ISA–The Instrumentation, Systems, and Automation Society

WATER & WASTEWATER INDUSTRIES

Division Newsletter

Summer 2001 Editor: Steve J. Marrano

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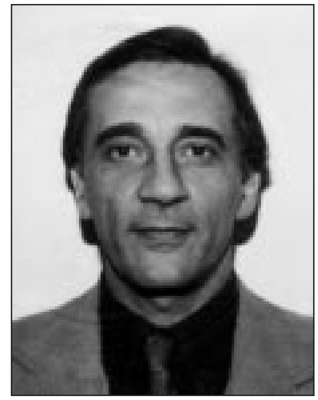
Director's Message

By Joseph T. Provenzano



I am pleased to announce that as of this writing we have established a Division roster of officers in place to be of service to you as you need. Please review the roster because there are several positions that need to be filled. Interested candidates should feel free to contact me to discuss the position of interest.

If you have been following my Director's message posted on our Website, you will note that one of my initial goals was to participate in the technical sessions at ISA 2001, in September. We have been able to develop 5 technical sessions for ISA 2001, to be held at the George R. Brown Convention Center in Houston, TX, 10-13 September, 2001. Please review the article in this newsletter that identifies each session. There will be a joint A&T and I&S Department Awards Luncheon on Wednesday, 12 September 2001, at 12 p.m. in the Convention Center. Tickets are $27 per person and may be purchased using an online registration form. The form, and additional information about the Houston event, can be found at www.toobigtomiss.com. This past June I attended the President's Summer Meeting in Calgary, Alberta, Canada and can state that the Society is working hard to ensure that ISA 2001 will be an event that every ISA member will be proud of.

I am pleased to report that Mr. Paul Lanzillota, P.E. from the Long Island, N.Y. Section has accepted the position of Membership Chair for the Division. Paul will be the contact for any issue related to membership as it pertains to WWID or to ISA.

I would like to take this opportunity to remind you of yet another great benefit for our Division members. Thanks to our E-mail list server, you are no longer restricted to just networking with your peers locally. You can now get advice and ask questions electronically all around the world. For more information on this great benefit see our ad on page 7.

Don't forget to visit us online, at: www.isa.org/techdivmem, or contact me directly at joe_provenzano@hotmail.com. Please remember that each member of this Division manages and controls water, the most precious natural resource on the planet. Be proud of your industry and participate in this Division, as you are able to.

Sincerely,

Joseph T. Provenzano
Water & Wastewater Division Director

ISA 2001 Technical Conference Schedule

for Water and Wastewater Industries Division

Tuesday, 11 September 2001

ISA027 Radio Communications for SCADA Systems (Tutorial Session)

Time: 10:15 a.m.–11:45 a.m.

Developer: Larry Reynolds, *Camp Dresser & McKee*

The purpose of this paper is to discuss radio communication options available to be used for SCADA system applications. The discussion includes identifying potential operational radio bands, broadcast and point-to-point radio communications, as well as truncked radio and spread spectrum radio systems.

ISA122 Poster Presentations

Time: 10:15 a.m.–1:30 p.m.

A PC-Based SCADA System for a Wastewater Treatment Plant

Robert J. Dusza, Jr. *Manchester Water and Sewer Department*

Realizing Energy Savings with VFD SoftStart

Don Bildfell, Andrew Carrothers *Cutler-Hammer*

ISA028 IEC-1131 - The First Universal Process Control Language (Tutorial Session)

Time: 1:00 p.m.–2:30 p.m.

Developer: Bruce Morris, *Bristol Babcock, Inc.*

The session will discuss and demonstrate the five general methods of programming used in IEC-1131. The product that will be used for demonstration will be the Bristol Babcock Control Wave process controller.

ISA029 Ethernet PLCs Reduce Oxygen Consumption (Tutorial Session)

Time: 2:45 p.m.–4:15 p.m.

Developer: Brad Carlberg, *BSC Engineering*

The Anoxic/Oxic process modifications control system is designed to monitor, facilitate control, and improve the efficiency of the Anoxic/Oxic process operation. This session describes this and other features associated with this package.

Wednesday, 12 September 2001

ISA045 SCADA System to Monitor the District of Houston (Canada) Water Distribution System (Tutorial Session)

Time: 10:15 a.m.–11:45 a.m.

Developer: Victor Wang *Dayton & Knist, Ltd.*

This session will discuss the SCADA system used at the District of Houston (Canada). The system described monitors and controls eight well-sites that serve as the source of water for the District of Houston. It is a radio-based system utilizing eight intelligent RTUs that communicate back to a PC-based central. The system monitors the state of each site, as well as the generating of water feeding into the distribution network.

ISA046 SCADA, "The Next Step" (Tutorial Session)

Time: 1:00 p.m.–2:30 p.m.

Developer: Steve Shaddox, *City of Houston, Texas*

A new, third generation SCADA system currently monitors three water plants and approximately 100 other system water sites for the city of Houston, Texas. This system replaces two older SCADA systems, merging their responsibilities into this new system. The paper reviews the network, and discusses the "open system" philosophy, as well as optimization features.

S&P News

by Tom McAvinew

There are three items that I'd like to bring to your attention in this newsletter. First of all, a new member benefit was approved in February at the Albuquerque President's Winter Meeting. Members can now receive unlimited copies of standards via ISA website download for an annual fee of $25. Check www.isa.org for details.

Secondly, in a move to align our practice with ANSI (American National Standards Institute) guidelines and the way that other standards writing organizations designate standards, ISA has dropped the "S" preceding a standard's number. Recommended Practices and Technical Reports will retain the "RP" and "TR" designations. In other words, what has been called S5.1 or ISA S5.1, is now, officially, ANSI/ISA 5.1.

Lastly, the S&P Board has approved a long awaited revision to good old "S20," spec sheets, which will now be generally referred to as ISA 20. Actually, only 2 of the 4 parts of it have been approved as follows:

- ISA TR20.00.01-2001 "Specification Forms for Process Measurement and Control Instruments," Part 1: General Considerations. This part contains the forms, which should be available sometime this summer.
- ISA 20.00.03-2001 "Specification Forms for Process Measurement and Control Instruments," Part 3: Form Requirements and Development Guidelines.

The remaining 2 parts, "Instructions for Using the Specifications Forms" (a standard), and the "Data Dictionary" (a Technical Report) are still in the draft stage.

This revision is several orders of magnitude more comprehensive than its predecessor in order to more completely describe the instruments and control devices of today. Some would say that it is unnecessarily complicated for small firms and projects, but wait, help is on the way. Ian Verhappen of Syncrude Canada, LTD, in Ft. McMurray, Alberta, a recent addition to the S&P Board as a Managing Director, is heading up the formation of a subcommittee to develop a short form of the newly approved ISA 20. This subcommittee's aim will be to produce a set of spec sheets that, while better suited to today's instruments, are a better fit for smaller firms. If you'd like to contribute to this effort, Ian can be contacted at **(780) 790-4079** or at **verhappen.ian@syncrude.com.**

Application Considerations for Radar Level Devices

Steven J. Marrano, P.E. Senior Principal Engineer, Hazen and Sawyer

Many level applications within water and wastewater plants have the need to measure level. The ideal measurement device would have the following characteristics:

1. Non-intrusive: measuring element does not need to be in physical contact with the liquid or the gas in order to operate properly.
2. Instrument inaccuracy does not fluctuate with changes in the process, chemical composition, or environment.
3. Little or no maintenance required.
4. Sensor electronics in the transmitter should be able to "see" around obstacles.
5. Easy set-up.

Characteristics and Application Challenges in Applying Ultrasonic Level Transmitters

A common choice based on the above characteristics has been the ultrasonic level transmitter. Ultrasonic transmitters have been successfully applied in the monitoring of liquid level for many common chemicals (such as sodium hydroxide, sodium hypochlorite, sulfuric acid, etc.) They have also been successfully applied for "hydraulic" in-plant measurements (such as filter levels).

Ultrasonic transmitters have important limitations in making measurements; they are sensitive to changes in temperature, reflection, and propagation. This becomes a problem when the ultrasonic transmitter is installed on a tank that contains a chemical that can produce a vapor. Vapor production above a liquid level becomes a concern for ultrasonic measurement because of the following reasons:

1. When a liquid level produces a vapor above the liquid level interface, the density of the air above the liquid level becomes denser. Since the speed of sound changes (because it cannot go through the air to the liquid level as quickly), it follows that the performance of the ultrasonic level transmitter will change. Because measurement of time to echo is an integral part of making an ultrasonic measurement, it follows that changes in time to echo will change the instrument's performance.
2. When the temperature changes, it follows that the amount of vapor being produced changes. In the Northeastern United States, this can become a concern because during the spring and winter months, there are large temperature changes that cause more dramatic expansion and contraction of the vapor space above the liquid. This change is based on the application of the ideal gas laws. As the vapor space changes because of changes in temperature, it follows that even a vigilant re-calibration of the instrument will not be able to compensate for changes in vapor space caused by temperature.
3. As the level in the tank decreases, more vapor is available above the liquid level interface. If the chemical being measured is one that is used in daily plant operation, it follows that the ultrasonic level transmitter will be susceptible to changes in accuracy. In an actual plant, the author observed degraded ultrasonic level accuracy as the tank level was lowered (and vapor space replaced liquid level).

Since plant personnel desire a non-contacting measurement, the instrument engineer needs a different type of instrument. One alternative to ultrasonic level transmitters is the radar gage.

Principle of Operation

Like ultrasonic transmitters, the radar gage still requires some form of energy reflected from the target (typically a liquid level) to reach the transmitter. The medium in this case is electromagnetic waves in the microwave range. The two principle types of gages available are the horn and parabolic dish type antennas. The gage is typically oriented so that its microwave signal will go directly down to the liquid level interface. The signal reflected from the liquid level interface is reflected back to the antenna.

Application Considerations

When attempting to apply the radar gage, the user needs to consider the following items:

1. Determine the dielectric constant of the material to be measured. The speed of microwave transmission is proportional to the speed of light divided by the substance's dielectric constant. It turns out that the dielectric constant of a substance does not change much under varying temperature and pressure (when compared to air). Therefore, changes in the tank conditions (going from empty to full or from hot to cold) will not affect the measurement inaccuracy of the radar gage.
2. Determine the size of the antenna. Antenna diameter size is proportional to the fourth power of signal strength. Antenna diameter size is also directly proportional to the divergence angle (to the target). Some literature points out that the size of the divergence angle has some trade-offs. A small divergence angle allows for a more concentrated beam to hit the target (liquid level interface). This means that coordination for instrument location is not as critical as the smaller beam will "hit" fewer items that are not associated with the measurement that can absorb the beam. A wider beam divergence angle allows for more of the beam to hit the liquid level interface but the beam can run into more obstacles (such as an internal metallic ladder, manway, etc.) that can absorb the energy from the radar gage.
3. Determine antenna frequency—at least one manufacturer claims that a higher frequency allows for a larger frequency sweep. This allows for the ability to look at the measurement over greater frequency spectra.
4. Application Software—typically, the radar gage uses digital signal processing (DSP) techniques. Some

characteristics of an "ideal software package" would include:

a) Ease of use ("user-friendly")
b) Menu-Driven
c) Built in diagnostics to help the user troubleshoot the gage.

The basic principle of the software's operation is to provide a plot of amplitude versus frequency after applying a Fourier transform. When you know the frequency, you can determine the physical distance to the liquid level interface. It is desirable that the plots have a very high signal to noise ratio. If the plot of amplitude versus frequency has too many "peaks" at approximately the same height, this implies that the radar gage is encountering noise (from an object absorbing the microwaves inside the tank, etc.).

It should be noted that at least one manufacturer currently requires a person trained in the software set-up to be present at start-up. This manufacturer does not release the software to the owner when the project is finished. This implies callbacks from the manufacturer (or his representative) if the level measurement degrades. Because call-backs for owners can become expensive outside of the warranty (estimated at a minimum of $1200 per day), the specifier should ensure that a certain amount of visits be included in the purchase specification to ensure that adjustments can be made after final acceptance of the instrument is made.

5. Agitation and Foam — in general, the radar gage is immune to effects from mechanical agitation and foam.
6. Recalibration — the Instrument Engineer's Handbook makes the claim that the gage does not require recalibration once started up.
7. Licensing Requirements — there are no licensing requirements for radar gages (unlike nuclear gages that are just as accurate but require licensing from the Nuclear Regulatory Commission).
8. Signal Output — typically, radar gages can produce a 4-20mA output. It should be noted that some of them are loop powered (24VDC) and some require 120VAC. If the instrument requires 120VAC, ensure that the client/plant maintenance personnel are consulted for the following:
   a) The quality of the power. It makes no sense to install electronic instrumentation on the same branch circuit as your induction motors (such as fans, etc.). Try to get a dedicated branch circuit for instrument loads. Consult IEEE Recommended Practice 1100 for additional information.
   b) Check about concerns with shock hazards associated with AC power signals. If the instrument has to be mounted on the top of the tank, ensure that adequate clearance is available per the National Electrical Code.

Physical Tank Characteristics and Radar Gage Performance

When the instrument engineer decides to use the radar level device, the following items should be considered:

1. Moisture — some antennas require a window between the antenna and the level element to keep condensation from going onto the antenna. The instrument supplier should be consulted when the device is installed in an outdoors or non-space conditioned environment.
2. Location of obstructions inside the tank — the specifier should ensure that the instrument supplier is given both a plan and an elevation of the tank. Specific items to highlight to the instrument supplier would include, but not be limited to:
   a) Location of tanks manways
   b) Location of items such as packaged heater (immersion heaters are typically metal and will extend inside the tank)
   c) Location of thermowells used for thermocouple temperature measurement
   d) Location of vents
   e) Location and operation of fill lines. If the flow into the tank

(figure 1)

Condition	Drastic Change In Temperature	Temperature Constant
Tank Full	Tank Full – Drastic Change In Temperature	Tank Full – Temperature Constant
Tank Empty	Tank Empty – Drastic Change In Temperature	Tank Empty – Temperature Constant

is on the top, this may create a pattern of flow that may cause false measurement. The specifier should clearly describe the method of tank filling and emptying to the supplier in specifications before the instrument is purchased.

f) The geometry of the tank — the user should clearly describe or sketch the tank top, its orientation (vertical or horizontal), the shape of the tank (cone, sphere, cylinder, etc.). The specifier should pay particular attention to dramatic changes in the tank geometry. Example, if you have a vertical cylinder for the top of the tank and a cone on the bottom (commonly found on a storage silo), the manufacturer may place limitations as to where the gage can be located on the top of the tank.

A Brief Application Case Study

A client had installed some ultrasonic level transmitters on the top of some horizontal "bullet tanks" that held approximately 5700 gallons of 29% aqueous ammonia (for the removal of chloramines in a water treatment plant). The transmitters were being used to allow the plant operators to know how much inventory was in the tank and for high and low level alarming.

Plant instrument personnel noted that when the tank was full, the accuracy of the ultrasonic level transmitter worked within specified limits. As the tank level decreased during the application of ammonia, the instrument technicians began to notice that the level transmitter did not work within stated accuracy. This was verified by comparing manual sticking of the tanks to the level transmitter's output.

The author's firm was called upon to evaluate the situation and suggest alternatives to the ultrasonic gage if needed. The author developed a set of tests based on the input from the plant operators as to when the gage failed to perform. It was determined that the gage exhibited the most erratic behavior when the gage experienced significant changes in temperature, changes in level (from full to approximately 10-15% full tank conditions). Based on this input, the author developed the following methodology for testing the ultrasonic level gage: *(see figure 1)*

The data suggested that level in the tank was the predominant cause for errors in the instrument. This meant that even temperature compensation (available from the ultrasonic manufacturer) would not have cured measurement problems.

Once it was determined that ultrasonic was not applicable for this installation, we had to determine why this was so. It turns out that aqueous ammonia in this concentration produces a vapor as the level in the tank is drawn down. This effect was probably exaggerated by the fact that temperature changes would change the volume of the vapor inside the tank.

Discussions with the radar gage vendor yielded that a radar gage would work. Based on the obstructions inside the tank and the location of a fill line, it was decided to place the level instrument on an existing flange as far away from the fill line as possible. The vendor suggested that we add a process window to keep the moisture away from the antenna. This was tried but ultimately removed because it seemed to interfere with the correct propagation of the signal to the target.

Alternatives to the radar gage included:

1. Level measurement with a pressure transmitter — this approach was used in the past but was not preferred because of the relative inaccuracy of pressure measurement to non-contacting measurements (in theory). This type of measurement also requires a minimum of two (2) process taps on the tank. This increases paths for leakage and hence poses additional dangers to plant personnel.
2. Use strain gage/weight measurements — this approach was dismissed on the basis of expense. It should be noted that this method of measurement is relatively accurate and has the added bonus that it requires no flanges or tank connections (which pose a path for leakage).

Some lessons learned from this experience were:

1. Ensure that you get operator input for current instrument performance before making changes to equipment. In this case, instrument technicians helped us pinpoint and document the source of problems.
2. Ensure that you understand the characteristics of the chemical being stored in the tank. In our case, the chemical's ability to produce a vapor had a dramatic effect on the ultrasonic level transmitter's ability to make the measurement accurately.
3. Ensure that you have an adequate understanding of the location of equipment on the tank.
4. Consult early and often with the vendor before the instrument is purchased and installed. A qualified manufacturer's representative reviewing the project with you before installation saves a great deal of time and embarrassment.

References:

1. Instrument Engineer's Handbook, Process Measurement and Analysis, Chilton Book Company, Radnor, PA, 3rd Edition, 1995, B.G. Liptak, Editor, pp. 351-356.

WWID New Members

MARCH 2001
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