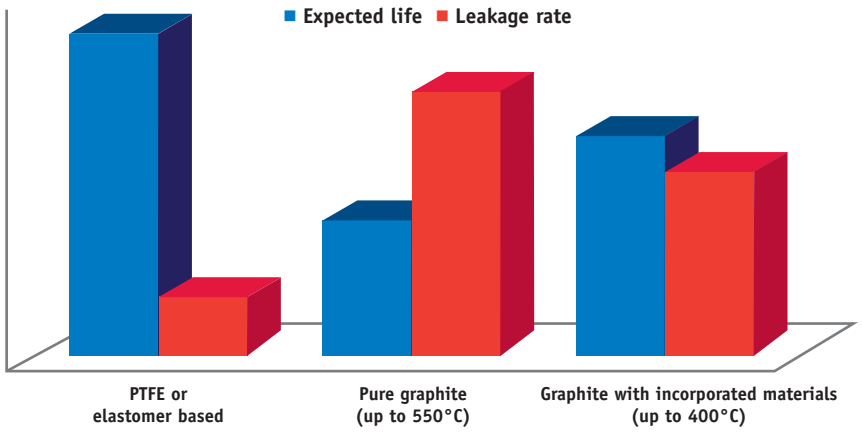
The quality of masterfully designed metal bellows has been proven by their ability to last for several years of service. Superior design focuses on reducing the amount of stress applied to the bellows seal. The first method in alleviating stress is reducing the total valve travel to decrease movement and external forces. Along that same principle, a second method involves increasing the number of convolutions per unit of measure, which in turn reduces the forces and stress on each individual convolution. By increasing the number of convolutions, small travel is accounted for without fatigue to the metal bellows. This is especially important when only these small movements are required to control the process.

Another method to reduce stress on bellows is to increase the length of the components. A typical rule of thumb is that the bellows should be 10 times the nominal stroke of the valve. In this way, bellows enjoy an exponential increase in service life and give a high amount of trouble-free cycles.

Stress can also be reduced through design. For example, the best way to reinforce the bellows is to design an increased wall thickness via multi-layering while also achieving a uniform wall width throughout the convolutions. In this way a metal bellows seal can be constructed to enhance durability, serviceability and longevity.

CHANGING VIEWS

The market's predominant reliance on packing to address fugitive emission needs is mostly due to end users' lack of exposure and education on what metal bellows sealing technology can do. Regardless of design or type, all packing is subject to a gradual wear that starts with an initially



□ Figure 4. Comparison of packing types for expected lifetime and sealing ability

acceptable leakage rate that will worsen with each stroke. Packing sealing systems also depend on the use of the right lubricants, proper smoothness of the plug stem surface, ensuring operations in the material temperature range, proper tensioning of packing, elimination of stick-slip effects and other constraints (Figure 4).

Most valve stem packing systems today are based upon one of the three packing material groups. The first group is known for producing less friction, longer life and lower leakage at the expense of handling higher temperatures. The second group addresses the higher temperature needs but lacks the advantages of the first packing material. The third group is a hybrid of the prior two materials groups.

Meanwhile, metal bellows can meet the extended temperature range while outlasting and outperforming packing systems. They are pressure-tight, resistant to temperature and corrosion, maintenance-free, reliable, able to achieve long life, and provide a low life-cycle cost compared to all other types of control valve stem-sealing methods.

Manufacturers with close production process control and detailed cycle testing of metal bellows can provide accurate predictions for the expected product life. These bellows are designed and tested to adhere to stroke counts and life expectations typically required of customers as well as the most rigorous testing procedures. State-of-the-art metal bellows have been proven effective throughout the world in thousands of installations, from normal operating conditions to the most extreme temperatures, pressures, flow circumstances and hazardous process conditions. Given that metal bellows have a proven record in lethal service, their ability to meet fugitive emissions requirements should be a certainty.

From a cost view, metal bellows are more expensive than traditional packing methods but the monetary savings provided by reducing the loss of process to the environment, as well as the increase in process uptime with less frequent shutdowns, far outweighs the additional cost. State-of-the-art metal bellows seals are the best available technology solution for valve stem leakage offering optimal fugitive emissions prevention able to exceed regulatory standards and customer requirements. VM

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FOOTNOTES

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Figure 1. Remote Christmas tree equipped with ESD

Valve Automation Solutions for Emergency Shutdown in Shale Applications

BY TOM JEANSONNE

In many regions of the U.S., the proliferation of gas and liquids discovered and extracted from shale formations has created a need for rapid infrastructure development. Valves and their automation play key roles at every stage of processing and transporting the gas and fluids—from the well to the storage facilities and distribution systems. This means they are vital in providing safety to personnel, process control for operations and protection for valuable assets as well as prevention or mitigation in the case of environmental events.

Because of the new technologies driving this unprecedented shale growth, operators have an increasing number of federal, state, local and industry regulations, standards and permitting requirements to deal with, many of which are in flux and not yet clearly defined. Also, states and municipalities not traditionally challenged with the growth of rapid infrastructure or new industry are scrambling to enact their own restrictions as a reaction to pressure from the public. That public is genuinely concerned about the safety of this unconventional technology, as well as water usage/disposal and how the drilling and production might impact the environment and their communities.

Executive Summary

SUBJECT: As the U.S. moves to become more energy self-sufficient, shale gas plays a greater role. However, the awareness of potential environmental impacts and the need for the oil and gas industry to find the safest methods mean that emergency shutdown equipment, including valves and their automation, are vital to the picture.

KEY CONCEPTS:

- Need for emergency shutdown
- Proliferation of regulations
- Current systems used
- Automated valve solutions

TAKE-AWAY: Automated shutdown valves will grow in importance and use.

VALVE AUTOMATION CONSIDERATIONS AND RESULTS

Automated valves are often used to prevent or mitigate undesirable events.

In addition to reducing risk and exposure to the facility personnel, civilians and assets, the following implications and concerns should be considered:

- Preserving and protecting the environment = Operating responsibility
- Mitigation of the effects of any spill or overfill = Risk, event cost and life-cycle cost reduction
- Legal actions and resultant regulations = Lower cost and regulatory compliance
- Lower operating costs, reduction of downtime = Increased availability and efficiency gains by extended health diagnosis
- Fines, penalties and property damage claims = Lower risk and reduced operating cost
- Lost revenue, goods and production = Revenue efficiency by extended health diagnosis
- "Alarm overload," inexperience and physical reaction time = Event mitigation and prevention
- Transportation, outside business disruption and emergency support dilution = Lower risk, event mitigation and operating cost savings
- Damaged reputation, corporate citizenship, socio-economic issues = Corporate market value
- A deterrent to product theft and better inventory control = Product loss prevention and efficiency gains
- Effect on future expansion, permits, locations or scope plans = Hidden operating value increased and reduced regulatory compliance cost

Oil and gas producers are inherently safety conscious, as well as aware of the need to avoid adverse events or activities that might result in an impact on regulations. They are also familiar with the consequences of bad press and negative public opinion that any production upset would incur. Frequently these producers are in the "crosshairs" of 24/7 media coverage that can be inaccurate, incomplete and prone to sensationalism. They know their wells and the supporting equipment are often in remote areas that can't be readily or continually monitored by field personnel. Yet these locations need to be shut-in immediately in case of an anomaly in the processes, an emergency or a spill. Often, the answer to well and process safety is an automated emergency shutdown (ESD) solution (Figure 1).

This article discusses applicability of existing and proposed regulations on these issues as well as the industry oversight that promises to have an enormous impact on onshore oil and gas wells and related activities. The article also identifies and addresses many of the current equipment technologies regarding valve automation solutions or final control elements (which are automated shutdown valves). These final control elements are an integral part of many ESDs as well as process shutdown (PSD) solu-

tions used at wells and flow lines. Note that this article begins discussion at the automated production or flow wing valve and is not intended to address offshore well equipment (API 17D), subsea, downhole safety valves and master valves, nor should it be considered all inclusive.

NEW AND PROPOSED REGULATIONS

A quick Internet search reveals hundreds of proposed or new regulations on shale gas. It also shows many guidance/draft/amendment rules and programs by numerous governmental agencies, standards organizations, various states and local jurisdictions, the U.S. Environment Protection Agency (EPA), the U.S. Department of the Interior, the Bureau of Land Management and the U.S. Corps of Engineers, to mention a few. A handful of states currently have fracturing moratoria in place and public awareness has been raised that hydraulic fracturing fluids may be exempt from certain EPA rules such as the Safe Drinking Water Act of 2005 (unless the process uses diesel in the fracking fluids).

Meanwhile, the EPA's New Source Performance Standard (NSPS) 40 CFR, part 60 and 63 subpart 0000 (AKA 'Quad O') has been approved. Quad O regulations summarily apply to "emission standards for stationary equipment" and cover many of the activities and components used in oil and gas production, particularly in newer shale infrastructure. On top of the many regulations passed or in the works, a lengthy period of time (many say two to four years) will likely be needed to seriously address the many issues raised and to create, update or amend the applicable best practices or standards.

In the meantime, many companies and organizations are responding to growing shale development concerns by taking unique actions. A growing number of shale field coalitions and organizations that share information, such as establishing "new or local" best practices and addressing issues, have been born. For example, energy companies and environmental organizations recently formed a consortium—The Center for Sustainable Shale Development. The initial focus for this group will be minimizing air and water pollution and establishing a certification process. (For more updated information on the issues, go to www.northamericashaleblog.com.)

□ Figure 2. Automated hydraulic ESD at the choke valve

EMERGENCY OR PROCESS SHUTDOWN

An ESD, PSD or Safety Instrumented System is a set of components, logic solvers and final control elements arranged for the purpose of taking a process to a safe state when predetermined conditions are tripped. These components typically incorporate a spring return actuator to close the valve in the event of an upset. Such a system is important in all flow situations and is especially significant when the field is remote, unmanned or where an external power source is unavailable, undependable or prohibitively expensive. Reliability and prevention are key factors for these systems. The valves and their automation often remain in a static position for extended periods of time, yet they must perform without room for error when required for immediate shutdown or diversion. If these systems did not have this level of dependability, disasters would be much more probable (Figure 2).

POWER/ENERGY SOURCES

All ESD/PSD actuators that require a motion, a reaction or that must lock-in-last to a "trip signal" (not just a fail in place) need some type of power source to transfer that energy into a form that can drive a valve to its predetermined ESD/PSD position or safe state. Generally that power source, in conjunction with valve type, must be established before significant automation progress can begin. Rather than simply listing the three primary energy sources, the following is a summary of the power sources or combined power solution ideas that may be found in the

shale field for typical ESD/PSD actuator use. These ideas or methodologies are certainly not all inclusive, but they represent possible out-of-the-box automation solutions.

Manual power (human effort): This source can be used to generate energy, often in the form of a manual hydraulic pump which in turn can compress a spring (in a spring return actuator).

Pneumatic or gas supply to directly compress a mechanical spring: This can take the form of instrument air supply (compressed air), a gas supply derived from the media in the valve (such as natural gas), a nitrogen bottle or any suitable pressure vessel such as an air fail-safe tank.

Pneumatic or gas stored supply: This source can be used in an adequately pressurized volume so it powers an actuator through an ESD/PSD function. This can be a gas motor or other gas-powered actuator (e.g., a gas-over-oil unit.)

Hydraulic or hydraulic power unit: Direct hydraulic power, which normally requires an electrical supply to power a hydraulic pump, can compress a spring or store hydraulic energy in a storage vessel (hydraulic accumulator).

Electric (AC, DC, including solar panel derived): Pure, electrically powered units are not normally found in ESD applications, except for situations in which a charged battery storage bank provides a backup power source or when smaller, spring return, quarter- or part-turn units are involved.

Electric hybrid: Electro-hydraulic actuators typically use an electric power source to create hydraulic pressure used to compress a mechanical spring.

FAIL MODE TRIP

Automation solutions can be configured many ways to respond to a trip and ESD or PSD signal. The most common methods used in shale fields include:

Shutdown by ESD/PSD signal to a solenoid valve: The system can be remotely or locally shutdown by an electrical signal, typically through de-energizing the solenoid valve or valves.

Loss of supply pressure: This is usually a piloted control valve with functionality similar to the solenoid valve.

High- and/or low-pressure shutdown: This is often one or two pressure pilot valves (high and/or low). Pilots or pressure sensors are installed on the flowlines at various points to automatically trigger the valve shutdown in the event the preset pressure range is exceeded (which is called an Overpressure Pipeline Protection System) or falls below a given value or range. Versions of this are also available to measure pressure drop over time, allowing for temporary pressure fluctuations within a pre-determined period of time to avoid spurious trips.

High-temperature shutdown: This is often a fusible plug device or temperature sensing device that can typically vent a motive pressure.

Wireless: A newer technology is available for monitoring the valve and flow lines and transmitting an alarm or monitoring signal for position recognition in the field. Generally, wireless transmitters are not yet considered suitable for ESD on basic process control system functions.

A mix: One or more of the above methods are combined including redundant or sequentially interrelated.

SAFETY AT THE WELL—API 6A

The Christmas tree, ESD/PSD and other equipment in a shale field are subject

□ Figure 3. 6D application on a flow line equipped for ESD/PSD

to many factors that impact the type of valve and automation solution. For example, the Bakken wells generally produce 1,000 to 3,000 barrels per day (bpd) at pressures of 2,000 to 4,000 psig, with temperatures averaging below 200°F (93°C). By comparison, the Eagle Ford wells can produce as high as 4,000 bpd with flow pressures to 7,000 psig and temperatures to 350°F (177°C), while other fields may see less than 100 psig.

At the Christmas tree, the API 6A standard, Specification for Wellhead and Christmas Tree, generally prevails for manual and automated valve design and functionality. For ESD/PSD service, API 6A production or flow wing valves are usually reverse-acting gate valves designed for operating pressures typically ranging from 2,000 to 15,000 psig. The ESD/PSD valves on Christmas trees are normally and historically located on the production or flow arm of the tree upstream of the production choke. These wing valves and choke valves may or may not be automated, depending on ESD functionality.

When the valves are automated, some shale producers are now adding or moving the API 6A ESD valve and/or the ESD/PSD function to the downstream side of the choke to further protect downstream equipment. This is so that, should the choke or other equipment fail, such as when a choke suddenly washes out from unanticipated wear or "slugs," alternating slugs of gas or liquid/solids downstream don't severely damage equipment such as heat exchangers and production separators. Traditionally, at the Christmas tree, ESD/PSD-equipped API 6A valves are hydraulically powered or in some fields powered by compressed air. However, a newer development is that API 6A ball valves are gaining acceptance for some fields and applications.

There has been a substantial increase in the demand for stand-alone or manual hydraulic, self-contained shutdown systems, in part because of best practice decisions made in the field as well as the sheer volume of shale play wells with new, inexperienced or learning curve operations. It is also because of the remoteness of these shale plays (not just measured in miles, but also measured by available manpower to well count allocations or densities).

Stand-alones or manual afford ESD/PSD protection with little or no additional control or power supply infrastructure required. Self-contained, manually powered units also have at least one advantage over most traditional units in that they do not rely on external power sources. Instead, they are powered by hand-pumping a small manual hydraulic pump located at the actuator. This attribute makes them adaptable for locations where alternate power sources are not available or may be considered less dependable.

SAFETY FOR FLOW LINE VALVES—API 6D

Beyond API 6A use at the Christmas tree and the production choke valve, valves in a shale application generally are part of the gathering, processing and storage systems. The API 6D, Specification for Pipeline Valves, and many other standards such as API 598, 599, 600, 602 and ASME B16.34 apply. The quarter-turn ball valve is often found in the ESD/PSD applications as well as check, gate, plug and butterfly valves (Figure 3).

Gathering lines carry the hydrocarbons from the well to the various separation and treating facilities, then flow to intermediate storage and fiscal custody transfer stations before product is transmitted via pipeline further downstream to processing and distribution points. At all points along the way,

□ Figure 4. Pneumatic scotch-yoke fail close actuator

flow lines are susceptible to rupture, overpressure, backflow or hazards that would require immediate shutdown.

Flow lines also travel to and from facilities over considerable distances, crossing rivers, interstates and highways, areas with much human activity and to locations in remote areas where there is limited infrastructure and local supervision. These flow lines need shut-in capabilities. Automated ESD/PSD valves are viable solutions to address the many potential problems that can result.

API 6A AND/OR 6D

Generally, the same technologies used near the well are available for API 6D applications. In fact, other than special valve considerations and probable power supply source availability issues, there really is very little difference in the basic automation functionality between 6A and 6D applications. The few differences—available power source, experience with the application and the total cost of ownership—can make some solutions more prevalent for certain applications (Figure 4).

CONCLUSION

Shale plays continue to be discussed as a catalyst for the United States' effort to become energy self-sufficient. Because oil and natural gas holds the most potential for reaching that independence, the need to produce from domestic shale sources has meant a dramatic increase in the number of wells drilled and produced. With the energy industry spearheading positive safety solutions through technology, ESD and PSD valves and actuators will play a prominent role in increasing the public's confidence in the industry's initiatives toward safety and environmental preservation. VM

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Picking the Right Flowmeter

BY DAVID W. SPITZER

There are many types of flow devices used to measure liquids and gases in closed pipes and open channels. Knowing which flowmeter is appropriate for which application requires knowing the difference between the many choices. This column seeks to give readers a basic understanding of the different types of flowmeters and what to consider when selecting them.

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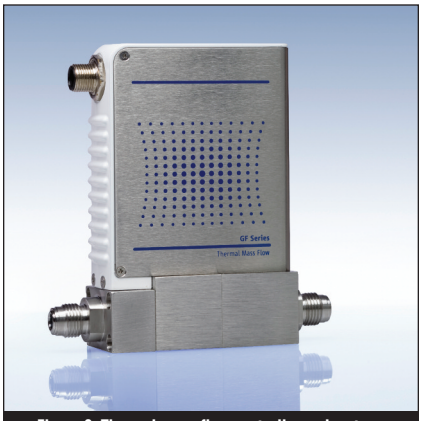
□ Figure 1. Magnetic flowmeter



BROOKS INSTRUMENT

□ Figure 2. Thermal mass flow controller and meter

THE CHOICES

Positive displacement meters are used for both liquids and gases, often with high accuracy. They come in a variety of types, such as oval gear, reciprocating piston, nutating disc and rotary piston. They repeatedly entrap fluid, emulating a bucket—one bucket in, one bucket out. This type is the only flowmeter technology that measures the actual volume of the fluid. Positive displacement flowmeters can accurately measure highly viscous materials up to hundreds of thousands of centipoise.

Differential pressure flow measurement is still one of the widest used technologies in the process industries. The method is relatively inexpensive and utilizes differential pressure transmitters that the plant often uses for other process measurements (such as pressure and level). These flowmeters operate by sensing the differential pressure across an orifice (or other restriction) where the flow rate is proportional to the square root of the differential pressure produced.

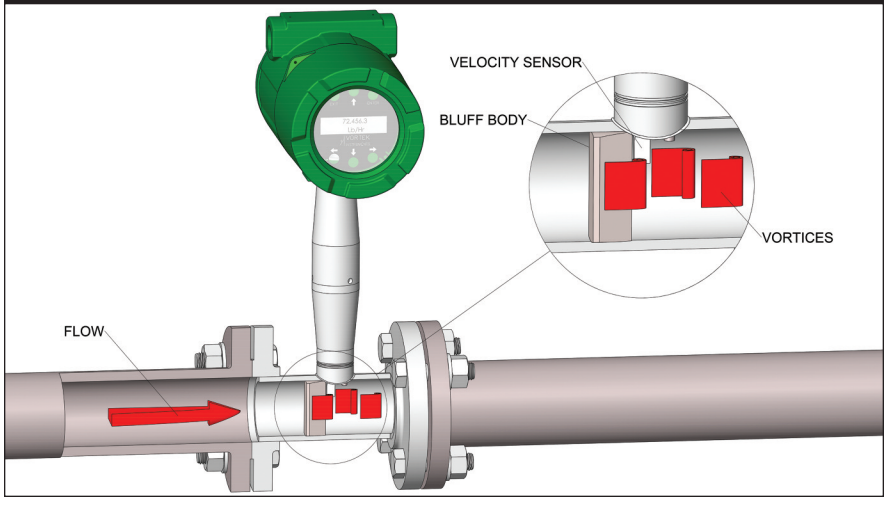
There are a wide variety of types and styles of mechanical flowmeters with moving parts that measure velocity such as **turbine, paddlewheel, impeller and propeller flowmeters**. The speed of their rotor is proportional to the velocity of the flowing fluid. These flowmeters can be quite accurate (better than 1% of reading) or only approximate (such as 5% of span). They can be spool piece style, barstock style or insertion devices that can range from inexpensive to medium priced. Models with high precision and special materials can be relatively expensive.

Full-bore spool piece **magnetic flowmeters** (Figure 1) can accurately measure the average velocity of electrically conductive fluids over a wide range of flows and flowmeter sizes. Other flowmeters that rival the installed accuracy of a magnetic flowmeter include turbine flowmeters, correlation-type ultrasonic flowmeters with calibrated spool pieces and Coriolis mass flowmeters.

Ultrasonic flowmeters operate by either measuring the transit time between two sensors or the Doppler shift caused by the movement (velocity) of the solids-bearing liquid. Transit time ultrasonic flowmeters may have clamp-on, wetted or inline sensors whereas Doppler ultrasonic flowmeters usually are supplied with clamp-on sensors. Ultrasonic flow meters are perhaps the most misapplied flow meters around. When they were first introduced, they were supposed to replace all other flow meters. But as with many tools, they settled into niches over time.

Thermal dispersion flowmeters are used for flow measurements in low-flow applications (Figure 2). This technology is commonly applied to the mass flow measurement of gases by measuring the thermal dispersion caused by a gas flowing past a heated temperature sensor. Thermal insertion flowmeters can be used to measure flows in large pipes.

□ Figure 3. Cutaway of an inline vortex shedding meter. The internal illustration shows the vortex bluff body and the vortices being shed.



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MICRO MOTION

Figure 4. Coriolis flowmeters

Fluidic meters operate by forcing the fluid to continuously oscillate in a repeatable and detectable fashion. Fluidic flowmeters have no moving parts and use the fluid itself to generate oscillations. The most common types of fluidic flowmeters include **vortex shedding, swirl and Coanda effect flowmeters**. A traditional vortex shedding flowmeter uses a bluff body (shedder bar) to produce repeatable oscillations (Figure 3). Swirl flowmeters use a stationary "rotor-like" device to twist the flow in conjunction with a restriction to contain the oscillations and make them repeat. Coanda effect flowmeters use hydraulic feedback to force the fluid to oscillate in proportion to its velocity.

Coriolis mass flowmeters (Figure 4) use the properties of mass to measure the mass flow of liquids and gases. These meters can also measure density and allow determination of the volumetric flow. Most Coriolis mass flowmeters have an internal temperature measurement that approximates the temperature of the flowing fluid.

Open channel flowmeters operate by measuring the head height (level) within or upstream of an open channel flow restriction. The level can be measured with various types of sensors, such as capacitance, float, ultrasonic and radar level sensors. In open channel installations, the flowmeter primary is the flow restriction (such as a flume or weir) and the secondary instrument is the level sensor used to automate the flowmeter reading. It should be noted that even a manually-read yardstick could be used to measure the level.

SELECTING AN APPROPRIATE FLOWMETER

When faced with so many choices, what goes into finding an appropriate flowmeter for the application?

The first cuts should be clear—liquid, solid, gases. Each of these categories eliminates many types of flowmeters. Then further cuts can be made. For example, if the flow is liquid, the second cut might be whether the pipe is full or not.

Consider the useful life expectancy of the flowmeter so the flowmeter is appropriate to avoid over-engineering or under-engineering the application.

Beyond these distinctions, there are other considerations, such as price. When it comes to price, choices often are based on whether the price tag is under or over about $1,000, an amount that often divides "inexpensive" and "expensive" flow elements.

Additional considerations might justify a second look at the price tag. For example, it is hard to find a 4-inch (100 millimeter) flowmeter with 1% of flow rate accuracy for under $1,000. If better accuracy is a requirement, the price tag may be well over $1,000.

One can then consider the constraints of the application. Does the application require high accuracy? If not, relaxed accuracy requirements might allow the use of a less expensive flowmeter. Good accuracy is often desirable when feeding high value fluids and batching, or when product quality is dependent upon the correct fluid flow. However, the best flowmeter accuracy is usually reserved for custody transfer applications where the flowmeter determines the amount billed for material that is bought or sold.

High temperature, high pressure and a wide variety of flow needs can also justify looking at the price tag. For example, if 10:1 turndown is required, several relatively inexpensive meters may perform well. However, the available choices diminish rapidly if 100:1 or 300:1 turndown is required.

Chemical compatibility and abrasion resistance are other considerations that can make the flowmeter choice more expensive. For example, there are a few flowmeters available larger than 1-inch in size that are highly corrosion resistant—and most are expensive.

Finally, be sure to consider the useful life expectancy of the flowmeter so the flowmeter is appropriate to avoid over-engineering or under-engineering the application. VM

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Q: CAN YOU BRIEFLY DESCRIBE WHAT IS INVOLVED IN PRODUCING DUPLEX STAINLESS STEEL CASTINGS THAT MEET NORSOK REQUIREMENTS?

A: The Norwegian petroleum industry developed the Norsok standards. Norsok M-630, Material Data Sheets (MDS) and Element Data Sheets (EDS) for Piping. MDS cover a number of materials while EDS cover items such as forming methods, hardfacing, bolting, etc. Duplex stainless-steel castings are covered by MDS D46 for ASTM A995 Grade 4A (CD3MN) and by MDS D56 for ASTM A995 Grades 5A (CE3MN) and 6A (CD3MWCuN).

In essence, these MDS impose additional requirements to account for perceived inadequacies in the ASTM A995 standard and have achieved a large degree of worldwide acceptance. Following is a brief summary of the additional requirements:

Melting: All grades are required to be refined using AOD (argon oxygen decarburization) or an equivalent refining method. ASTM A995 requires the use of an electric furnace process with or without separate refining.

Composition: The minimum nitrogen content for CD3MN is 0.14%. ASTM A995 requires 0.10% minimum.

CE3MN must have $S \leq 0.025$, and $P \leq 0.030$. ASTM A995 requires $S \leq 0.040$, and $P \leq 0.040$.

Heat Treatment: Components are required to be arranged in such a way as to allow free circulation of air (during the heating phase) and water (during the quenching phase).

Test Sampling: Production tests are required to be performed on material removed from test blocks that are to be either integrally cast on the component or gated to the component. The thickness of the test block must match the flange thickness in flanged components or the thickest section in the casting for non-flanged components. The other dimensions of the test block, as well as the locations within the test block from which test specimens are to be removed, are defined. The test block is to be tack-welded onto a casting if the casting is post-weld heat treated (PWHT). ASTM A995 does not require correlation of test block size to casting section thickness; locations of test specimens are not defined in much detail; and no requirement is made for test material that has been PWHT.

All tests are required to be run on each chemical heat and heat treat load, including PWHT (if performed).

Tensile Testing: CE3MN and CD3MWCuN must have a minimum ultimate tensile strength of 700 Mega Pascal (MPa). ASTM A995 requires 690 MPa minimum.

Impact Testing: All grades must be Charpy V-notch impact tested at -51°F (-46°C). The acceptance criteria is 45 J minimum average and 35 J minimum for a single specimen. ASTM A995 doesn't require impact testing.

Micrographic Examination: A specimen must be examined at 200X minimum magnification to verify that the ferrite content is 35-55%, and that the material is free from intermetallic phases and precipitates. Interestingly, M-630 indicates that these MDS ensure compliance with NACE MR0175/ISO 15156, but NACE MR0175/ISO 15156 requires the examination for intermetallic phases and precipitates be performed at 400X minimum magnification. ASTM A995 doesn't impose metal-

lographic examination as a standard requirement.

Corrosion Test: CE3MN and CD3MWCuN are required to exhibit no pitting at 20X and weight loss less than 4.0 grams per square meter (g/m^2) after 48 hours exposure to an ASTM G48 Method A test performed at 122°F (50°C). There are specific instructions for pickling the specimen prior to testing. Corrosion testing is not required for CD3MN.

NDE: For non-destructive evaluation (NDE), liquid penetrant testing is required in accordance with ASTM A995 Supplementary Requirement S6, and radiography based upon ASME Section VIII Division 1 Appendix 7 and ASME B16.34 is required, with frequency based upon pressure class and size. ASTM A995 doesn't impose NDE as a standard requirement.

Surface Finish: White pickling is required, although machined surfaces do not have to be repickled. ASTM A995 does not require pickling.

Weld Repair: The welding procedure may be qualified in accordance with ASTM A488 or ISO 11970, but must be qualified on cast material of the same grade that is to be welded in production. A change in filler brand name requires requalification.

PWHT is required after all major repairs. Minor repairs may be performed without PWHT. Each approach requires a separate procedure qualification.

The welding procedure qualification must include tests to demonstrate that all requirements of the governing MDS have been fulfilled. For weld deposits, the allowable ferrite content range is expanded to 35-65%. Two sets of three impact tests must be performed—one set with the notch located in the weld deposit, and one set with the notch located at the fusion line. For CE3MN and CD3MWCuN, the corrosion test must include weld metal.

Qualification: Materials may only be produced by manufacturers qualified in accordance with Norsok M-650, Qualification of Manufacturers of Special Materials. M-650 requires a "Qualifying Company" to perform the qualification. It recommends that the qualification be carried out by a recognized Qualifying Company so that the qualification is accepted by other customers. Because of this, these qualifications are generally performed by well-known testing, inspection and certification companies.

The result of the qualification is a Qualification Test Record (QTR), which documents the producer's manufacturing processes, heat treatment procedures, test results, weld procedures, historical production data, quality assurance program, etc. The QTR will list specific limitations, such as maximum component size, weight and/or section thickness, as well as permitted welding procedures. It may also restrict production to certain equipment, such as particular heat treat furnaces. The QTR document includes a summary front page that is signed by the Qualifying Company, which serves as the certification that the supplier is qualified to produce that material in accordance with the Norsok MDS.

Note that many of the major oil companies require that they review and approve a manufacturer's QTR before that manufacturer can produce castings for their projects. VM

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A Chilling Effect

BY KATE KUNKEL

While the Canadian winter sees a sizeable portion of the population scurrying to points south, those bone-chilling temperatures left behind will eventually provide relief in Toronto during the humid, hot summer months. This is because of a phenomenon that occurs with Lake Ontario.

During the chilly months, the surface of Lake Ontario cools to about 39°F (4°C), which means the water is denser and sinks to the lake's bottom. In summertime, the surface water heats up, but that water remains on the surface because it is not dense enough to sink. However, no matter how hot the ambient temperature during the summer, the deeper water remains very cold. This creates a permanent reservoir of cold water on the bottom of Lake Ontario that can be used for cooling.

TAPPING INTO THE SOURCE

To use the renewable energy of this cold water, Enwave Energy Corporation created Deep Lake Water Cooling (DLWC), the world's largest lake-source cooling system. For this article, Alex Sotirov, Enwave Energy Corporation's vice president of engineering, provided details that describe the system he helped design and install and how that system works.

Three 63-inch high-density polyethylene (HDPE) pipes are installed along the natural slope of the lake bottom to pump water from a depth of 273 feet (83 meters) to the Toronto Island Filtration Plant, which is 3.1 miles (5 km) away (Figure 1). Because this water ultimately ends up in the city's potable water system, the pipes and valves with which it comes into contact are specified food grade. Enwave uses American Water Works Association standard valves.

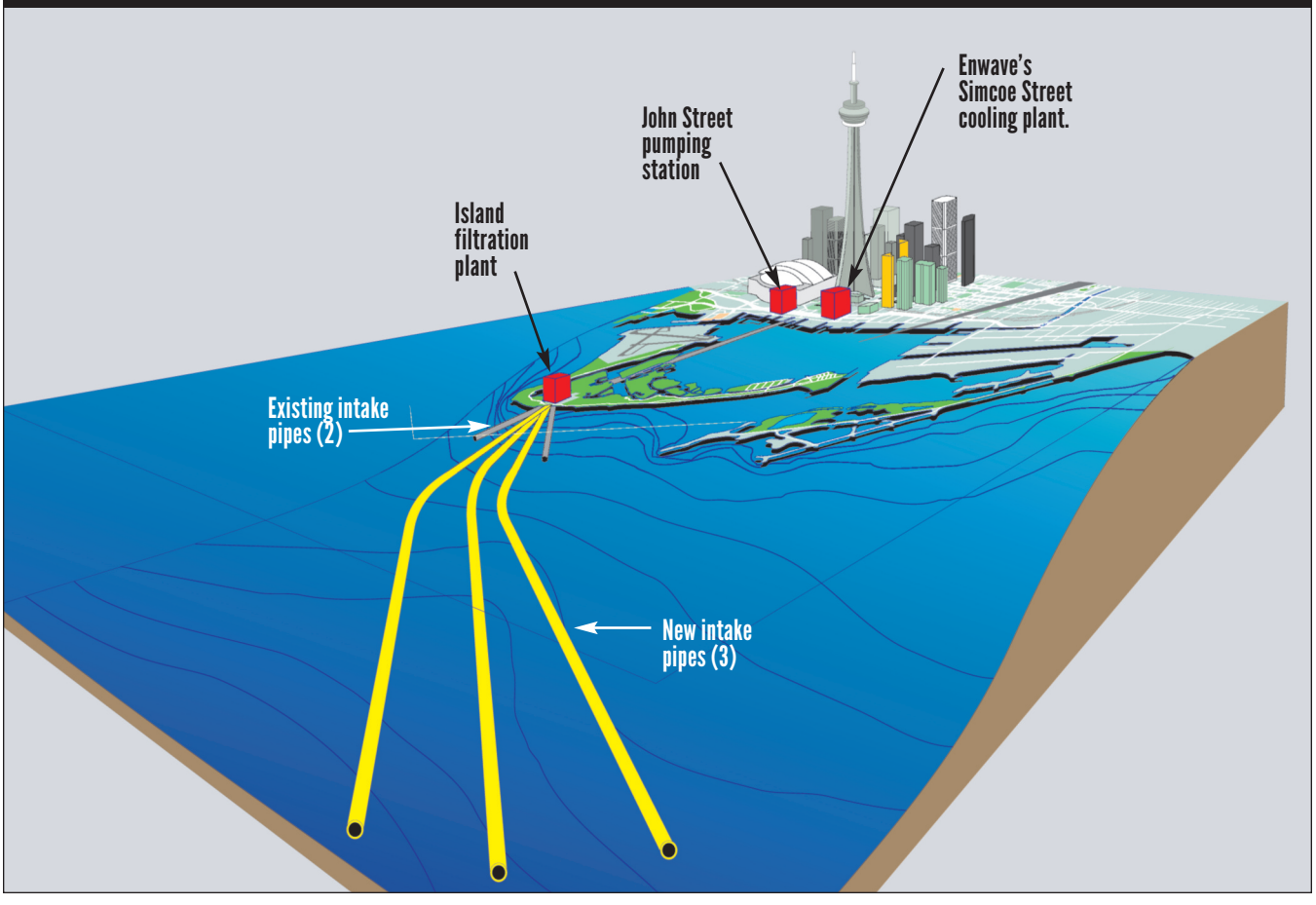
At the intake, 52-inch carbon steel butterfly valves direct the cold water to Enwave's energy transfer station at the city's John Street pumping station. These valves were chosen because they take up less space, are lighter than gate valves, and have packing and seating designed to last 80 years.

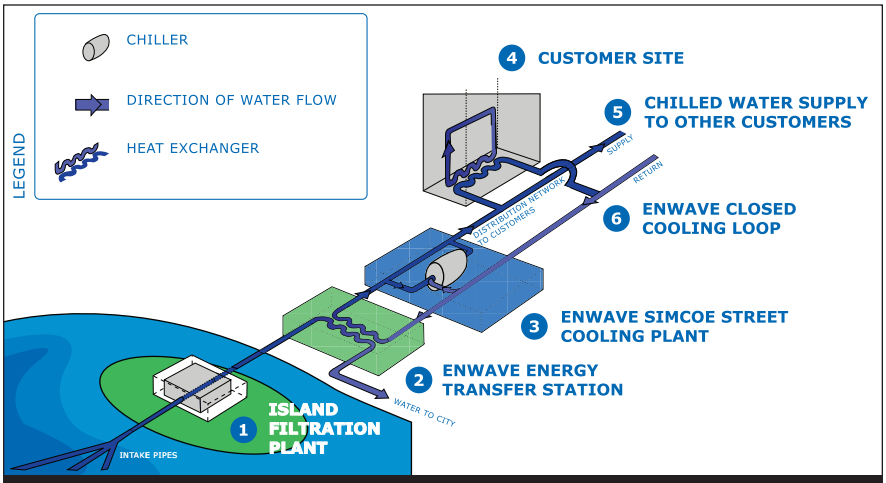
At this stage, heat exchangers facilitate an energy transfer between the cold lake water and Enwave's closed chilled-water supply loop (Figure 2). At the time it was built, the DLWC project had the largest set of heat exchangers ever specified in Canada.

The closed loop contains supply and return pipes running in a tunnel built specifically for this purpose.

About 7.5 miles (12 km) of underground pipe has been installed beneath the city's core to serve as a distribution network. The loop runs from Simcoe

□ Figure 1. A three-dimensional map of the Enwave system laying pipe





□ Figure 2. Deep lake water cooling system schematic

Street near Lake Ontario north through the financial and hospital districts to Queen's Park and back to where the pipe system begins. The downtown closed loop is made of steel and HDPE and contains over six million gallons of water. The flow rate through the system peaks at over 72,000 gallons per minute (gpm) and averages over 30,000 gpm.

A back-up system for the city's closed loop has been constructed for situations such as high heat days: 14,000 tons of additional back-up cooling can be provided by two steam-powered centrifugal chillers and two traditional electric centrifugal chillers. In routine circumstances, the heat from the loop is removed using lake water alone and what flows through the downtown loop will bypass the four supplemental chillers.

For use here, there are full bore, 48-inch ball valves handling pressures of 120 psi. By using specialized access points, maintenance crews can test the valves, and adjust and replace seating and packing without removing the valves.

The chilled water passes from the main Enwave system into each building's cooling system via a two-position,

□ Back flow preventer

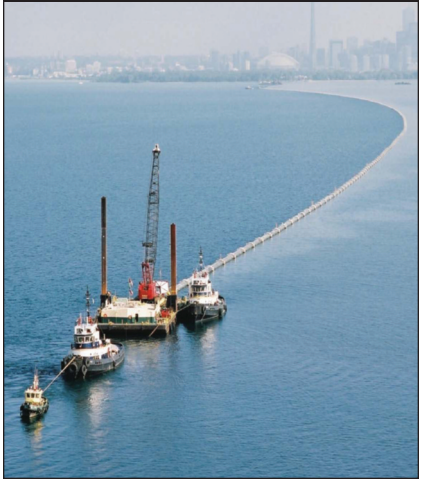
□ Energy transfer station pipe gallery

motorized butterfly valve that sends it to a metering system and then through a series of control, isolation and balancing valves to the building's system.

Once inside a building, flow of the chilled water to the building's exchange system is controlled by a manual isolation valve. The water is pumped directly to the building's heat exchanger where it chills the building's closed loop system. The chilling water is then pumped back to the Enwave system through a motorized two-position valve and a balancing valve to a temperature sensor. Once past the sensor, the water goes back out to the main system through a modulating two-way control valve.

After conveying its energy to the building's internal system, the Enwave chilled water continues its journey through the system. Meanwhile, each building's internal closed loop system uses thousands of valves, including manual isolation and ball valves, to convey chilled water to individual

□ Deep Lake Water Cooling pipe deployment



offices. As new customers want to go online or as new skyscrapers are built, the system can accommodate needs simply by drilling from the basement of a new building into the Enwave dedicated tunnel.

But what happens to the lake water itself, many wonder. The answer is that it has never mingled with the Enwave system; only its energy has been conveyed to the closed system.

BENEFITS OF DLWC

The benefits of the system are numerous. Building owners appreciate it because Lake Ontario serves as the engine of cooling, eliminating the need for electrically powered chillers. This frees up significant square footage and reduces maintenance costs for retrofits at existing buildings. It also saves hundreds of thousands of dollars in capital investments at new construction.

Additionally, when combined on average, the buildings that use this system instead of using individual chiller packages free up 61 megawatts of power on the Toronto electric grid. Because less electricity is required to power individual air-conditioning installations, less fuel is required for consumption at local utility plants. The corresponding carbon dioxide (CO_2) gas emission reductions are figured to be about 87,000 tons annually, the equivalent of about 16,000 automobiles on the nation's roadways.

The DLWC also reduces the need for hydrochloroflourocarbon- and chlorofluorocarbon-based refrigerants. And, even though the water running through the system warms up about 2°F (less than 1°C), when it enters the city's potable water system, minimal heat returns into the lake, and no extra water has been used to accommodate the system.

Like any project, this system is ultimately dependent on the components of which it is comprised. For that reason, high-quality valves designed to last decades are key to ensuring its continued reliable service. VM

□ Energy transfer station pipe gallery risers to heat exchangers

□ Heat exchangers, which provide the way for energy transfer between the cold lake water and the closed chilled-water supply loop

KATE KUNKEL is senior editor of VALVE Magazine. Reach her at kkunkel@vma.org.

Governors and the Vena Contracta

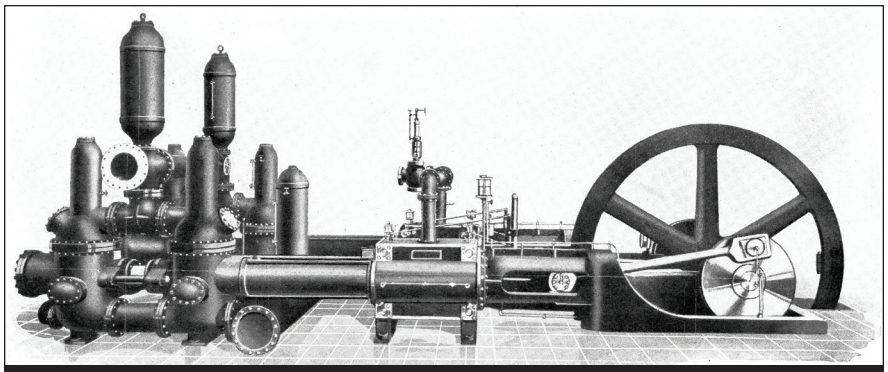
BY GREG JOHNSON

Like most early developments with valves, the control valve industry was pulled along as a valuable companion in the nation's drive to harness and control the power of steam.

The first steam control elements, which were called governors, can be traced back to the late 18th century and the work of British engineers James Watt, Thomas Mead and Mathew Boulton. The result of their work was the fly-ball or centrifugal governor.

This device used the principle of feedback from the output of the prime mover to mechanically control the output of the engine. The design was simple: a pair of brass balls was attached to a shaft that connected to a final control element (valve) on the steam engine. This, in turn, was connected by gears to the output of the engine. As the steam output increased, the balls spun faster, and centrifugal force caused them to rise, which then caused a connecting shaft to pull up and close the main valve on the steam engine, thus reducing its speed.

This was a huge leap in controlling steam engines, but it resulted in a very coarse, cyclic form of control because the speed oscillated between the full open and full closed position. Additional inventions added the concept of feedback loops and "integral" response, which helped greatly to even out the control of the engines.



□ A typical 19th century steam engine is shown here with its regulating control valve.

AGE OF INNOVATIONS

As the 19th century and the Industrial Revolution steamed ahead, the 1880s saw the beginning of an age of innovation in the field of control valves. In 1880, William Fisher, an engineer at the city waterworks in Marshalltown, IA, developed a constant-pressure pump regulator to alleviate the 24-hour-a-day attention that manually-operated steam-driven pumps required. This constant attention was needed because water requirements changed drastically if there was a fire or major waterline leak, which meant the pump had to be manually adjusted to compensate for increased demand.

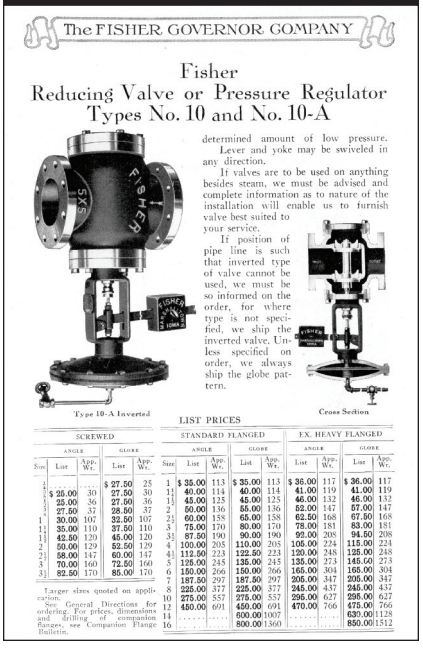
Fisher perfected his designs and formed the Fisher Governor Company in 1888. Also during that time, another future control valve icon, William B. Mason, designed and patented a number of pump regulators and pressure-reducing valves. The pressure-reducing valve was a huge boon to the railroad industry because it made supply of reduced pressure steam available to heat the railroad cars. Mason went on to form the Mason Regulator Company.

Around the turn of that century, other manufacturers, such as Atlas, Keckley, Cash, Leslie and Kieley-Mueller, also began to manufacture governors and control valves. For the first 40 years of the 20th century, the art of mechanical controls would be elevated to its zenith as a host of designs for controlling flow, pressure and level were developed. These designs would marry the concept of pneumatics with the hydraulics of the final control elements in the form of pilot-operated regulators and actuators, and later positioners.

Meanwhile, steam pressures climbed steadily higher and flow requirements increased so the standard-shaped plug design proved inadequate and unstable in operation. New linear and proportional disc designs would help to greatly stabilize control valve flow.

Although stability was attained with the new plug designs, it wasn't until the double-seated design emerged that dynamic forces on the plug would be

□ Fisher was an early leader in the design and manufacture of control valves. Pictured is a state-of-the-art offering from the company's 1915 catalog.



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Type 10-A Inverted

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¼			$ 27.50	25	1	$ 35.00	113	$ 35.00	113	$ 36.00	117	$ 36.00	117
⅜	$ 25.00	30	27.50	30	1¼	40.00	114	40.00	114	41.00	119	41.00	119
½	25.00	36	27.50	36	1½	45.00	125	45.00	125	46.00	132	46.00	132
¾	27.50	37	28.50	37	2	50.00	136	55.00	136	52.00	147	57.00	147
1	30.00	107	32.50	107	2½	60.00	158	65.00	158	62.50	168	67.50	168
1¼	35.00	110	37.50	110	3	75.00	170	80.00	170	78.00	181	83.00	181
1½	42.50	120	45.00	120	3½	87.50	190	90.00	190	92.00	208	94.50	208
2	50.00	129	52.50	129	4	100.00	205	110.00	205	105.00	224	115.00	224
2½	58.00	147	60.00	147	4½	112.50	223	122.50	223	120.00	248	128.00	248
3	70.00	160	72.50	160	5	128.00	245	138.00	245	135.00	273	145.50	273
3½	82.50	170	85.00	170	6	150.00	266	150.00	266	165.00	304	165.00	304
					7	187.50	297	187.50	297	205.00	347	205.00	347
					8	225.00	377	225.00	377	245.00	437	245.00	437
					10	275.00	557	275.00	557	295.00	627	295.00	627
					12	450.00	691	450.00	691	470.00	766	475.00	766
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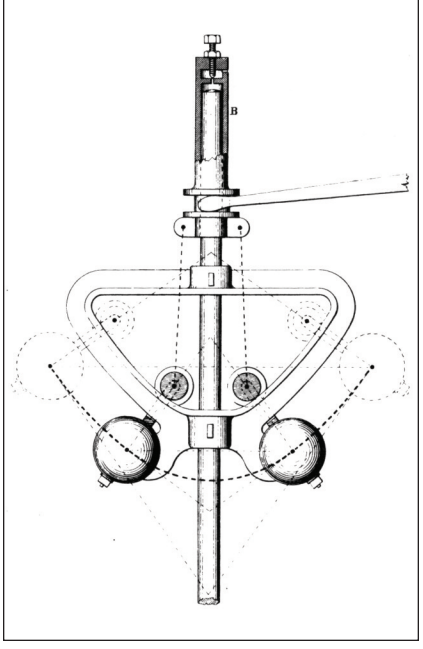
□ These contraptions were called fly-ball governors, and they helped start the control valve industry.



stabilized enough to allow the maximum valve size increase to NPS 12.

Control valve materials during the first quarter of the 20th century mirrored those in the gate, globe and check valve industry: The two primary choices were black or gold (black being cast iron and gold being brass or bronze). The manufacture of steel-bodied control valves began about 1910, and cast steel would eventually overtake iron as the primary control valve body material by the end of World War II.

The oil industry exploded into national prominence with the Spindletop Gusher in Beaumont, TX in 1901. The timing of the Spindletop event coincided nicely with the gasoline-addicted automobile industry that was soon to come. This created an oil processing and refining boom heard around the world. The new industry was in dire need of control valves, and one of the first companies to meet that need was The Neilan Company, founded by Thomas Neilan during the 1920s. Neilan focused his product line on this fast-growing petroleum industry and its refinery applications.

The 1930s saw additional innovations including the first valve positioner (in 1936). It was also during this time that control valve manufacturers realized large-diameter stems were a hindrance because of their increased friction. Control instrument suppliers, such as Foxboro, Taylor and Bailey, began to integrate control systems into complete control loops with the integration of designs with basic valves purchased from other suppliers. The late 1930s also saw the first connection between control valves and electricity, when electrical switches and control were included in some devices.

□ Customer service at its zenith was given through this 1930s vintage Mason-Neilan service and delivery truck.

WORLD WAR II

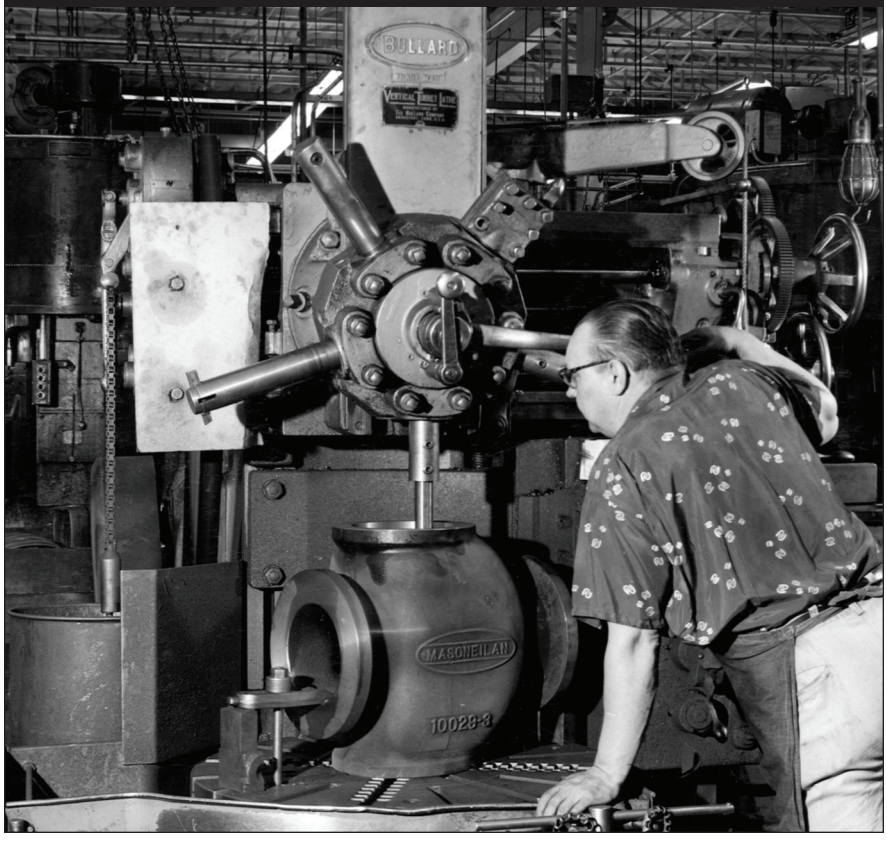
The enormous research and development effort that was World War II yielded innovations in every industrial sector, including control valves. Valve manufacturers were asked to design products to control fluids that didn't exist 10 years before, and to control those products at pressures and temperatures previously unrealized. Control systems also had to be much more accurate and repeatable.

The war highlighted the need for standardization in the control valve field as well. Up until that time, end-to-end dimensions for control valves were "manufacturers standard," making interchangeability between brands costly and difficult. A group of manufacturers that would later form the nucleus of the Fluid Controls Institute led the way toward dimensional standardization that would finally become a reality about the same time the war ended.

The dominance of the globe valve as *the* final control element was challenged for the first time in the mid-1950s with the design of the first butterfly-type control valve, although the concept had been used in engine carburetors for decades. By 1975, the market share for globe-type control valves would drop all the way down to 3% of the market. The rotary-revolution was decidedly won by the quarter-turn valve. Quarter-turn valves would bring their own set of difficulties and idiosyncrasies, however, that were dealt with as the market segment matured.

Following World War II, the business of control valves and control systems got a big boost with the creation of the

□ Control valve bodies are machined on a vertical boring mill in this post-World War II image.



Instrument Society of America (ISA, which later changed its name to International Society of Automation) in 1946. ISA would organize engineers and technicians and create a forum for the exchange of ideas. The organization later took over sponsorship and maintenance of many of the Fluid Control Institute (FCI) standards.

Before passing along its control valve standards creation authority to ISA, FCI created two groundbreaking and much needed control valve standards. The first, Recommended Voluntary Standards for Determining Control Valve Capacity, was created in 1958, and the second, Recommended Voluntary Standards for Control Valve Sizing, was created in 1962. These two standards did much to codify control valve sizing as well put the phrase "vena contracta" (the point in a fluid stream where the diameter is the least and velocity is at maximum) in everyday control valve dialogue.

The 1960s and 1970s would see great improvements in the area of valve trim design. Problems with cavitation damage and excess noise would be addressed in many unique disc and closure element designs.

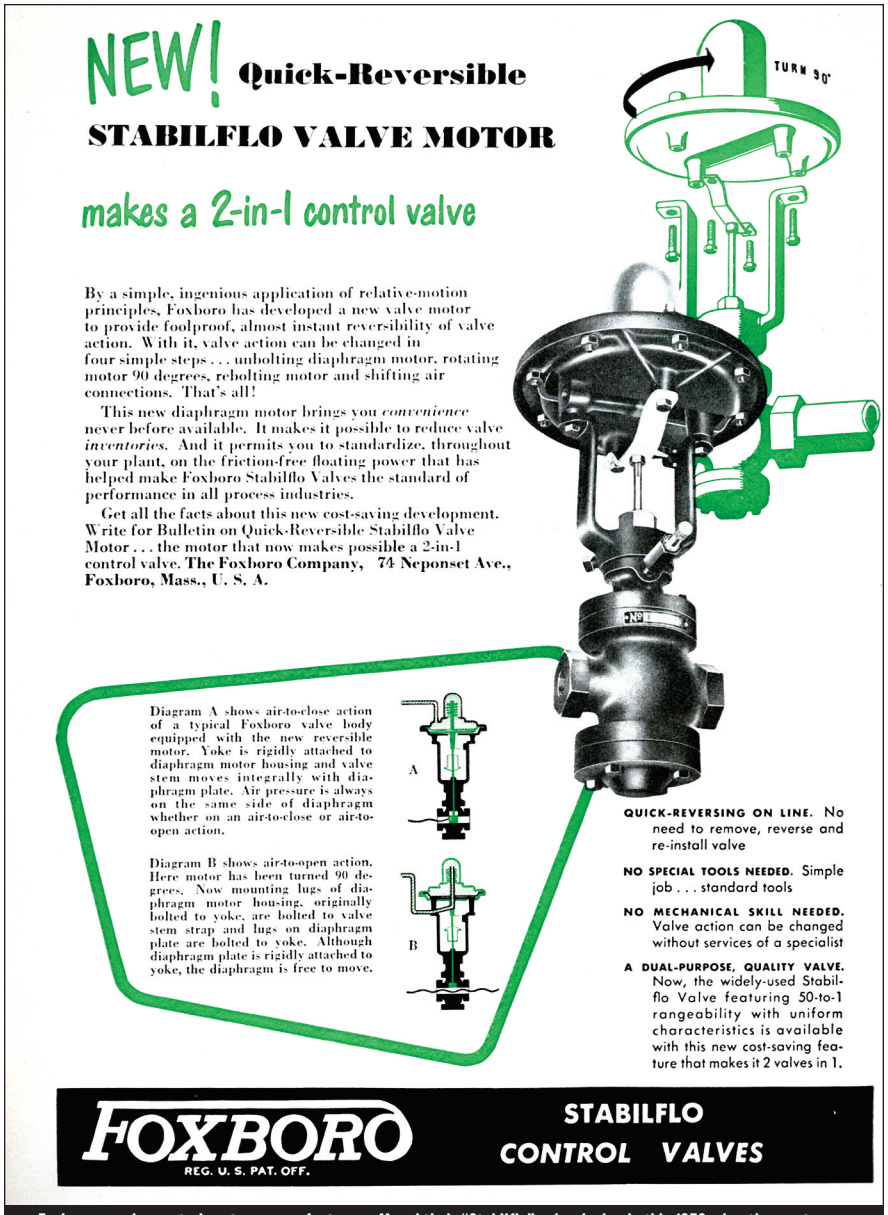
EVEN SMARTER DESIGNS

The last quarter of the 20th century also would see radical changes in control valve control systems and protocols. Basic but effective analog systems began to lose popularity as the end of 1990s approached. The new buzzwords were smart valves and digital control systems. The market for surplus copper wire was soon flooded, as multi-conductor cables for analog control and feedback gave way to the simplified series-wired digital fieldbus systems.

The new century saw many new control valve innovations as valves could now "talk" back to the control room and relay their status and operating conditions. But the 21st century has also brought challenges. One of the primary areas is control of fugitive emissions. In every plant that generates or uses volatile organic compounds, fugitive emissions are a problem, and valves are the number one culprit. Block valves that are only occasionally opened or closed are hard enough to seal well, while constantly moving control valve stems create even greater challenges.

The FCI developed a standard for fugitive emissions testing and qualification in 1990. The document, Standard for Qualification of Control Valve Stem Seals, details a testing protocol that requires from 5,000 to 100,000 mechanical cycles, as well as temperature cycles. Meeting these requirements requires the highest standards of packing system design and construction.

While steam is no longer the driving force in control valve design and development, the responsibility has fallen to the process industries. Infinite control and repeatability is now the attainable goal for control valves. Improvements in control system architecture continue to advance, but at the end of the day, the disc or other final control element is not that much different from the closure element at the end of Mr. Watt's fly-ball governor. VM



□ Foxboro, a major control systems manufacturer, offered their "Stabilflo" valve design in this 1950 advertisement.

As the Valve Manufacturers Association celebrates its 75th anniversary in 2013, we present this series of articles on the history of valves, with a final article scheduled to appear in the special fall anniversary issue of VALVE Magazine.

GREG JOHNSON is president of United Valve (www.unitedvalve.com), Houston, and is a contributing editor to VALVE Magazine. He serves as chairman of VMA's Education & Training Committee, is a member of the VMA Communications Committee and is president of the Manufacturers Standardization Society. Reach him at greg1950@unitedvalve.com.

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For more information on joining the Valve Repair Council, contact Marc Pasternak at 202.331.0104 (mpasternak@vma.org).

EMERSON'S Fisher FIELDVUE DVC6205 remote-mount digital valve controller is for applications in which accessibility, extreme temperatures (up to 250°F/120°C), extreme vibration or confined space make integral mounting difficult or impractical.

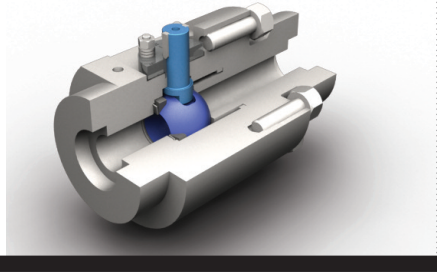
Industries such as pulp and paper and nuclear power have typically preferred to isolate valve-mounted instruments from harsh environments. With the DVC6205, only the valve position feedback is mounted on the control valve, while the remainder of the digital valve controller can be mounted more than 300 feet away in a less severe or more accessible environment.

ASCO NUMATICS introduces two intrinsically safe solenoid valves with Ex ia IIC T6 certification. The solenoid operators are designed for use on the 327 range of direct-operated solenoid valves and are available in epoxy-coated aluminum or stainless steel. The solenoids are certified to ATEX, Category 1G/2D and Equipment Protection Level (EPL) Ga/Db. Both operators are IECEx approved and certified to IEC 61508 Functional Safety (SIL 3 capable).

The polarity insensitive solenoid operators have a power consumption of 0.5W at 24V DC and feature a newly developed electronic booster coil and stainless-steel core for optimum performance.

VALVTECHNOLOGIES has added bidirectional flow capabilities to its existing V1 valve product line. According to the company, this is the first backpressure-resistant, metal-seated ball valve on the market.

The new V1 valve line feature prevents the load spring from collapsing, providing tight shutoff or zero leakage in the preferred direction after a reverse flow condition. The bidirectional flow capabilities protect against damage to the internal components and load spring when the valve is exposed to back pressure.



VICTAULIC has introduced AGS Full Flow Fittings with Vic-Rings, a line of grooved carbon steel pipe fittings for abrasive applications in the mining industry. The fittings are designed for use with the AGS (Advanced Groove System) Vic-Ring System, which simplifies the installation and extends the service life of large-diameter abrasive service piping systems.

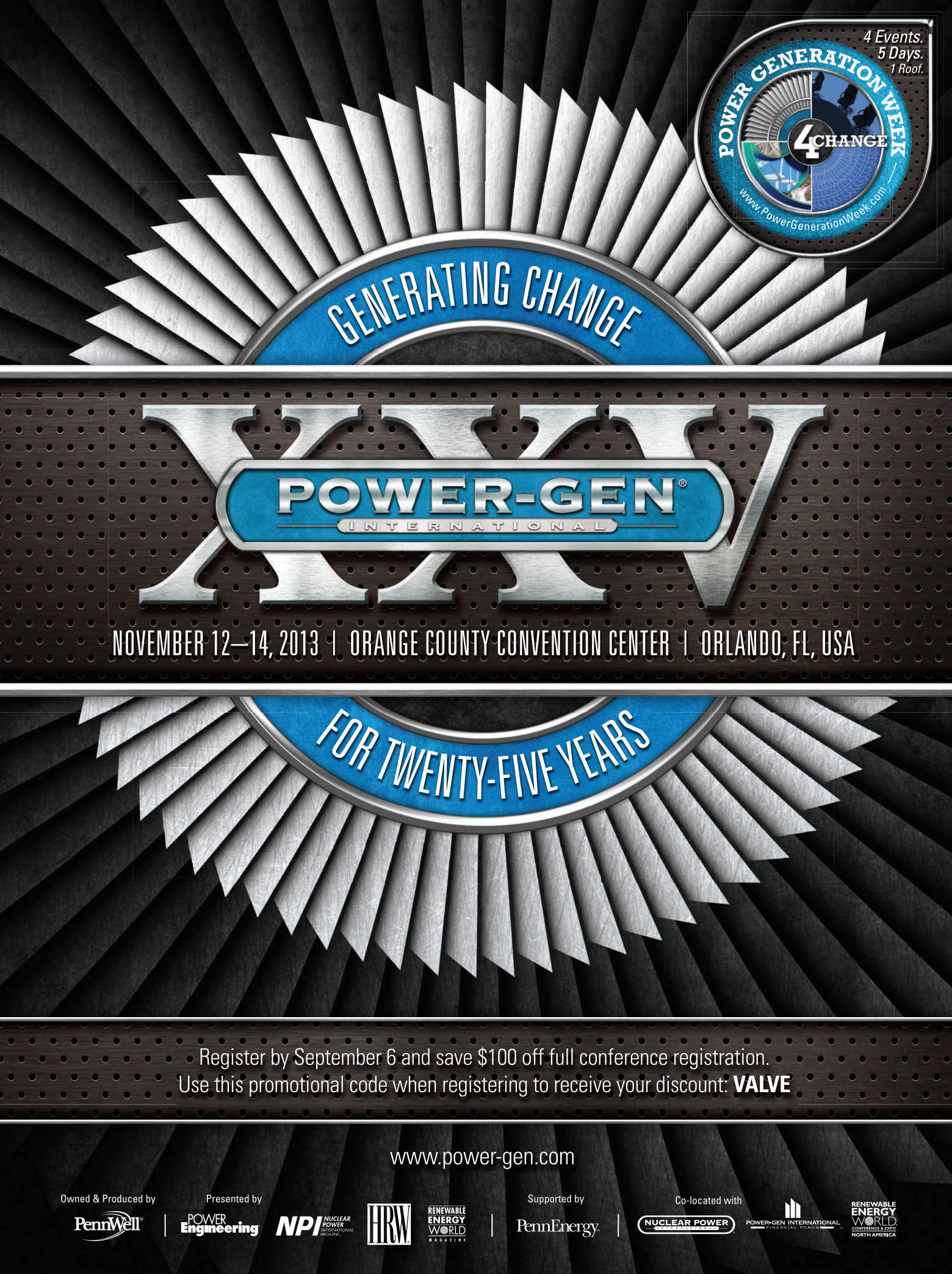
The fittings enable fast installation without field preparation and feature integral Victaulic AGS Vic-Rings, eliminating additional fabrication requirements and pipe preparation time. The design permits increased pipe-end/component-end separation for easy alignment and quick installation. The integral Vic-Rings maintain a smooth bore through the fitting with no reduction in wall thickness at the joints, making the fittings suitable for applications such as tailings and slurry lines.

These fittings are available in sizes ranging from 12 to 48 inches (300 to 1,200 millimeters), and are offered in a variety of straight and reducing styles, including elbows, tees, caps, concentric and eccentric reducers, and adapter nipples. They can be supplied in standard weight or extra heavy construction, and are available for unlined pipe or with abrasion- or corrosion-resistant rubber lining.

SPIRAX SARCO released the SP500 HART electropneumatic digital positioner supporting HART communication protocol. The HART protocol is comprised of a digital data transfer and communication over existing 4-20 mA wiring, requiring no additional power supply or wiring to the positioner.

Through the protocol, the positioner can be configured and process parameters updated or modified remotely using a PC or handheld device. The positioner permits continuous condition monitoring, leveraging higher processing power to integrate the SP500 HART and information about its adjacent control valve into data logging applications and advanced control strategies.

AUMA actuators are now available with Bluetooth wireless technology that can monitor and diagnose AUMA actuators. Free company software can be downloaded from AUMA's website to a PDA or laptop. This provides plant owners and operators a user-friendly interface to run the actuator, set parameters and download diagnostic information with a few key strokes.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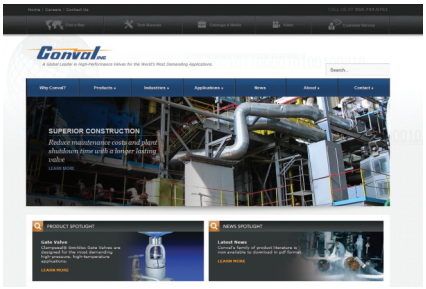

CONVAL recently upgraded its website, Conval.com, to help engineers and plant personnel find the information and contacts they need for new construction, maintenance and repair projects. The new website contains a comprehensive search tool, product animations, standard and special application product information, industry-specific features and benefits, servicing videos, PDF literature in various languages and global contact information.

PENTAIR VALVES & CONTROLS has launched two new Keystone Global Resilient (GR) seated heavy-duty industrial valves aimed at general-purpose applications. Available in lug (GRL) and wafer (GRW) body styles, the new valves offer longer cycle life and a lower total cost-of-ownership through increased reliability and performance. Based on an upgraded global design, the valves offer a host of benefits, including a proprietary Pentair polymer seat for increased pressure-holding capabilities and decreased wear. Other advanced features include higher pressure ratings, blow-out resistant shafts for increased safety of field personnel.

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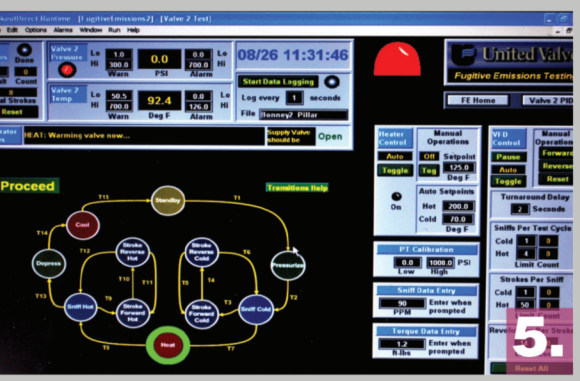

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