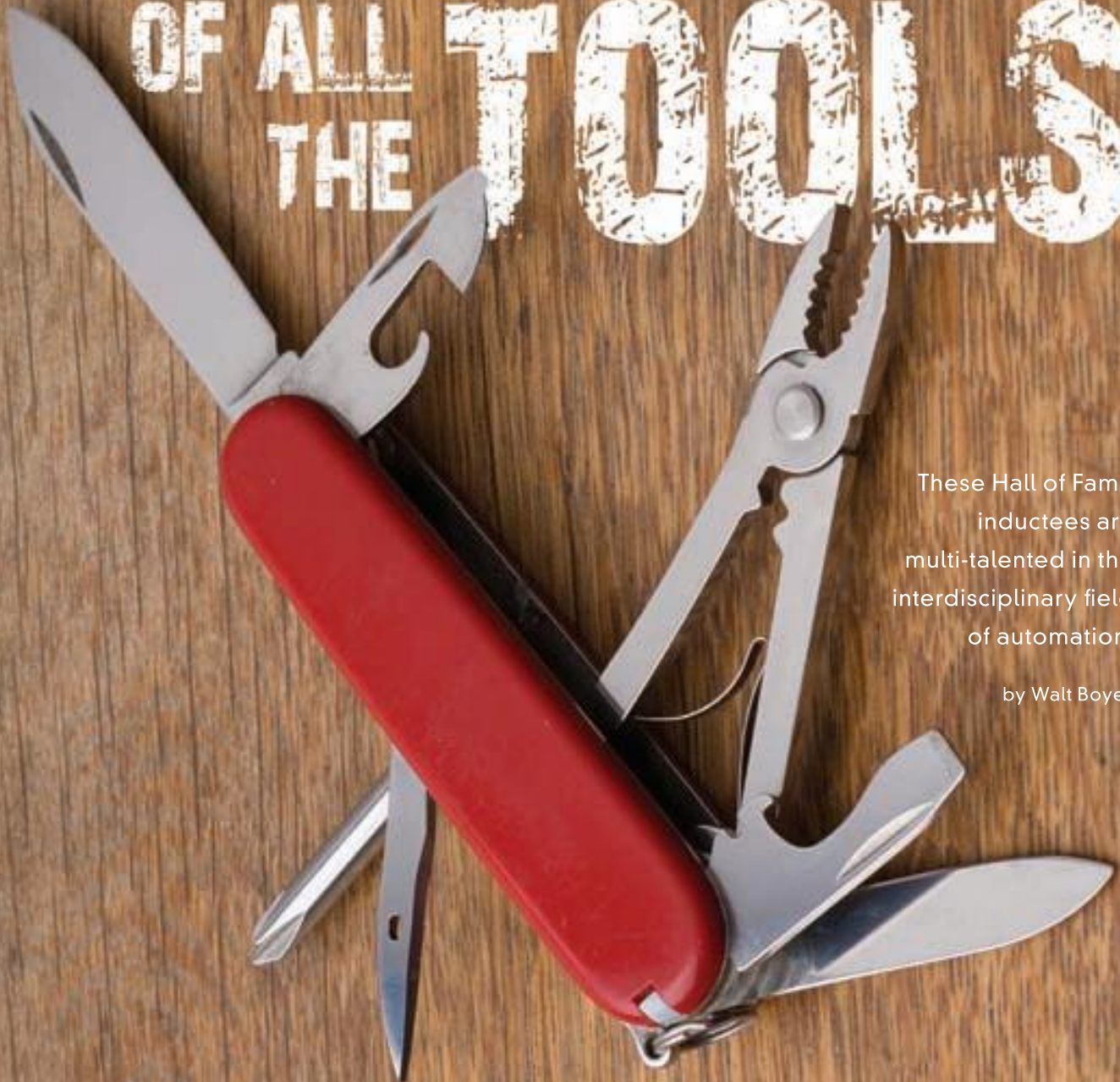


PROCESS AUTOMATION HALL OF FAME

# MASTERS OF ALL THE TOOLS

These Hall of Fame inductees are multi-talented in the interdisciplinary field of automation.

by Walt Boyes





## PROCESS AUTOMATION HALL OF FAME

It's time, once again, to introduce you to the new inductees into the Process Automation Hall of Fame. It's a truly international group this year. This year's inductees are John Berra, former chairman of Emerson Process Management, Sigurd Skogestad, professor of chemical engineering at NTNU, Trondheim, Norway, and Maurice Wilkins, former Honeywell fellow, WBF chairman and now vice-president for global marketing services at Yokogawa Electric Corp. It is a diverse and eclectic group, as you can see, but there are themes that run through the lives and careers of all three.

These masters of the process automation arts have come to the field in sometimes unusual ways. Automation is a multidisciplinary set of skills, and these skills are hard to acquire in any one place, be it university, trade school or on-the-job training. These three men managed to acquire their exemplary skills and then work their entire careers to extend the skills and the reach of automation in manufacturing and especially in the process industries.

### THE BUSINESS VISIONARY

# JOHN BERRA

"I graduated from Washington University in St. Louis with a degree in system science in June of 1969," says John Berra, former chairman of the board at Emerson Process Management. "At that time, there were two paths you could follow with this sort of degree—aerospace and process control. I interviewed with many companies and came to the conclusion that the space program wasn't going to be as active once a man walked on the moon. So I decided to join Monsanto as an instrument engineer."

Berra worked in the corporate engineering group at Monsanto and received excellent training in what process control was all about. Monsanto's training program of that era has produced a significant number of inductees into the Process Automation Hall of Fame. Berra's first projects were pneumatic instru-

mentation and some very early analog electronic control loops.



"Monsanto was good," he says, "but I wanted to move faster, so I took a job with J. F. Pritchard, an engineering contractor in Kansas City. I learned a lot there and got to spend time in the field on start-ups. I spent a lot of time ringing out wires!"

From there, Berra took a sales engineering job at Beckman Instruments (now Beckman Coulter Inc., [www.beckmancoulter.com](http://www.beckmancoulter.com)) and then joined a company called Rosemount (now the Rosemount Measurement Division of Emerson Process Management, [www2.emersonprocess.com](http://www2.emersonprocess.com)), which had some radical new pressure-sensing technology.

"The rest, as they say, is history," Berra recalls. "I grew up with the company and was promoted several times

## THE PROCESS AUTOMATION HALL OF FAME

The Process Automation Hall of Fame was established in 2001 to honor pioneers of process automation technologies and luminaries of the discipline. Each year, the previously inducted members nominate and select three to five automation professionals whose contributions to the profession have made them significant. Anyone can propose a nominee, but only the inductees vote on the final selection.

Here are the members of the Process Automation Hall of Fame in the order of their induction:

Marion "Bud" Keyes  
 Béla Lipták  
 Greg McMillan  
 F. Greg Shinsky  
 Terry Tolliver  
 Harold Wade  
 Karl Astrom  
 Lynn Craig  
 Charles Cutler  
 Terry Blevins  
 Thomas M. Stout  
 Ted Williams  
 Richard H. Caro  
 William G. "Bill" Luyben  
 R. Russell Rhinehart  
 Edgar Bristol II  
 Richard E. Morley  
 Wyman "Cy" Rutledge  
 Kathleen Waters  
 James H. Christensen  
 Thomas F. Edgar  
 Angela Summers  
 Vernon Trevathan  
 William M. Hawkins  
 Dale E. Seborg  
 Hans D. Baumann  
 Renzo Dallimonti  
 J. Patrick Kennedy  
 Carroll Ryskamp  
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## PROCESS AUTOMATION HALL OF FAME

before becoming the president of Rosemount.”

When Emerson, which had acquired Rosemount just a few months after Berra joined, decided to purchase Fisher Controls from Berra’s alma mater, Monsanto, Berra became head of the combined Fisher and Rosemount controls business, then called Fisher-Rosemount.

“We ultimately launched DeltaV during my time as president,” Berra says modestly. Other Emerson employees, though, recount stories of his deep and intense involvement in the design and creation of DeltaV, which became the model for the second generation of DCS products worldwide, and one of the most successful.

At the same time, Berra was responsible for the development of two of the most successful digital communications buses in process automation. “I am a geek at heart,” he says.

First, under his direction, Rosemount developed HART, which has now over 30 million devices installed. Then, after personally working with the ISA SP50 standard committee, he helped launch (and became chairman of) the Fieldbus Foundation ([www.fieldbus.org](http://www.fieldbus.org))—which is, especially in the petrochemical industry, growing as a powerful vendor-non-specific communications and control platform.

Berra has been a champion of the independent standards movement, personally in his involvement in ISA standards, as well as in his role as business leader providing the impetus for Emerson’s involvement in standards work.

After Rosemount developed the HART protocol as a proprietary technology, Berra led the development of the HART Communication Foundation ([www.hartcomm.org](http://www.hartcomm.org)), and

deeded the patents on the HART technology over to this not-for-profit organization. “The HART protocol was conceived at an offsite meeting that I chaired,” he says.

“OPC also began on my watch,” Berra notes. “I remember going to Microsoft and meeting with Mike Maples, who was then head of technology there. We were trying to stir up some interest at Microsoft in process automation.”

“More recently,” he continues, “I was associated with wireless technology and was proud to launch wireless products and WirelessHART during my time as business leader.”

“Clearly no single person does all of this, and I am not the engineer who did the technology,” Berra says. “But I am very proud of my leading role in all of these things that changed our industry. Automation is better because of these innovations, and it is very gratifying to know that I have been a part of it. My other source of pride is the people that I’ve hired and developed over the years.”

Berra has been married to his wife Charlotte for 41 years, and they have three children and three grandchildren. “The grandchildren are the highlight of our life,” he says. “I was a pretty decent tennis and basketball player in my younger years, but now my sport is golf.”

Berra’s idea of retirement is typically busy. He sits on the board of directors of two public companies, Ryder and National Instruments, and is a trustee of the Dell Children’s Medical Center in Austin, Texas. “I sponsor four scholarships each year at the Washington University School of Engineering, [where he and Charlotte did their undergraduate work, and where they met—ed.],” he said.

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## PROCESS AUTOMATION HALL OF FAME

### THE ACADEMIC VISIONARY

# DR. SIGURD SKOGESTAD

Dr. Sigurd Skogestad took three classes from the electrical engineering department at the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway, when he was in the Norwegian army. "However, these were rather theoretical, and during my following three-year career in the process industry, I did not find any use for these courses."



He was much more interested in thermodynamics, so when he decided to go for his Ph.D., he directed his studies towards that or process systems engineering.

"I had no plans of getting into control engineering," Skogestad recalls, "but then Professor Manfred Morari of CalTech came to visit our company [Hydro, [www.hydro.com](http://www.hydro.com)] and gave some lectures on the pinch method for heat exchanger network design. I was very impressed with him, and I joined his group at CalTech. The main focus of his work was control, and I became fascinated with the power of feedback control."

Skogestad relies on his four years of experience at Hydro's research center in Porsgrunn, Norway, to shape his work. "I have always had a strong interest in doing work that engineers may find useful in their daily work," he says, "and my first control paper was a paper on PID tuning that was written during my first year as a Ph.D. student." In fact, this paper has been so useful that it is still Skogestad's paper with the most citations in other works. "Presently at 365 citations," Skogestad says.

Skogestad was born in the small town of Flekkefjord, Norway, but moved to South Africa with his family for the next five years. Moving back to Norway, he finished high school in Porsgrunn, certain that he wanted to study engineering. "I ended up in chemical engineering because my father was a chemical engineer and working in large chemical plants seemed interesting and challenging," he says.

Sigurd married Anne-Lise when he was still a student, and they have two boys and two girls. Since he returned to Norway in 1987, he has been a professor of chemical engineering at NTNU and has been head of the chemical engineering department for some time. He is an avid cross-country skier and hunter, mostly of grouse. He is also a fan of orienteering, or "running with compasses." Skogestad is also active in local politics, as well as being a coach and umpire for girls' baseball.

"I think my main contribution," he says, "and one I am still working on, is to take control theory and make it workable in practice. As you can see if you look at my home page ([www.nt.ntnu.no/users/skoge/bio.html](http://www.nt.ntnu.no/users/skoge/bio.html)), the object of our research is to develop simple, yet rigorous methods to solve problems of



## PROCESS AUTOMATION HALL OF FAME

engineering significance. We would like to provide the engineer with tools to assist in problem solving.’”

Skogestad has been working on plant-wide control for 25 years. “I am trying to find a systematic approach for finding the right control strategy, especially for finding

the best controlled variables (CVs). I expect to keep working at least for another 15 years.”

You can find his paper, “A Systematic Approach to Plant-Wide Control” at [www.controlglobal.com/plantwidecontrol.html](http://www.controlglobal.com/plantwidecontrol.html). “The paper summarizes my efforts so far...” he notes.

### THE BATCH WIZARD

# DR. MAURICE WILKINS

“It was 1978,” says Dr. Maurice Wilkins, vice-president of global marketing services for Yokogawa Electric of America ([www.yokogawa.com/us/](http://www.yokogawa.com/us/)), “and I was just finishing my Ph.D, when a friend of mine who had graduated the year before to join Esso Chemical Ltd. in the New Forest area of southern England called to tell me about a cool new project he was working on using a new control tool called a DCS.”



It was a Honeywell TDC2000 with eight loops and a single data entry panel.

Wilkins continues his story: “At the time I knew nothing about process control—we had done some on the chemical engineering course I had taken—but not much, and my Ph.D. studies had been on the control of water pollution using activated charcoal cloth. He said that Esso was looking for one more control engineer and 17 process engineers,

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so I decided to apply, and got the job. I was on a Honeywell training course while still writing my Ph.D. thesis. I remember my first day at Esso Chemical—my boss pointed to a line of columns and told me that I would be responsible for putting all of them onto TDC2000 and adding advanced controls—and so began my first project.”

“Esso was very good at giving basic control training to its engineers,” Wilkins says, “and then throwing them in at the deep end—and boy, did I learn a lot quickly.” Like Berra, Wilkins spent lots of time working on every type of process unit. Then he was sent to Esso’s additives plant called Paramins, and this changed his life. He was sent there to learn the ins and outs of batch control.

“It was seen as ‘relegation’ by the continuous control ‘elite,’ ” Wilkins remembers, “but boy, did I have some fun there.”

Wilkins took his new found batch expertise on the road, teaching process automation for KBC Process Automation’s (now Honeywell Process Solutions) batch group for the next three years. He spent 18 months working on a huge batch project for Shell with Foxboro NL, the Dutch subsidiary of Foxboro ([www.foxboro.com](http://www.foxboro.com)), and while there he learned about Easybatch, a Foxboro product far ahead of its time that used subroutines to control operations in the way ISA-88 later used phases. Moving to Honeywell (<http://hpsweb.honeywell.com>), he became involved in creating Modular Batch Automation, which was a forerunner to ISA-88.

“During this period, I became a Honeywell Fellow—a position bestowed on very few people in their organization,” Wilkins said. “In 1993, I was transferred to Honeywell’s EU HQ in Brussels to head a European Batch Center, and while in this position, I attended the inaugural World Batch Forum “Meeting of the Minds” held in Phoenix in mid-1994, which was another event that would eventually be life-changing.”

After a period of time as a global consultant for Honeywell, a short engagement at SimSci just before its acquisition by Siebe, and a stint with his own consulting company, Wilkins bumped into Tom Fisher at the 2000 WBF North American Conference. “Tom Fisher was really the father of ISA-88 and revered in the batch community. I had never met him but he said, ‘so you are Maurice Wilkins! I have read several of your papers on modular batch automation!’ It was one of the most humbling experiences of my life. Following the conference, Tom asked me to join the WBF board, where I eventually became chairman.”

Wilkins cycled back to the end-user side of things next, with a position at Millennium Specialty Chemicals (now part of LyondellBasell, [www.lyondellbasell.com](http://www.lyondellbasell.com)) in Jacksonville, Fla. At the same time, he served as WBF chairman from 2004 to 2009. “I am still the longest-serving chairman,” he said, “having seen the organization get to the brink of extinction, and then with the help of a great board of directors, pull it back to viability once more.”

In 2006, “consulting came calling again,” and Wilkins joined ARC Advisory Group ([www.arcweb.com](http://www.arcweb.com)) as vice president of consulting services. He had always wanted to have an influential position at a DCS vendor, and in 2008 such a position came up at Yokogawa. “I could not say no,” Wilkins says. “I thoroughly enjoy working for Yokogawa and being an internal consultant for the organization.”

In addition to his role at WBF as “Chairman Emeritus,” Wilkins is also co-chair of ISA-101, the HMI standard committee, and he is a member of





## PROCESS AUTOMATION HALL OF FAME

the Standards and Practices board. He is co-managing director of ISA-88 and ISA-95, and was instrumental in the formation of the ISA-106 standard committee for procedural automation. With ISA-88, the issues around the automation of batch processes had been addressed, but although ISA-88 could apply, it had not addressed purely procedural operations in continuous processes—start-ups, shutdowns and grade changes, for example. “So, along with Dave Emerson and Walt Boyes,” Wilkins says, “I did some market research

and found that there was a need for this standard, and we cajoled ISA into launching ISA-106 in April 2010.”

Dr. Wilkins is married to Sara and lives in the Dallas suburb of Allen, Texas. “I have two daughters living in England, and three stepsons living in Belgium—and we also have two of the most adorable dogs in the world, both rescues,” he said. “Sara and I love to run together, and we both enjoy traveling together and eating good food and drinking good wine.”

## THREE VISIONARIES SEE THE FUTURE

“I think that taking the knowledge I received from being involved with and consulting on modular batch automation, ISA-88, WBF and human factors, and applying all of it to the formation of the new ISA-106 standards committee will prove to be my most important contribution to the automation profession,” Wilkins says. “I would also like to think that through my leadership I helped WBF—an organization vital to the batch and procedural automation world—to survive a very difficult period over the recent recession and to be reborn around ISA-106—in addition to its excellent work with ISA-88, ISA-95 and the BatchML and B2MML schemas.”

“I think we still have quite far to go in implementing the advances and developments that have already been made,” Skogestad says. “Even with retuning PID controllers, one can get large improvements in most plants, and if one looks more carefully into controlling the right economic variables—which I call ‘self-optimizing’ variables—then even more can be gained. Thus, I see the need to streamline the theory to make it accessible for engineers.”

He continues, “A fundamental problem is that chemical plants are complex and modeling is costly. This, plus the fact that almost every plant is different, puts limitations on the use of advanced control. Maybe plants should be built to modeling specs, rather than the other way around.”

Wilkins says that he sees a huge growth and diversification in sensor technology as “computing power improves and miniaturizes, and as wireless sensors become more and more ubiquitous.”

“I see a time,” he goes on to say, “when a group of sensors could ‘act’ together to address process issues and prevent process upsets before they even arise. I also see the control room as we know it disappearing, as we move more and more to mobile devices and tablet PCs. And of course, I also see the adoption of ISA-106 influencing the design and operation of procedures in the process industries and helping these industries to retain (and repeat) the knowledge of the retiring workforce.”

John Berra says, “I gave an interview to Walt Boyes [[www.controlglobal.com/multimedia/2010/AutomationPillar1010.html](http://www.controlglobal.com/multimedia/2010/AutomationPillar1010.html)] that touched on some of this. I am a strong believer in wireless and see it playing a more and more important role in the future. My belief is not based just on the wiring savings. Predictive intelligence can make process plants run safer, use less energy and be more productive. Wireless opens many doors to enable better and more comprehensive predictive intelligence.”

Like Skogestad, Berra believes in the power of modeling. “I also see a growing role for simulation,” he said. “Simulation will get better and better, and will move from its largely training role to being a part of the automation system itself. Plants will be modeled, and the models will run faster than real time. It will give engineers a way to run things through the simulator to see what will happen before they actually do things to the process. It will be the ultimate way to conduct safe tweaks to the control scheme without causing upsets. It will also be a big boost to predictive intelligence.”

Berra continues, “Finally, there is another trend underway that I believe will continue. I call it ‘smartening up dumb things.’ For example, if you think about it, operating a process plant is a lot like being asked to play chess blindfolded. You have to make the moves, but you can’t see the board. A lot of what is going on today is about revealing more of the board, and that will certainly continue.”

In addition, all three of this year’s inductees to the Process Automation Hall of Fame believe that strong efforts are necessary to entice young people into the engineering professions as well as process control and automation. Skogestad put it succinctly, “The students do not see challenges in this field. We need to tell them that these exist.” ■

You can read more of the inductees comments on their careers and the future of automation in the process industries online at [www.controlglobal.com/1102\\_coverextra.html](http://www.controlglobal.com/1102_coverextra.html).



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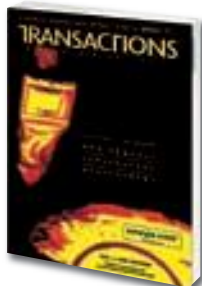
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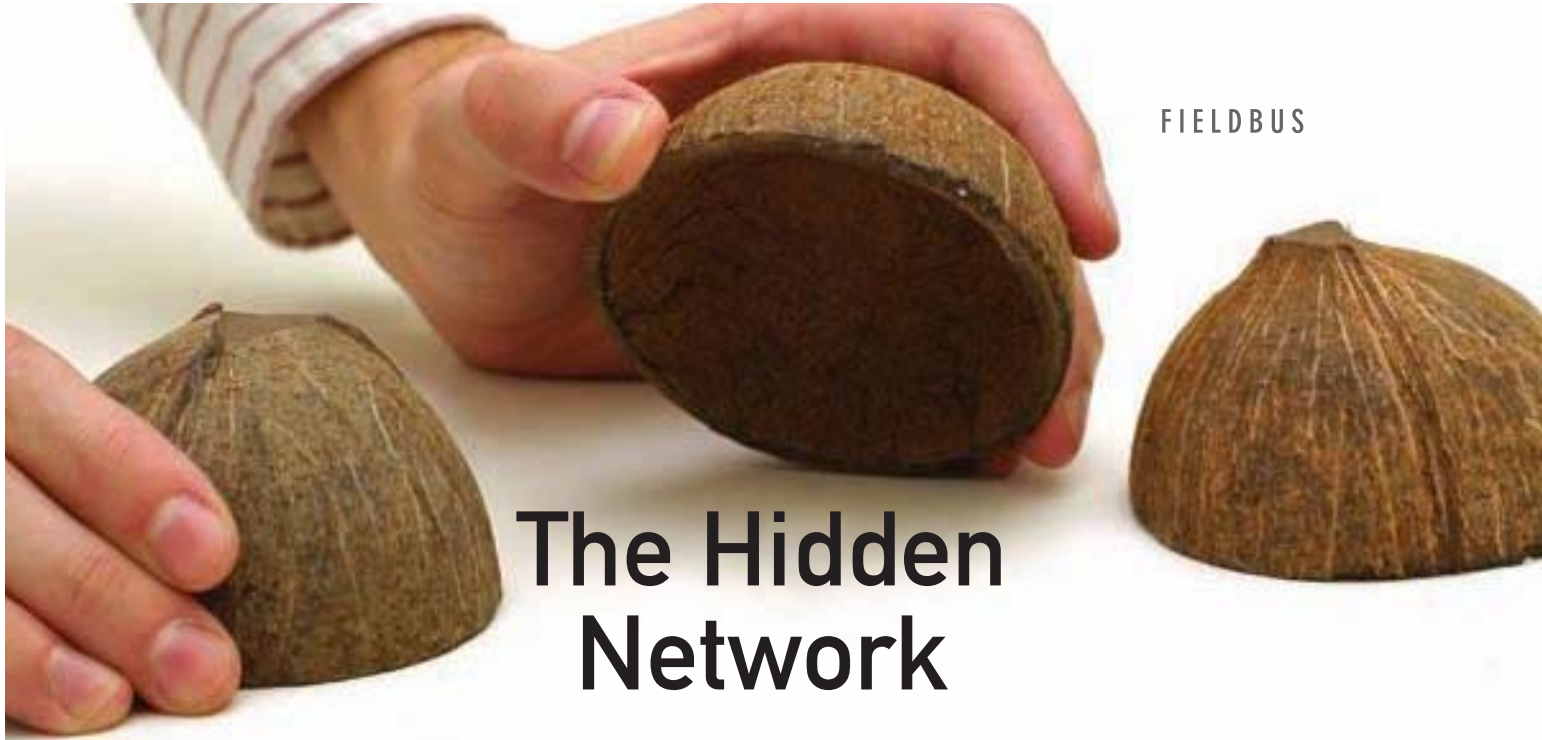
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# The Hidden Network

The “black channel” takes a path through the network “that wasn’t there.”

by Ian Verhappen

Practically all the fieldbus protocols take a “black channel” approach to their safety bus. However, defining a black channel is almost a black channel itself; everyone talks about it and uses it, but descriptions of it are mostly absent.

The name black channel is derived from the concept of a black box. The intent of both a black box and a black channel is that what goes in one end does not “see” anything between the inlet and outlet as it passes through the device. The difference is that, rather than a piece of hardware, it is the network itself that must appear to “not be there.” The bus system, therefore, does not perform any safety-related tasks, but only serves as transmission medium.

Following a white-channel scheme would require that the bus networking and protocol be designed from the ground up for safety. All the network components would have to be safety-related and would need the associated approvals. The black-channel concept uses a non-trusted transmission sys-

tem; the network gear is not safety-related. As a result, the advantage of the black-channel concept is that we can reuse regular network hardware for safety networks without having to modify more than the devices or nodes themselves.

No changes to the physical layers means the safety measures must be added as a safety layer on top of the Open Systems Interconnection (OSI) protocol Layer 7. The new layer is responsible for the transport of safety-relevant data. The remainder of the application layer is responsible for the acquisition and processing of user or process data.

As shown in Figure 1, the black channel uses a safety layer between the communication stack and the application per IEC 62280-1. The safety layer performs safety-related transmission functions, and checks on the communication to ensure that the integrity of the link meets the requirement for SIL 3 continuous, high-demand mode. Though it is an unlikely scenario, it is possible to use the black-channel

| Error  | Measure                           |                                 |                                    |                      |
|--|-----------------------------------|---------------------------------|------------------------------------|----------------------|
|  | Consecutive Number (sign of life) | Time-out (with acknowledgement) | Codename (for sender and receiver) | Data Integrity (CRC) |
| Repetition                                     | X                                 |                                 |                                    |                      |
| Loss   | X                                 | X                               |                                    |                      |
| Insertion                                      | X                                 | X                               | X                                  |                      |
| Incorrect Sequence                             | X                                 |                                 |                                    |                      |
| Data Corruption                                |                                   |                                 |                                    | X                    |
| Delay  |                                   | X                               |                                    |                      |
| Masquerade (standard message mimics fail safe) |                                   | X                               | X                                  | X                    |
| FIFO errors in intermediate routers            |                                   | X <sup>a</sup>                  |                                    |                      |

<sup>a</sup>No acknowledgement from routers (lower levels of OSI Model)

**MEASURES TAKEN TO IDENTIFY COMMUNICATIONS ERRORS**

Table 1. From *The Industrial Communication Technology Handbook*, Richard Zurawski, CRC Press 2005, pp. 28-1-28-19.





## FIELD BUS

concept with some non-safety related devices sitting on the same bus and sharing the communication media so that if somebody accidentally connects a non-safety device to the safety bus, it will not negatively impact the safety operation.


To comply with the relevant safety standards, a safety-bus frame must be passed completely unmodified from a safety sender to a safety receiver, no matter what kind of transmission system both nodes are using. Thus the safety measures are encapsulated in

the communicating end nodes/devices as shown in Figure 2.

This means that none of the error detection mechanisms of the chosen communication technology are taken into account to guarantee the integrity of the transferred process data. Basically there are no restrictions with respect to transmission rate, number of bus devices or transmission technology—as long as the given safety application reaction times can tolerate the additional overhead parameters.

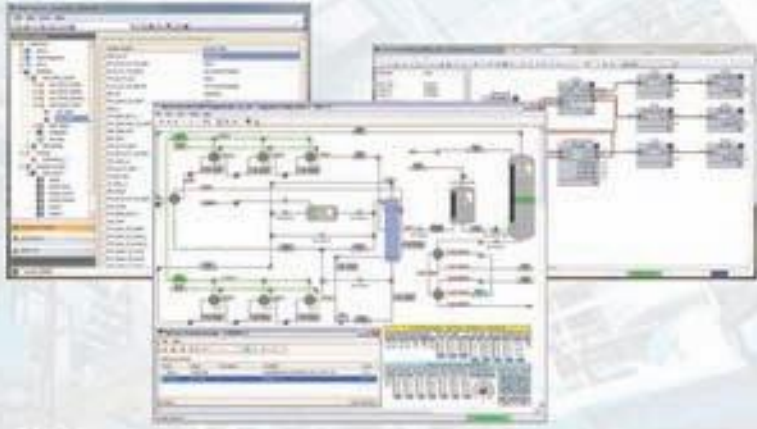
Detecting corrupted data bits through an additional cyclical redundancy check (CRC) plays a key role in meeting safety bus reliability requirements. The necessary probabilistic examination can benefit from the definitions within IEC 61508 that consider the probability of failure of the entire safety function. Because a safety circuit includes all sensors, actuators, transfer elements (this is the safety bus) and logic processes that are involved in the safety function, and the IEC 61508 standard defines overall values for the probability of failure of the system for different safety integrity levels, some fraction, typically 1% to 2%, of the overall SIL rating is assigned to the transfer element, which is the network equipment or black channel. For SIL 3, the probability of failure is  $10^{-7}$ /hour, and if transmission uses 1% of the permissible probability of failure, the probability failure rate for the safety bus system must be  $10^{-9}$ /hour. By selecting appropriate CRC polynomials for the intended frame length, the resulting residual error probabilities of the undetected corrupt data packets are guaranteed to meet or exceed the required limits (in this example  $10^{-9}$ /hour). Therefore, we are no longer depending on the error detection of the standard fieldbus protocol (white channel) because we have added the supplemental checks shown in Table 1.

The measures in Table 1, other than CRC for data integrity, are indicated in the appropriate column check for a range of other types of communication errors that can arise during transmis-




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## FIELDBUS

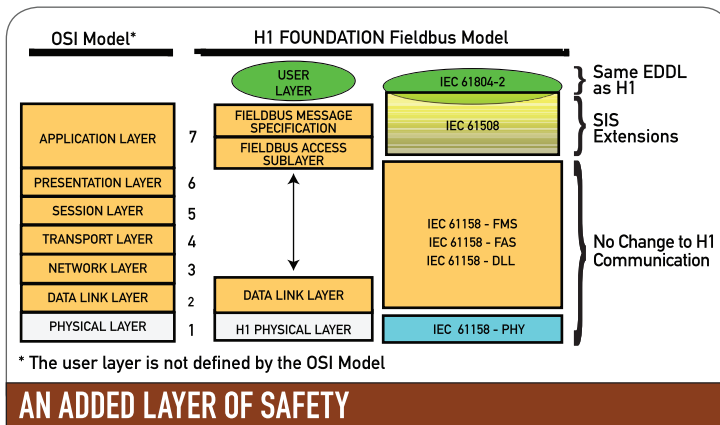


Figure 1. The black channel uses a safety layer between the communication stack and the application.

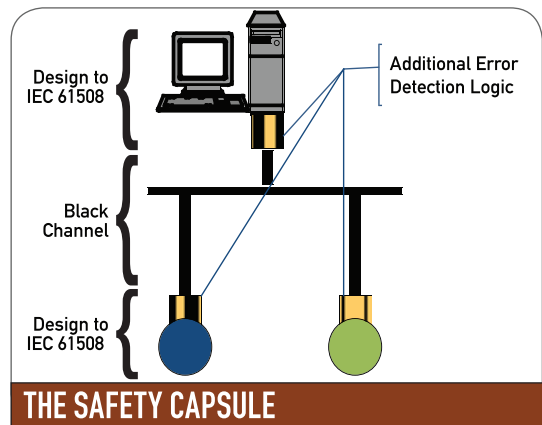


Figure 2. The safety measures are encapsulated in the communicating end nodes/devices as shown.

sion of a message between any two points. Each of these measures, as implied by the short explanation in brackets, provides the following benefit and increase in confidence of the reliability of the transmitted information:

- Consecutive Number – Confirming that the message transmitted is received and reassembled in the proper sequence is important, especially for messages that have more than one route option to get from point A to B.

- Time Out – Many buses have some form of acknowledgement mechanism, however, the majority of the Industrial Ethernet protocols use UDP, which does not support message acknowledgement. Therefore, an independent dedicated tool must be used.

- Codename – This is a way to be sure that messages are transferred between the two end devices/nodes for which they are intended and no others.

Using a safety layer as just described provides the advantage of easy and fast implementation and also allows safety margins to be ideally dimensioned and machine clock rates to be increased to meet the overall system safety/SIL requirements.

The functionality of the safety protocol is not concerned which transport protocol is used, because all safety-related mechanisms are integrated exclusively on the application layer of the protocol, and the safety bus functionality is thereby independent of the underlying transport layer.

The safety bus network does not benefit from any error detection mechanisms of underlying transmission channels, and thus supports the securing of whole communication paths, even backplanes, inside controllers or remote I/O.

Using the black channel approach ensures that the safety quality is independent of the communication channel.

Is the black channel concept really “black magic”? No. At most it is “sleight of hand,” since just like the black box, it moves responsibility for making the “trick” work from the medium or messenger to the parts of the system actually doing the work and having the intelligence to tell the difference. ■

Ian Verhappen, P.Eng., is an ISA Fellow, ISA Certified Automation Professional and an authority on Foundation Fieldbus and industrial communications technologies. His website is [www.industrialautomationnetworks.com](http://www.industrialautomationnetworks.com).

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LEVEL

# The Right Tool for Tricky Measurement Jobs

Gamma nuclear level gauges handle the toughest applications.

by Walt Boyes

Let's say you have a reactor vessel. It is 6 ft. (1.8 m) in diameter, glass-lined, has a big agitator in it, and has both a jacket made of 1-in. (25-mm) copper cooling coils and a 4-in. (100-mm) layer of insulation covered with thin steel lagging. Worse yet, there are no accessible entrances into the top of the vessel that aren't already being used for something. For the process to work, you must measure the level in the vessel with significant precision. You've even tried weigh cells, but there isn't enough precision to just weigh the contents of the reactor, with all that tare weight. Oh yeah, and you can't stop the reactor to modify it, and since it is a glass-lined and code-stamped vessel, you can't drill any holes in it either. What do you do?

Or, suppose you're making glass for a variety of products. The glass is produced by melting silica sand, glass frit from recycled bottles and some trace minerals in a very hot furnace with firebrick walls that are over 1 ft (300 mm) thick. The glass is too hot to pump, so it must flow by gravity down a firebrick-lined channel to where it is cast or molded or extruded. Your requirement is that you have to measure the level of the molten glass and control it to  $\pm 0.0005$  in. ( $\pm 0.013$  mm), or the process doesn't work. Glass castings have holes called holidays in them, and extruded glass, whether tube or sheet, has flaws and holes. What do you do?

You are responsible for the air pollution control system for a very large coal-fired power plant. You have electrostatic precipitators that remove the fly ash from the stack gas before it gets released into the atmosphere, causing international pollution incidents and costing your utility millions in air-pollution-control violation fines. But the hoppers that hold the precipitated fly ash keep plugging up, and fly ash is very hot and also acts like concrete and sticks to everything. You need some way to tell when the hoppers are full, so you can empty and clean them, but





anything you stick into the hopper just gums up and fails so fast that you have given up. What do you do?

Sound familiar? Nearly every plant, from mining to wastewater and every process vertical in between, has a level application that is both critical and difficult, if not impossible, to measure.

### Enter the Gamma Level Gauge

Since the 1950s, the answer to all of these applications has been the proper application of a gamma level gauge. Gamma gauges work based on both the inverse-square law—radiated energy decreases with the square of distance—and the fact that dense materials absorb gamma energy—1 in. (25 mm) of steel, for example, cuts the energy from a gamma beam by 50%.

Very early on, engineers came up with the idea that rising material or liquid would change the amount of energy reaching a detector on the other side of the vessel from an emitting source. In the case of a point level switch measurement (Figure 1), rising material would simply trigger a relay if the energy beam were interrupted. In the case of a continuous level measurement (Figure 2), the rising material would cause a decrease in the intensity of the energy beam reaching the detector that could be calibrated to be proportional to the rise in level, and when the level fell, then the energy would likewise increase.

### Designing to Fit

In order to figure out how much energy will reach the detector, essentially all you have to do is to add up the densities and thicknesses of all the materials between the energy source and the detector, and make the energy beam intense enough to pass

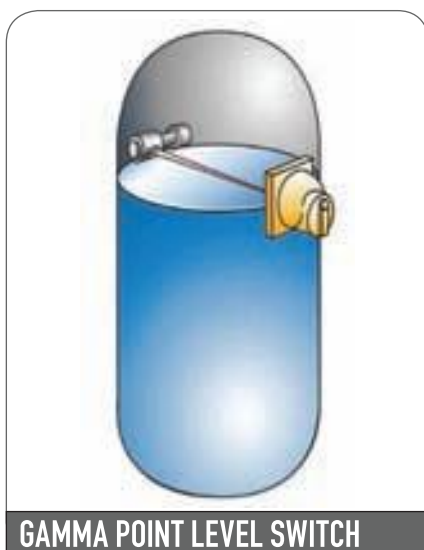
through all that material and reach the detector. Safety requires that the intensity of the energy beam be designed to be as small as possible and still make the measurement.

“Modern detector designs have made it possible to use significantly lower activity sources than in previous years,” says Mick Schwartz, business unit manager of Berthold Technologies USA LLC ([www.berthold.com](http://www.berthold.com)), a manufacturer of gamma level gauging products. “This means that the risk of exposure to gamma energy for personnel is minimized and amenable to proper safety precautions. Gamma energy does not cause any of the measured product or the vessel to become radioactive.”

All manufacturers of gamma level gauges have software that makes the calculation of energy source size straightforward. You or the vendor plug in the numbers for the thicknesses and densities of the material, not forgetting the air gap between the walls of the vessels—air has density, and energy decreases with the square of distance—and the software spits out an optimized energy source size and, in most cases, the appropriate housing design and detector selection.

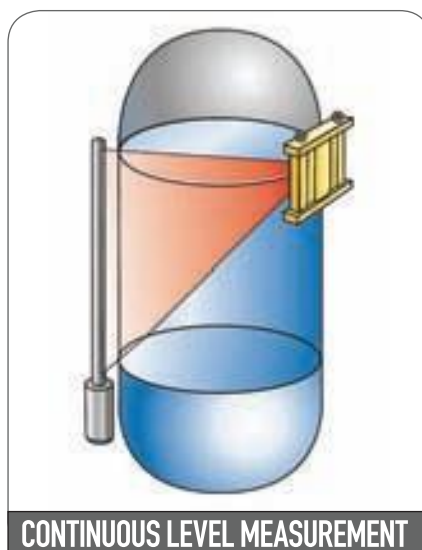
### Gauging in the Real World

So let's look at how to do the level application in the jacketed vessel we talked about earlier. This is not quite as easy as putting a source and a detector across from each other because there are vessel internals, including an agitator, that have to be missed. The way to do this application is to “shoot a chord” of the vessel's diameter—that is, put the source and detector off to one side of the diameter. Because the thicknesses that the energy beam will shoot through will be greater, the source activity that will be required will be greater by some amount than shooting the diameter would be. The blades of the agitator



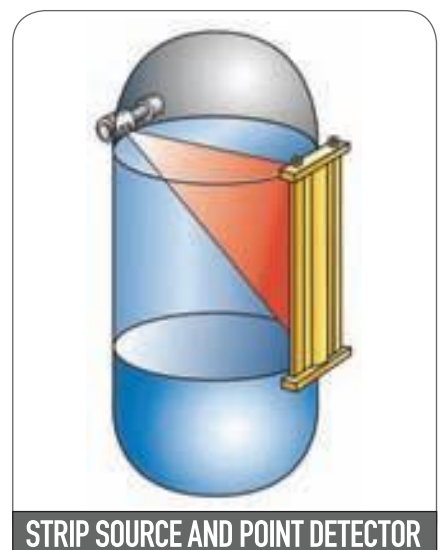
**GAMMA POINT LEVEL SWITCH**

Figure 1. Rising material triggers a relay if the energy beam is interrupted.



**CONTINUOUS LEVEL MEASUREMENT**

Figure 2. Rising material decreases the intensity of the energy beam.



**STRIP SOURCE AND POINT DETECTOR**

Figure 3. Here the apex of the triangle is aimed at the point detector.



## LEVEL



**POINT LEVEL SWITCH IN A HOPPER**  
Figure 4. A narrowly collimated conical beam is aimed across the vessel at the point detector.

need to be considered, and, if possible, eliminated by shooting the chord between the blades and the vessel wall. If that isn't possible, many gamma level gauges can be programmed to ignore the repetitive density fluctuation caused by blades swinging into and out of the beam. It just makes the signal noisy.

Now let's look at the glass level gauge. There's a lot of firebrick on either side of the glass channel, so it may be necessary to drill holes in the firebrick to reduce its thickness. This will cause the temperature on the outside to rise, so the detector must be water-cooled to bring the internal temperature of the electronics down to the normal range.

There are three geometries that can be used in continuous gamma level measurement. The most common is a point source that is collimated to produce a right-triangle-shaped beam with the 90° angle at the top of the detector. Next is a strip source that is characterized to produce a similar shaped beam, but with the apex of the triangle at the point detector (Figure 3). Third, there is the geometry of a strip source and a strip detector. This geometry is often used for highly precise level measurement on small diameter vessels or pieces of pipe, such as vertical risers.

In point level applications (Figure 4), the source produces a narrowly collimated conical beam that is aimed across the vessel at the point detector. In most point level applications, the reason a gamma gauge is being used is because the inner walls of the vessel are subject to vibration, corrosion, abrasion, or fouling or coating with material. Fly ash hoppers are classic examples of this kind of application. The energy activity of the source must be sized, so that the point level gauge continues to work correctly through a reasonable thickness of fouling or coating, perhaps as much as a couple of inches.

### How to Measure a Tank of Tomato Paste

Larry Fontes, maintenance and production supervisor at

Ingomar Packing Co. ([www.ingomarpacking.com](http://www.ingomarpacking.com)) in Los Banos, Calif., uses a gamma level gauge on a very difficult food industry application. "We were using a dual remote diaphragm seal system with chemical T diaphragm seals and a 4-20 mA DC HART transmitter to control a valve, which would control the level in a holding tank," Fontes says. "The holding tank is 38 in. (nominal 1 m) in diameter and about 30 ft (9.1 m) tall. The product inside the tank is tomato paste with a specific gravity of about 1.134 at 210 °F to 215 °F (a little over 100 °C) at a flow rate of approximately 250 gallons per minute."

"After a 100-day processing season," Fontes continues, "the diaphragm seals would become coated due to the temperature of the product, and the level indication would begin to drift as the diaphragm was unable to pick up the change in pressure as the level changed."

Fontes reports that the problem became so severe that product spilled out the vent on top of the tank, while the transmitter reported little or no change in percent level.

Fontes looked into other level technologies, including radar. "I was looking for a level system that wouldn't be affected by the properties of the product due to the thermal processing," he says. "We had used a [gamma] device to measure soluble solids from Berthold Technologies, so I was somewhat familiar with the technology. Berthold worked with the consulting engineer we had contracted for the expansion of our aseptic processing system. [Process Resource Inc.. [www.processresource.com](http://www.processresource.com)]

"Berthold provided onsite start-up and training for myself and several of our operators," Fontes goes on. "The installation was made much easier with the help of all the individuals from Berthold. We operate the gauge under the general license in the Code of Federal Regulations."

And how has it worked out? "Since the installation of the Berthold level gauge (Figure 5) in 2007," Fontes reports, "we have had instances during a couple of processing seasons that would have resulted in the same issues as before. The dual diaphragm system level indication began to drift, while the gamma level gauge remained constant."

Fontes concludes, "The Berthold level gauge in-



**CONTINUOUS LEVEL GAUGE ON TOMATO-FILLED COLUMN**  
Figure 5. During a 100-day processing season, the gamma level gauge remained constant.

## LEVEL

stallation was part of a \$1.3 million expansion to the flash cooler, which is part of our aseptic processing.

### The Business of Using Gamma Level Gauges

Similar to every other device that uses nuclear byproduct material, even the smoke detectors in your house, gamma level gauges are required to be licensed. This means that applications, paperwork and rules have to be known, understood, followed and kept current. However, once you are set up to do this, licensing can be relatively simple and not too onerous.

“Many gamma level gauges can be distributed under the general license in most states in the United States,” says Berthold Technologies’ radiation safety officer (RSO), Mark Morgan, “but the general license does not exist in other countries, and the U.S. NRC plans to do away with it in one to three years anyway, in favor of specific licensing. The NRC plans to make the specific license procedure simpler and more streamlined.”

The general license has less paperwork, but has restrictions on gauge geometry, exposure levels, shielding, and other environmental health and safety issues. The other kind of license, used globally as well as in the United States is called a “specific license.” This means that you, as the gauge owner, are licensed to do several specific things with the gamma level gauge you own.

So what does this mean for operations and maintenance? Maintenance on the electronics, including the detector, can be done by any plant-qualified instrument tech or maintenance tech. No license is required by persons doing that level of maintenance. Since a gamma energy source is basically a steel-jacketed lead box with a capsule the size of a horse-pill inside of it, maintenance on source housings is minimal. A trained, licensed person is required to change the geometry of the gauge or to move it.

And when you aren’t using it anymore, you are required to dispose of it properly—not just send it to a junkyard. Most manufacturers of gamma gauging instruments will accept a returned source, take title to it (so you and your management don’t have to keep track of it forever), and send you a document saying that you are no longer responsible for it.

Knowing these simple rules in advance can mitigate management’s reluctance to undertake a new regulatory duty.

### So There You Have It

Gamma level gauges are a good long-term solution to many of the most difficult level applications you will run into. They will operate with fewer maintenance headaches and, in some cases, operate where nothing else will. ■

Walt Boyes is Control’s editor in chief.

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# Basics of Analyzer Sample Systems, Part 1

Here's how to know your process conditions by calculating dead spaces, system lag time and system pressure drop, simplifying a planned system and picking the right equipment for it.

by IAN VERHAPPEN

If you had to design and install a process analyzer sample system today, how would you do it? First, remember that an analyzer system includes the sample tap, sample system, analyzer, sample return, signal transmission and control system. If any of these components fail, your company won't gain the economic benefits the system was supposed to produce. And don't forget, it's generally accepted that sample systems are victims of the Pareto principle, which is that 20% of a system consumes 80% of the resources because they're responsible for 80% of analyzer system problems.

While the engineer's golden rule of "keep it simple, stupid" (KISS) also applies to sample systems, this time it also stands for: Know your process conditions; Involve the right people; Simplify the system; and Select the right equipment.

## Get the Right People

In addition to process engineers, a project team will involve several other people as well. A likely group will include the following:

**Chemist**—A representative from the laboratory who will not only provide the stream composition but also know the present method of analysis used on the stream.

**Maintenance/Analyzer Technician**—A person, or group of people who must be involved from the beginning, not only to gain a sense of ownership of the process, but also to understand the technology and equipment before it arrives on-site to get commissioned. P

**Project Manager**—A person who coordinates the entire project, gets the funding, arranges for necessary approvals and other important duties as they come up.

## Know the Process Conditions

It's important to understand the process conditions, not only at the sample inlet, but also at the analyzer and all along the sample loop. To do this, three basic calculations must be made: 1) dead spaces; 2) system lag time; and 3) system pressure drop.

Using this information, a phase diagram (Figure 1) should be generated for all sample streams. This diagram represents

how the fraction of liquids, solids and vapors change as a function of pressure and temperature. It is invaluable when trying to determine if there are condensable products in the stream that can later be vaporized as the pressure decreases. This is similar to checking for cavitation in control valve sizing, only in reverse, since rather than looking for vapor in a liquid, one is looking for a momentary liquid phase in a vapor stream. A process or chemical engineer can generate this diagram, along with a range of pressures and temperatures over which the system may be operating, from the stream composition.

## Dead Spaces Often Overlooked

One of the biggest and often overlooked items when designing a sample system is dead spaces or volumes. Dead spaces are parts of the sample system where pockets of fluid can be

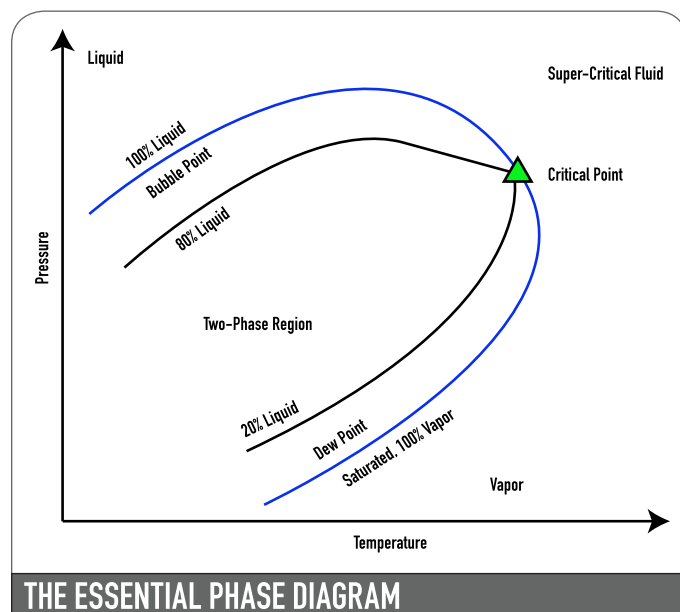


Figure 1. The fraction of liquids, solids and vapors change as a function of pressure and temperature.

## ANALYTICAL INSTRUMENTATION

come trapped and can't move along with the remainder of the sample. Perfect places for dead volumes are tee fittings, separators or any other sharp-edged flow change. To minimize its effect, use the following rules:

- Minimize tee fittings in the system;
- Purge the sample system three times for each analyzer cycle;
- Use the smallest size fittings able to do the job within other constraints;
- Use the minimum number of fittings possible, which reduces dead time and minimizes potential leak or failure points;
- Operate your continuous sample systems in the turbulent flow regime.

For example, the first column of Figure 2 shows a configuration designed to minimize dead volume. The three-way valves eliminate elbows, and when a stream isn't flowing to the analyzer for measurement, it's still flowing to a vent or sample return point, ensuring a continuously fresh sample at every point in the system. The second two columns show the configuration when streams AX-1A and AX-1B, respectively, are being analyzed.

### Lag Time Depends on Velocity and Volume

The second item to consider and one of the first things to calculate is the system lag time. System lag time is the sum of the analyzer cycle/measurement time and the sample lag time. Meanwhile, sample lag time is the amount of time it

takes for the sample to travel from the sample point to the analyzer sensor. It's simply the volume of the sample system divided by the velocity of the flow and can be calculated using Equation 1.

$$t = \frac{V \times L \times P_a \times Z}{F_s \times T_a}$$

Where:

$t$  = time

$V$  = sample system volume

$L$  = distance from the sample point to the analyzer sensor

$P_a$  = absolute pressure

$Z$  = compressibility factor

$F_s$  = flow rate under standard conditions

$T_a$  = absolute temperature

### Compressibility Is a Factor for Gases at Higher System Pressures

For liquids, compressibility is negligible and the compressibility factor is  $Z = 1.0$ . However, in gas systems operating at more than about 35 to 50 psia, compressibility must be considered. For gases, compressibility changes as a function of pressure and temperature according to the rules of the ideal gas law, as shown in Equation 2

$$Z = \frac{P_a V}{nRT_a}$$

Where:

$Z$  = compressibility factor

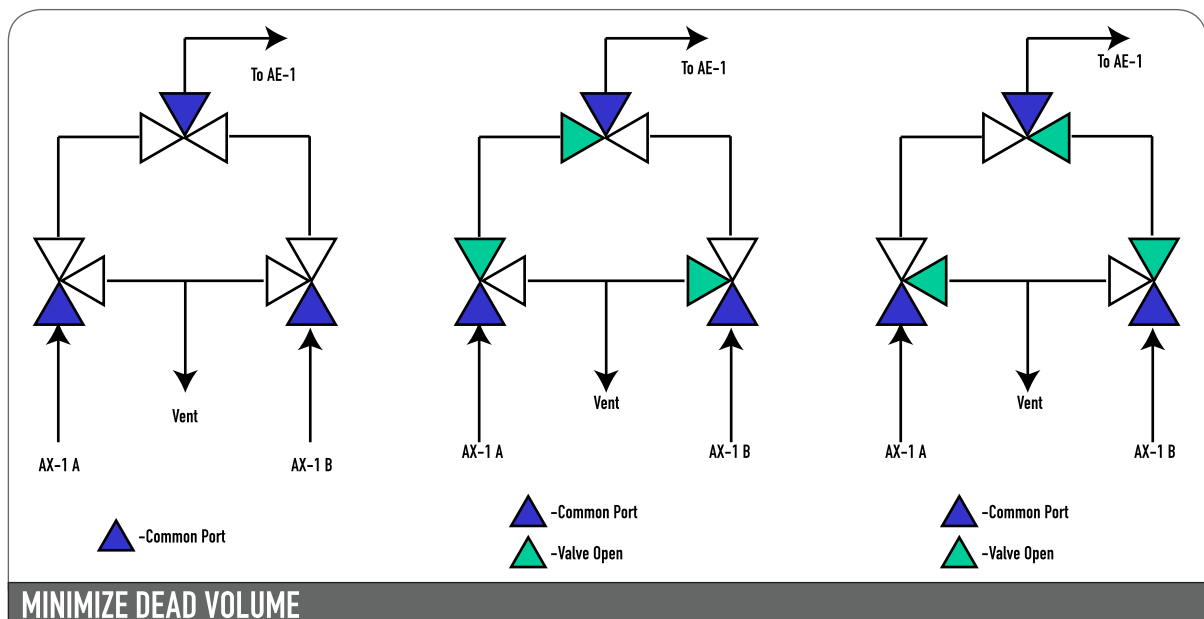


Figure 2. Analyzer systems should be designed to so that a fresh sample is available at every point. Careful arrangement of three-way valves and vents can ensure this.



## ANALYTICAL INSTRUMENTATION

$P_a$  = absolute pressure  
 $V$  = volume  
 $n$  = moles of fluid  
 $R$  = gas constant  
 $T_a$  = absolute temperature

The compressibility factor  $Z$  can be determined from compressibility charts and the associated reduced temperature  $T_r$  and reduced pressure  $P_r$ .

The reduced temperature and pressure are calculated as follows:

$$T_r = T_a/T_c$$

$$P_r = P_a/P_c$$

Where:

$T_c = y_1T_{c1} + y_2T_{c2} + y_3T_{c3} \dots$  ( $y_x$  is the mole fraction and  $T_{cx}$  is the critical temperature of component  $x$ )

$P_c = y_1P_{c1} + y_2P_{c2} + y_3P_{c3} \dots$  ( $y_x$  is the mole fraction and  $P_{cx}$  is the critical pressure of component  $x$ )

In addition, don't forget that the ideal gas law uses absolute pressures ( $P_a$ ) and temperatures ( $T_a$ ), so calculations must be done in psia or kPa (abs) and degree Rankine ( $R = F + 460$ ) or degrees Kelvin ( $K = C + 273.15$ ). Also, by combining and rearranging Equation 2 at two conditions and neglecting  $n$ , which remains constant, it is also possible to estimate the effect of pressure or temperature on volume.

$$\frac{Z_2}{Z_1} = \frac{P_2V_2T_1}{P_1V_1T_2}$$

Thus,

$$\frac{V_2}{V_1} \approx \frac{P_1}{P_2}$$

$$\frac{V_2}{V_1} \approx \frac{T_2}{T_1}$$

Where:

Subscript 1 refers to the inlet condition  
 Subscript 2 refers to the outlet condition.

### Calculate Sample Flow

If you have a certain size and length of line and want to figure out an appropriate sample flow rate ( $F_s$ ), at standard conditions, rearrange Equation 1 as shown in Equation 3

$$F_s = \frac{V \times L \times P \times Z}{t \times T}$$

Once you know the volumetric sample flow rate ( $F_s$  in

liters/min), you can determine the velocity ( $v$  in ft/sec) of a stream using Equation 4.

$$v = \frac{F_s \times 0.1079}{D^2}$$

Where:

$F_s$  = volumetric sample flow rate (liters/min)

0.1079 = a conversion factor to get the final result into ft/sec

$D$  = internal pipe diameter (inches).

As a general rule of thumb, the sample system velocity should be in the range of 1 to 2 m/s (3 to 6 ft/sec) to ensure that any components in the sample are carried along with the sample proper and do not drop out of solution.

### System Pressure Drop Depends on Velocity

The pressure drop in the system can be calculated using the sample system velocity calculated in Equation 4. This is not as difficult as it sounds, although it is important. Often the hardest part of the exercise is getting an estimate of the stream properties. The equation for pressure drop per 100 feet of tubing is shown in Equation 5.

$$\Delta P_{100} = \frac{0.13 \times f \times \rho \times v^2}{D}$$

Where:

$\Delta P_{100}$  = pressure drop per 100 feet of tubing (psi)

$f_d$  = Darcy Friction Factor

$\rho$  = density (lb/ft<sup>3</sup>)

$v$  = velocity (ft/s)

$D$  = pipe diameter (inches)

To calculate the Darcy friction factor ( $f_d$ ) we need to calculate the Reynold's number, as shown in Equation 6.

$$Re = \frac{\rho D v}{\mu}$$

Where:

$Re$  = Reynolds number

$\rho$  = density

$v$  = velocity

$\mu$  = viscosity

[Editor's note: There are two ways to calculate the Darcy friction factor, and they will lead off Part 2, which will run in the August 2011 issue of Control. To view both parts now, go to [www.controlglobal.com/samplesystems](http://www.controlglobal.com/samplesystems).] ■

Ian Verhappen is an ISA Fellow, a CAP and principal at Industrial Automation Networks ([www.industrialautomationnetworks.com](http://www.industrialautomationnetworks.com)).



## More on BP Oil Spill; Restriction Orifice Sizing

"Ask the Experts" is moderated by Béla Lipták, process control consultant (<http://belaliptakpe.com>) and editor of the *Instrument Engineers' Handbook* (IEH). He is recruiting contributors for the 5th edition of the IEH. If you would like to contribute by updating an existing or preparing a new chapter, or if you have questions for our team of experts, please write to [liptakbela@aol.com](mailto:liptakbela@aol.com).

**Q** In the August 2010 issue ([www.controlglobal.com/articles/2010/OilBlowouts1008.html](http://www.controlglobal.com/articles/2010/OilBlowouts1008.html)), you described how the BP blowout could have been prevented by correctly designed controls. My question is this: Once the blowout started, could properly designed safety controls have prevented the loss of the 11 lives?

HAROLD CROWNEY  
HCrowney@aol.com

| CONDITION  | ACTUAL RESPONSE   | CORRECT RESPONSE  |
|--|---|---|
| Violent Pressure "kicks"   | Rig was shut down for 9 days, yet the blowout preventer (BOP) was not tested or inspected because testing is "expensive." | Immediately do maintenance inspection of BOP  |
| Well is tested to see if it is leaking or properly plugged.          | Replacing heavy mud with light sea water above plug—"daring the well to blow."  | Compare the lifting force to weight of mud column before its replacement with sea water.                  |
| If blowout is detected or observed. . .                              | Close BOP. This too was under MANUAL control.   | <b>AUTOMATICALLY</b> close BOP. If it does not close in 2 minutes, activate hydraulic shear button (HAS). |
| BOP did not close after 2 minutes from activation or any time later. | None. The HAS was not pressed. Another MANUAL operation.  | <b>AUTOMATICALLY</b> activate HAS immediately   |
| Neither BOP nor HAS operates.  | None. Initiation of emergency system (ES) required MANUAL operation of 30 buttons.  | <b>AUTOMATICALLY</b> activate ES immediately.   |
| Hydrocarbon gas detected by many sensors.                            | None. Even sparking electrical equipment, engines, motors, fans and generators were kept running in MANUAL.               | Presence of flammables should have <b>AUTOMATICALLY</b> caused shutdown of all sparking equipment.        |
| BOP has failed, and fire is observed on deck.                        | Did not actuate general master alarm (GPA); another MANUAL operation.   | <b>AUTOMATICALLY</b> initiate "abandon rig" GPA alarm.  |
| Fire is spreading on deck and explosions are heard.                  | None. Did not activate emergency disconnect (EDS), which was also a MANUAL operation.                                     | <b>AUTOMATICALLY</b> activate EDS to disconnect the rig from the BOP and the well.                        |

### WHAT WENT WRONG AT DEEPWATER HORIZON

Table 1: The correct responses should be specified in a new national standard for undersea drilling.

**A** The absolute minimum safety requirement in any industrial application is to detect the presence of flammable gases and **automatically** shut down all ignition sources, including electric devices if they are present. Flammables or smoke should be detected by multiple sensors configured in redundant or voting systems. All safety devices should also be tested quarterly.

In case of the BP rig, neither the regular nor the safety controls were properly designed or maintained. As I wrote in August, the BP operators first injected foam cement into the well to plug it, and because they knew the integrity of the cement job was questionable (the cement was unstable), they checked if the plug would hold by using the "let us see if it blows" method. In other words, they reduced the force (the weight of the column of heavy mud) holding down the cement plug by replacing the mud with a column of light sea water to see if it still held. It did not.

Once the well started to blow, the emergency safety responses were even worse because there was no automatic response at all. It was left to the operators to manually activate the blowout preventer (which did not work, because it was neither tested nor maintained). They also had to manually shut down all ignition sources, including sparking electrical equipment when the presence of flammable vapors was detected. Even after the operators smelled the gas, these potential ignition sources were kept in operation.

In addition, even if the operators attempted to activate the shutdown controls, it would have required the operation of 30 switches and buttons to do so. Similarly, it was left to them to manually activate the switch that would have disconnected the rig from the well so that it could move away. Finally, even after the explosions and fire, the "abandon rig" alarm was still not activated because it too had to be manually activated. In short, lives were lost because the safety controls were badly designed and because they were operated under manual control.

The lesson to be learned is that all life-protection safety controls should be fully automatic. This is an absolute requirement, because if their activation is left to panic-stricken and poorly trained operators carrying out vague instructions, such accidents are unavoidable. The argument that false alarms due to sensor failure can be expensive is no excuse. The answer to such arguments is to select reliable sensors, use them in a redundant or voting configuration, and properly maintain them.

Therefore, it is not the operators who should be held responsible, but the designers of the control systems and the inspectors whose job should have been to check the design and operation of the safety systems. Naturally, the ultimate responsibility falls on the owners, who considered cost and schedule to be more important than safety.

The lesson to be learned from this disaster is that the entire deep sea drilling industry should be regulated and be forced to live up to the requirements of a predetermined minimum safety standard which includes the requirement that all life safety systems must be completely automatic (see Table 1). Process control engineers and the ISA should play a major role in developing the required safety standards.

**BÉLA LIPTÁK**  
liptakbela@aol.com

**Q** What are the globally accepted standards and formulas used for sizing restriction orifices. I understand that there is some formula in the Miller's handbook. Is this the only method?

**DEEPESH GOVINDANKUTTY**  
DeepeshGovindan.Kutty@maerskoil.com

**A** The restriction orifice is just another orifice which is installed not to measure, but to limit the flow (see chapter 2.15 of the *Instrument Engineers' Handbook*). In the case of gas flow, as long as the pressure upstream of the orifice is more than twice the pressure downstream of the orifice, the gas flow through the orifice will be "choked," and the gas will flow at ultrasonic velocity.

Under choked flow conditions, the flow through an orifice is proportional to the upstream pressure. It should be understood that choked flow limits only the velocity. Therefore, if the upstream gas pressure increases, the density of the gas also increases; and, therefore, the mass flow rate also increases. If you know the up- and downstream pressures and the properties of the gas, you can calculate the area of the restriction ( $A$ ) for any discharge coefficient ( $C$ ) or if  $(A)/C$  is known, you can calculate the flow by using the equation below:

Mass flow,  $kg/s =$

$$C A \sqrt{k \rho P \left( \frac{2}{k+1} \right)^{(k+1)/(k-1)}}$$

$C$  = discharge coefficient, dimensionless

$A$  = discharge hole cross-sectional area,  $m^2$

$k$  =  $cp/cv$  of the gas

$\rho$  = real gas density at  $P$  and  $T$ ,  $kg/m^3$

$P$  = absolute upstream pressure of the gas,  $Pa$ .

**BÉLA LIPTÁK**  
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**A** ISO 5167, Part 3, is the international standard for orifice plates. It can be found at <http://tinyurl.com/4w3s23o>.

**JIM CHRISTENSEN**  
james\_h\_christensen@hotmail.com

**Q** I would like to know if a new version of ANSI/ISA - 5.01.01, containing the primary element symbols that are shown in 4th edition of Volume 1 of the *Instrument Engineers' Handbook*, on page 24, is already available.

**OSMEL REYES**  
osmel.reyes@gmail.com

**A** ISA 5.1 was released in the fall of 2009.

**IAN VERHAPPEN**  
iverhappen@gmail.com

**A** No, the 5th edition of the *Instrument Engineers' Handbook* has not been published yet. The 2009 edition of ISA's "Instrument Symbols and Identification" (ANSI/ISA-5.1-2009) is available and costs \$120 to ISA members and \$145 to non-members. It can be ordered at <http://tinyurl.com/4aytp8j>. The minor changes that have been made to flow symbols in the 2009 edition are described in Mr. Jamieson's answer.

**BÉLA LIPTÁK**  
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**A** I was the co-author of Chapter 1.1 of the IEH with Alberto Rohr, and also have been active on the ISA-5.1 subcommittee for Instrumentation Symbols and Identification for more than 10 years. It took many years to get the latest version approved (ANSI/ISA-5.1-2009).

As to changes made in the 2009 edition concerning the primary flow element symbols, we now have 31 instead of 22 in the previous edition. One difference is that the connecting pipeline symbols in and out of the flow element are not shown. As to changes to the previous 22 symbols, only two minor changes were made. One change involves the sonic flowmeters, which in the 2009 issue are shown as a rectangle with a single vertical backwards "S" inside it. The other change is in the symbol for variable area flowmeters, which now is a vertical rectangle with a "float" symbol inside it.

The rest of the flow symbols in the 4th edition of the IEH are correct, except that some have a second or alternate symbol in the ANSI/ISA-5.1-2009 version.

**J.E. (JIM) JAMISON, P.ENG., PE**  
Jim.Jamison@Encana.com

## HMIs Are Everywhere

Find them in the “cloud,” on the plant floor, on your smart phone, just about anywhere.

### TOUCHSCREEN HMI

The PPC-157T, an Intel Core2 Duo processor-based 15-in. panel PC with touchscreen, is designed for high performance and multiple communication interfaces. Built-in expansion slots include PCIe, Mini PCIe, and Mini PCI. It has dual gigabit Ethernet connectors and is tested to 1G for vibration and 0 °C to 50 °C for operating temperature.

**Advantech**  
949/789-7178; [www.advantech.com](http://www.advantech.com).



### INTRINSICALLY SAFE HMIs

Simatic HMI Panel PC Ex and Simatic HMI Thin Client Ex are designed for hazardous zones 1/21 and 2/22 and eliminate the need for complex and expensive enclosures or additional certification. Both are offered in 15-in. and 19-in. touchscreen models with eight built-in function keys. Both are suitable for applications where ignitable gases, vapors and air/dust mixtures are present.

**Siemens**  
800/241-4453; [www.usa.siemens.com/automation](http://www.usa.siemens.com/automation)



### HIGH RELIABILITY AT SEA LEVEL

Sealevel's SeaPAC touchscreen flat panel systems offer solid-state operation, versatile I/O selection, including 10/100Base-T Ethernet, two serial ports, bright TFT LCD panels, three high-speed USB 2.0 ports, a wide temperature range, and shock and vibration tolerance. They are available in display sizes from 6.4 in. to 17 in. Since the system contains no moving parts, it offers unmatched reliability.

**Sealevel Systems Inc.**  
864/843-4343; [www.sealevel.com](http://www.sealevel.com)



### TINY TOUCHSCREEN

The C-more Micro-Graphic family of operator interfaces now offers a 4-in. TFT color touchscreen HMI panel with a 320 x 240 dot display and 32,768 colors. It is equipped with a standard Type B USB programming port, a serial communications port and five function keys with LED indicators. The unit offers 3.2 kB memory, LED backlight, multistate bitmap support and Windows font support.

**Automation Direct**  
770/889-2858; [www.automationdirect.com/C-more-micro](http://www.automationdirect.com/C-more-micro)



### HMI FOR HARSH ENVIRONMENTS

The new Panel PC 725 is a robust HMI solution for use directly on the machine. Installation on a support arm system permits a flexible mounting position and ergonomic operation, even in tight spaces. With IP65 protection, the housing holds up well in harsh environmental conditions. Equipped with an Intel Atom N270 processor, it works for all standard PC applications.

**B&R Industrial Automation**  
770/772-0400; [br-automation.com](http://br-automation.com)



### SMART AND NO MOVING PARTS

The Magelis Smart+ is the first industrial PC with Windows XP Pro that requires no maintenance and contains no rotating parts. It has a 15-in. Type 4X (IP65) touchscreen, an Intel Celeron M 1 GHz processor, 1 GB of RAM and two Ethernet ports. It has been certified to UL 508 for industrial control equipment, UL and ATEX for hazardous locations and marine.

**Schneider Electric**  
888/778-2733; [www.schneider-electric.us/go/HMI](http://www.schneider-electric.us/go/HMI)



**UPGRADED VIEWS**

Allen Bradley's PanelView Plus 6 HMI terminal includes more memory with faster refresh rates. It includes the latest FactoryTalk View Machine Edition (ME) and FactoryTalk ViewPoint software running on Windows CE 6.0, providing it with design enhancements, including a new extensive graphics library, enhanced color animation capability and access to a multi-language font library  
**Rockwell Automation**  
[www.ab.com/eoi/](http://www.ab.com/eoi/)



**BIG SCREEN HMI**

Beckhoff Automation's Control Panel and Panel PC series have 24-in. TFT displays. Models CP6204 and CP7204 come with integrated CPUs for IPC, automation, PLC and motion control tasks. Models CP6904 and CP7904 are "display-only." The CP7xxx series offers all-round IP-65 protection. The housings of the built-in CP6xxx P series have protection class IP 20 at the back and IP 65 at the front.  
**Beckhoff Automation**  
[www.beckhoff.com/controlpanel](http://www.beckhoff.com/controlpanel)



**NO FAILURES TO COMMUNICATE**

The G3 Series operator interface family is now available with the new Ethernet expansion card, G3ENET. Now users can add a second Ethernet port to increase bandwidth and separate networks. HMIs with the G3ENET card can communicate with devices on two Ethernet networks simultaneously—without an industrial router. It can be fitted to any G3 series HMI with a single Ethernet port.  
**Red Lion Controls, Inc.**  
 717/767-6511; [www.redlion.net](http://www.redlion.net)



**HMI IN THE CLOUDS**

GoToMyHMI cloud-based SaaS service enables HMI monitoring and control access from iPads, iPhones, smart phones and laptops. Its 256-bit encryption technology provides secure access to HMI information from anywhere. Users can choose among three levels of HMI screen monitoring, alarm notification and remote control service for as little as \$50 per month.  
**Software Horizons**  
 978/670-8700; [www.gotomyhmi.com](http://www.gotomyhmi.com)



**CLEAR SCADA**

ClearSCADA 2010 provides remote control and telemetry, enhanced connectivity to modern databases, improved security and enhanced alarm handling. It offers Windows authentication, allowing for centralized management of passwords and disabled user accounts, and it has consequential alarms and enhanced support for alarm filtering, reducing operation and maintenance costs.  
**Control Microsystems**  
 888/267-2232; [www.controlmicrosystems.com](http://www.controlmicrosystems.com)



**iHMI**

The ProSoft i-View application transforms iPhone, iPad and iPod Touch devices into mobile human machine interfaces using ProSoft Technology's 802.11 industrial wireless or cellular solutions. It enables real-time remote process control. The app creates a secure cellular or 802.11 interface between the iPhone/iPad/iPod touch devices and the control system. Download the app directly from iTunes.  
**ProSoft Technology**  
 661/716-5100; [www.prosoft-technology.com](http://www.prosoft-technology.com)



**TOUGH GUY**

The 4823CX Series PC has a 15-in., LED backlit LCD, glass-on-glass resistive touchscreen and can endure extreme temperatures. Other features include a low-power Intel Atom processor, optional Bluetooth, GPS, speakers, camera, microphone, WiFi antenna, battery and charger. It is rated NEMA 4X and FM-Approved pending Division 2 and Zone 2 ATEX rating.



**Daisy Data Displays**  
717/932-9999; [www.d3inc.net](http://www.d3inc.net)

**Compact HMI**

The AGP4100 Series Compact HMI has six models of 3.4-in. touchscreen-equipped operator interfaces. It offers full graphic touchscreen interfaces at text display prices, and uses a full range of features such as switches, lamps, graphs, alarm display, security and visibility animation to provide clear application feedback to the operator. PLC, servo, temperature and robot controller drivers are available.



**Pro-face America**  
847/296-2009; [www.profaceamerica.com/AGP4100](http://www.profaceamerica.com/AGP4100)

**TOUCHSCREEN SOFTWARE**

Automation Organizer is a software suite that combines IDEC's PLC WindLDR and OI WindO/I-NV2 software with new system configuration software (WindCFG), giving users a powerful and easy-to-use tool to design, debug and document control systems. WindLDR and WindO/I-NV2 have new graphic user interfaces and a total redesign of the menu icons. A free 30-day demo is available.



**IDEC**  
800/262-IDEC (4332); [www.idec.com/software](http://www.idec.com/software).

**WIDESCREEN HMI**

Phoenix Contact has added 16:9 widescreen options to its WP series of HMI panels, providing up to 40 percent more visualization space than 4:3 aspect ratio panels. The panels have 800-by-480 pixel native resolution. Available in 7-in., 9-in. or 12-in. screen sizes, the panels feature a color TFT touchscreen and an integrated micro-browser. It can connect via Ethernet to ILC 100 or 300 controllers.



**Phoenix Contact**  
800/322-3225; [www.phoenixcontact.com/usa\\_home](http://www.phoenixcontact.com/usa_home)

**APPROVED AND CERTIFIED HMI**

The VisuNet HMI system is now available with IEC approval. All VisuNet components can be used in environments that correspond to Zone 1 (gas) and Zone 21 (dust) as specified in the IEC standard (touch screens: Zone 22, dust). The system is also ATEX-, NEPSI-, EOST R- and Gosgortehnazor-certified for use in China and Russia.



**Pepperl+Fuchs**  
330/486-0002; [www.pepperl-fuchs.us](http://www.pepperl-fuchs.us).

**ON DISPLAY**

Opto 22's PAC display is an HMI development application used to create graphical interfaces that mimic a process. It offers support for alarm management, recipe handling, operator logging, real-time and historical trending, multimedia and unlimited tags. This functionality puts PAC Display on a par with HMI development applications costing thousands of dollars more per seat.



**Opto 22**  
951/695-3010; [www.opto22.com](http://www.opto22.com)



**LOW-COST TEMPERATURE TRANSMITTER**

Acromag's Model ST131 is an ASIC-driven RTD signal conditioner that combines the simplicity of a digital USB setup and calibration interface with the performance advantages of analog signal conditioning. Selling for just \$89 with free Windows configuration software, this DIN Form B head-mount instrument converts the input signal from any 100-ohm platinum RTD sensor to a loop-powered 4-20mA output.



**Acromag**  
248/295-0880; [www.acromag.com](http://www.acromag.com).

**PORTABLE PLOTTER**

The MCP Basic Plotter complements the MultiCard identification markers for terminal blocks, wires, cables and other electrical equipment. It is compatible with MultiCard marker formats and works with Weidmuller's M-Print Pro software. Lighter and smaller than the MCP Plus, it comes with a travel case for easy transport and storage, making it an ideal choice for customers with low volume or on-site printing requirements.



**Weidmuller**  
800/849-9343; [www.weidmuller.com](http://www.weidmuller.com)

**COMPACT CORIOLIS FLOWMETER**

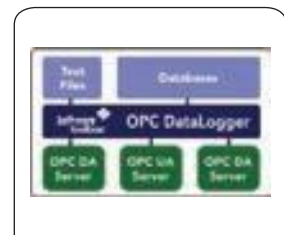
The Cubemass Coriolis flowmeter is a small, lightweight, flowmeter that is ideal for installation in spraying or coating equipment, engine test stands and process skids. It measures mass flow, volumetric flow, temperature and density in a single unit and communicates to controllers via pulse, frequency, 4-20mA current with HART and Modbus RS485. It is available in four pipe sizes, from 1/24-in. to 1/4-in. (DIN 1 to DIN 6). It has ATEX, IECEx, NEPSI, NEC/CEC and TIIIS approvals.



**Endress + Hauser**  
317/535-1329; [www.us.endress.com](http://www.us.endress.com)

**OPC-UA DATA LOGGER**

Software Toolbox's newest version of the OPC Data Logger includes support for OPC-UA connectivity. This expands the options for OPC Data Logger connectivity, enabling it to connect securely to OPC data sources with the latest standards. Wizard-driven configuration dialogs make setup and customization quick and easy. It is designed for applications where a full-featured historian isn't required or practical.



**Software Toolbox**  
888/665-3678; [www.softwaretoolbox.com](http://www.softwaretoolbox.com)

**SOLID LIGHTING**

The UPA-130S model provides solid-on LED lighting and alert capabilities for applications requiring enhanced NFPA70E and OSHA safety compliance. It pre-verifies electrical isolation from outside the control panel before its re-verification with a meter. The series operates over a standard range of 40 VAC to 750 VAC (30 VDC to 1000 VDC) line-to-line or ground-to-ground, is phase insensitive and offers high surge immunity protection.



**Marsh Bellofram**  
304/387-1200; [www.marshbellofram.com](http://www.marshbellofram.com).

**UNIVERSAL USB CONTROLLER**

IO-Warrior56 is a universal USB controller that allows easy access to input or output functions via a USB bus. Featuring 50 generic I/O lines, IO-Warrior56 is also an I2C/SPI master, allowing interface with a wide range of available ICs. It has a full-speed USB 2.0-compliant interface, 50 general-purpose I/O pins, 1000-Hz rate (input or output) and a SPI master interface, up to 12 MBit/sec, throughput up to 62 Kbytes/sec. It operates at temperatures between -40 °C and +85 °C.



**Saelig**  
585/385-1750; [www.saelig.com](http://www.saelig.com)

**WAFER-CONE FLOWMETER**

McCrometer's advanced Wafer-Cone Flowmeter is ideal for gas or liquid service in line sizes from 1 in. to 6 in. Space-saving and field-proven, it can be installed virtually anywhere in a piping system or be easily retrofit into an existing piping layout, resulting in significant installation flexibility and initial cost savings. It is also ideal for other applications, including natural gas wellheads, burners or ovens, cooling systems, HVAC and more.



**McCrometer**  
800/220-2279; [www.mccrometer.com](http://www.mccrometer.com)

**ANTI-FOULING TRANSDUCER**

The KPSI Series 705 level transducer has a double thickness of Teflon on its sensing area to further reduce material penetrating the diaphragm. The non-fouling submersible hydrostatic level transducer is ideal for use in highly viscous applications, including lift stations, slurry and pump control. It is available in custom level ranges from 6 ft, H<sub>2</sub>O to 115 ft, H<sub>2</sub>O, with analog outputs of 4 mA to 20 mA, or 0 VDC to 5 VDC.



**Pressure Systems**  
800/328-3665; [www.pressuresystems.com](http://www.pressuresystems.com)

**CONNECT AND DONE I/O**

The G10 family of Ultra-Compact I/O modules with Connect & Done technology can eliminate mounting requirements in many applications. The world's smallest AS-Interface I/O module with IP68/69K protection, at just 40 mm x 27 mm x 22 mm, the G10 fits easily into any cable duct and enables quick, convenient sensor connections using the integrated M12 pigtailed. All versions are equipped with bright diagnostic and status LEDs that are visible from all directions.



**Pepperl + Fuchs**  
330/486-0001; [www.pepperl-fuchs.us](http://www.pepperl-fuchs.us)

**BANSHEE PROTECTION**

The Banshee343 ultrasonic gas leak detector provides wide-area gas detection (toxic and/or combustible) coverage in any hazardous-area application where pressurized gas is present—regardless of environmental conditions. It only triggers an alarm when inaudible, ultrasound—only produced with the release of highly pressurized gas—is detected. The analog, relay or modbus outputs can communicate directly with any existing plant control system.



**Net Safety Monitoring**  
[www.net-safety.com](http://www.net-safety.com).

**TWO-WIRE MAGNETIC FLOWMETER**

The ADMAG AXR is the world's first two-wire magnetic flowmeter employing the "dual frequency excitation" method which cancels process-generated noise without sacrificing response time. It can be installed in a loop-powered system, eliminating the need for a second conduit run, extra wiring, a separate power supply and additional engineering, drastically reducing the meter's installed cost. It has a full dot-matrix LCD display, an electrode adhesion level diagnosis function and multi-lingual capabilities.



**Yokogawa**  
800/888-6400; [www.admagxf.com](http://www.admagxf.com)

**CERTIFIED PRESSURE TRANSMITTERS**

Winters Instruments' newest line of industrial pressure transmitters come with CSA, CE, RoHS and ATEX worldwide certifications and feature all stainless steel construction and ceramic sensors, ensuring a compact yet robust level of performance. They are available in vacuum to 10,000 psi pressure ranges and have 0.25% and 0.5% accuracy ratings, in 2- and 3-wire output configurations and a wide range of mechanical and electrical connections.



**Winters Instruments**  
800/WINTERS; [www.winters.com](http://www.winters.com)



## Operators Unleashed

Greg McMillan and Stan Weiner bring their wits and more than 66 years of process control experience to bear on your questions, comments, and problems.

Write to them at [controltalk@putman.net](mailto:controltalk@putman.net).

**Stan:** The operator is the most underutilized resource in the plant. I think most operators would appreciate a greater understanding of the process and playing a bigger role in improving its performance. This is not to say operators don't already do a tremendous job in dealing with the inevitable unknowns and problems to keep a plant running nonstop.

**Greg:** When we did opportunity assessments, we found the production units at one plant consistently out performed the units at other plants. The difference was that the operators knew the practical limitations to production better than the technical support engineers, and were the initiators of most of the ideas for process control improvement. If the people on the front line who have to resolve problems on a minute-to-minute basis have an understanding of the process relationships, the result can be truly remarkable. The knowledge developed can be put into the automation system. Advanced control is, after all, the embedding of process intelligence.

**Stan:** The key to unleashing the true capability of a plant is the operator training system (OTS). Most companies realize an OTS is essential for getting the operators to make maximum use of an upgraded instrumentation and control system. The more astute companies realize it offers an ongoing role for exploring and understanding problems and capturing and disseminating knowledge, not only to operations, but also to technical and maintenance support functions. Probably the least recognized opportunity is getting maintenance and operations on the same page. As we said in our March 2010 column, the first question asked when production changes is, what maintenance was done.

**Greg:** To maximize the performance and ben-

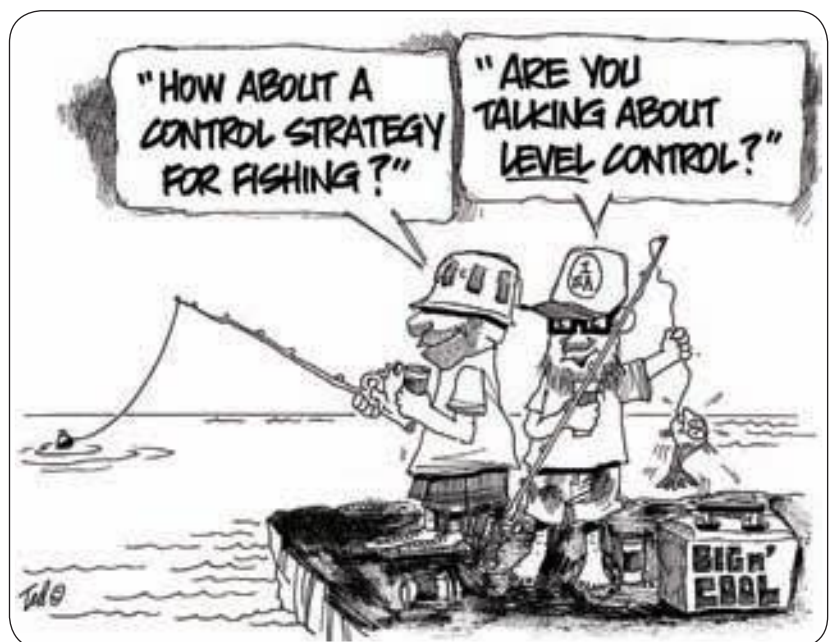
efits of an OTS, we continue our discussion with the president of Mynah, Mart Berutti.

**Stan:** What are the job functions and skills of people who build and deploy an OTS?

**Mart:** Operator training systems require process simulations that are dynamic and real-time. Because the purpose of both OTS and testing and system acceptance testing (SAT) is to provide realistic responses at the operator glass, the control system platform is very important to the overall performance. We find that the best developers of these systems are process control engineers, who understand the process and process dynamics. If they have advanced control background, they are often very good candidates for developing dynamic simulations. Of course, plant operations involvement is also essential. In many cases, the most experienced operators and operations supervisors



GREG MCMILLAN  
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can best dictate the use cases and acceptable performance for the dynamic simulator used in the SAT and OTS.

**Greg:** What type of simulation building environment do your customers find most useful?

**Mart:** Since we are working with control system engineers more so than process design engineers, we like to use IEC1131 programming languages such as function blocks and structured text. This allows the control system designer to make the transition to dynamic simulation developer without learning a completely new configuration environment. The only new paradigm the user needs to adopt is the use of process equipment objects in the IEC1131 function block environment. In addition, process equipment objects are not connected with wires carrying signal values, but with streams conveying dynamic process information (pressure, flow, temperature, density and composition).

**Stan:** What are the relative advantages and disadvantages of various methods of communication between the model and the DCS?

**Mart:** Most offline control systems have an OPC server, a Modbus TCP/IP or an Ethernet/IP slave interface. The dynamic simulation system needs to have an integrated OPC client or Modbus TCP/IP Master or an Ethernet/IP Scanner. Ideally, the simulator will have all three options and an I/O service that runs independently of the simulation engine. This allows the user to integrate I/O by tag name and not by the DCS I/O path. Utilities should allow the user to generate the dynamic simulator's I/O definition and low-level models, such as tiebacks, so that the I/O definition in the dynamic simulation matches the one in the distributed control system automatically.

**Stan:** Do you run your models stand-alone before the configuration is ready, and, if so, what control loops do you put in place, and how do you initialize the DCS loops?

**Mart:** So the OTS simulation can be developed in parallel with the DCS configuration, we run the dynamic model by including the basic control loops in the simulation via IEC1131 control blocks in our library. In order for volumes not to overflow or run dry, and for pressures to be in the operating range, the level and pressure loops are immediately put in Auto. Next the temperature loops are put in Auto because these loops are often the key to getting the composition right, in addition to regulating the energy balance. With these loops, the model can be fully explored, tested and documented by a library of operating conditions captured by snapshots. When the configuration is ready, the control can be readily transferred to the actual distributed control system, and a new library of snapshots created for restoring and resuming operating scenarios.

**Greg:** What do you do for really slow processes, such as distillation columns and bioreactors, to simulate periods of greatest interest?

**Mart:** We use snapshots of abnormal situations, upsets and interesting points in the batch cycle, start-up and continuous operations, to "restore and resume" and eliminate the need to wait for a model to reach these operating conditions. The virtual plant also has the capability of running about 10 times real time for a control module execution time of one second.

**Stan:** Mart, what type of abnormal situations do you simulate?

**Mart:** We allow the user to introduce scenarios that include simulated valves that are stuck or that have failed closed

or open by simply putting the analog output in manual and setting its output. We can do the same thing with discrete outputs for on-off valves and motors. For transmitters, we put the analog input in manual and set its signal to simulate failure as last value, up-scale or downscale. We can also create a huge variety of process disturbances by changing incoming stream flows, temperature, densities and compositions, and by changing model process parameters, such as a heat transfer coefficient and catalyst activity. Introducing sudden changes to atmospheric conditions can also be very effective events for operating training.

**Greg:** How do you measure operator performance?

**Mart:** We keep track of the time it takes each operator to solve a similar problem. We get rid of outliers and generate a plot that represents the composite learning curve for the set of operators. We can repeat these tests and generate the composite learning curve for a different type of problem to see if improvements in operator graphics are making a difference. We allow the user to define the expected results for each operator training scenario. Scoring conditions can be weighted and set for each expected results. There is no limit on how the user can define his operator scoring. Conditions can be set based upon operator tasks, such as acknowledging alarms or changing the setpoint or valve position on critical loops. Scoring conditions can be set to evaluate the health of the simulated process by evaluating key parameters in the dynamic simulation. The training session results (including scoring) are automatically saved for each student.

**Greg:** For more, including the benefits of an excellent OTS and the Top 10 Signs of an Excellent OTS, go to [www.controlglobal.com/1102\\_ControlTalk](http://www.controlglobal.com/1102_ControlTalk). ■





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### EQUIPMENT & MATERIALS

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## Sumo Showdown on Security

Before all the big games, hyperventilating commentators often say, "It all comes down to this!" The backdrop for today's contest is the ongoing organizational earthquakes triggered as microprocessor-based data processing forced its way onto the plant floor. This upheaval has fueled years of wrenching technical and corporate changes as many

controls and automation engineers learned to use PLCs, DCSs, PCs and more software-based monitoring, automation and controls.

Many mechanical, electrical, controls and other engineers were crowded together, of course, and they in turn were shoved together with system integrators, corporate managers and even IT technicians. This has sparked years of rivalries and turf battles. Fortunately, as the years passed, many former opponents learned to get along—at least on the surface.

However, different people and organizations are still at different stages of understanding, and many silos and their barriers remain. So, it seems like whenever a new technical challenge shows up, all the old bile and barbs come out again. One of the latest bones to be fought over is process and network security. When a destructive computer worm such as Stuxnet shows up, controls and IT staffs start to square off again like sumo wrestlers, this time about network segmentation, firewalls and patching policies. I can just hear the thighs being slapped, the feet stamping, flab colliding and the buildings shaking.

Unfortunately, there's evidence this infighting makes process applications and networks even more vulnerable to outside attacks.

"There are many acknowledged cases where IT network scanning tools shut down controls and production systems. This is because many legacy devices don't have full IP stacks, and so network scans can trigger an infinite loop in a PLC and disable it," says Joe Weiss, PE, CISM of Applied Control Solutions ([www.realtime-acs.com](http://www.realtime-acs.com)) and author of *Control's* Unfettered blog ([community.controlglobal.com/unfettered](http://community.controlglobal.com/unfettered)). "IT covers general network security, but we still haven't dealt with what's unique and different about control systems, and how to address them to improve security. For example,

IT wants everyone to change their default passwords periodically. However, when you change the hard-coded default passwords on a PLC, it may not be able to access its applications. Stuxnet used this to its advantage.

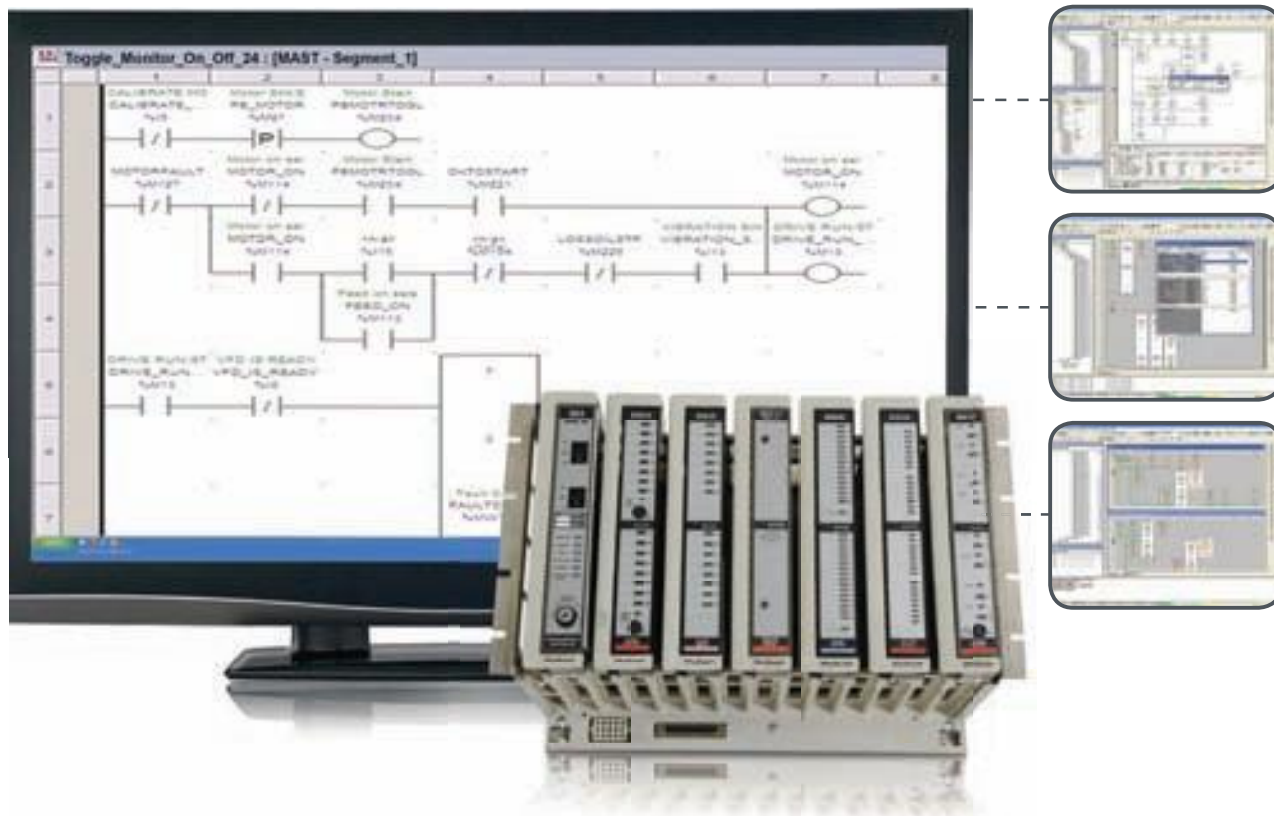
"Likewise, the U.S. Department of Homeland Security's (DHS) U.S. Computer Emergency Readiness Team (US-CERT) issued recommendations in September on how to deal with the Stuxnet worm. They covered how Stuxnet is using vulnerabilities in Windows as its delivery vehicle, but didn't give enough guidance on controls. There's been no additional guidance from DHS or even discussions about the PLC attack since late September. Since it is the PLCs and other field devices that can cause equipment failures and injuries and deaths, why have there been so few efforts by DHS and the U.S. Department of Energy to address securing field devices?"

Weiss adds there is only one investor-owned utility whose board of directors wants to do more than meet the North American Electric Reliability Corp.'s NERC CIP rules, and actually secure their facilities. As a result, Weiss is developing control system cyber security policies for all of the utility's mission-critical equipment. In almost every audit he's conducted, Weiss reports that he's found modems and wireless access points for control systems that the utility didn't know it had.

"Control and IT people must cooperate to look at the design and implementation of their networks, including control systems, because some of these viruses or worms can't be stopped," adds Weiss. "And, if an intruder can get in and manipulate controls, then users must have some physical safety system that's separate from their regular controls, in addition to segmenting their network with firewalls around vulnerable areas." That way, everyone wins. ■

True security for  
process control  
networks will  
require users, engi-  
neers and suppliers  
to cooperate far  
more closely than  
ever before.





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