Water/Wastewater Industry Division

Setting the Standard for Automation™

Calendar of WWID Events

Jun 2021	AWWA ACE 2021
Aug 2021	**2021 ISA Energy and Water Automation Conference** San Antonio, Texas, USA (Tentative Date: Aug 17-19, 2021)
Oct 2021	WEF WEFTEC 2021

In this Issue

Newsletter
Fall 2020

Director's Welcome

Don Dickinson, Phoenix Contact USA

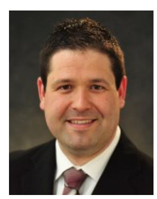
Greetings fellow WWID members! If you feel like you've been living in a cave for the last six months, you're not alone. What was assumed to be a two or three month interruption in our normal routines has become a protracted experiment in social isolation, and adaptation to new routines. At first it was great having an excuse for not going to the gym. Now, many months and pounds later, the reality of the situation has set in.

The beginning of this journey is clear for me. My last trip was to Austin, TX in early March for the ISA Strategic Leadership Conference. The impact of COVID-19 was just beginning to be felt. My Southwest flight home was surreal because the plane was almost empty. Glad I didn't pay extra for a seat upgrade! I returned home not knowing that my intended plans for the WWID would be so thoroughly disrupted along with those for my personal and professional life. Now I know.

Eight months later, the situation is still precarious as we face another resurgence of new COVID-19 cases and hospitalizations. Even if a vaccine is made available in the near term as expected, there is tremendous uncertainty as to when we will return to something called normal. At least we have football, well, sort of. Regardless, plans for traditional New Year's Celebrations in New York City to usher in 2021 have already been cancelled, replaced with virtual festivities. The same is true for water industry… **(continued on page 2)**

Newsletter Editor's Welcome

Graham Nasby, City of Guelph Water Services



Welcome to our fall 2020 newsletter. The year 2020 has been a year like no other. The global covid-19 pandemic continues. However, instead of looking at the negative, I prefer to focus on the positive. The pandemic has brought the best of human nature, as it has enabled us to shine when it comes to our capacity for resilience, compassion and adaptability. Though the past year has been a tough one for many (myself included), I feel it has also be a testament to our strength as a society. As WWID members, we have continued to keep the water running and the toilets flushing, and that is a good thing.

The year of 2020 has also been one of considerable change for the ISA. The ISA is in the midst of an internal governance review process. For the past two years the ISA's Executive Board has been working with a consultant to review how the ISA as a society internally operates. Part of this is reviewing what the roles of the ISA's many committees are, including both local sections and technical divisions. As the WWID is one of ISA's technical divisions, this process has been an opportunity for us to provide feedback on what sorts of supports/resources we feel we need to carry out our mandate. I would like to thank all of the many division leaders who have been helping with this governance review activity.

This issue of the newsletter has a number of technical articles that I encourage you to check out… **(continued on page 2)**

WWID Director's Message
(continued from Page 1)

… events as well. As of March of this year, all in-person events were cancelled for the year as COVID's impact came so suddenly that many events were cancelled entirely, including ISA's 2020 Energy and Water Automation Conference (EWAC). As much as possible, many scheduled in-person events became virtual events. For example, WEFTEC, the year's largest water-sector event was transformed into the virtual WEFTEC Connect conference.

I have now participated in several virtual industry events, and I can say the virtual experience is not the same as the in-person experience in terms of direct interaction with industry colleagues. However, and this is an important point, the virtual event is superior for delivering content. As noted on the WEFTEC Connect web site, "In addition to experiencing WEFTEC virtually, you can connect and learn 365 days of the year – WEFTEC Connect offers year-round access to WEFTEC content and contacts."

I do not know what to expect for 2021 industry events. I have read that it will take years for in-person trade shows and industry events to return to pre-pandemic activity levels. I am certain that virtual events and hybrid events (mix of in-person activities with virtual content) will become commonplace going forward because of the benefits of virtual events: increased accessibility to content, reduced costs to participate, and increased flexibility in scheduling.

We see this trend already starting. The WWID and the Power Industries Division (POWID) conducted four webinars this year to replace the 2020 EWAC. Overall, ISA has conducted numerous webinars and virtual conferences in 2020 that filled the void of cancelled in-person events. I expect that trend to continue in 2021 and beyond regardless of what happens with in-person events.

COVID-19 has brought abrupt and indelible changes to all aspects of our lives, and challenges us to embrace new approaches to personal and professional development. The virtual world is expanding opportunities for learning, collaboration, and communication. Let's make the most of the virtual resources that ISA offers that now includes ISA Connect, an online community for ISA members to engage in technical conversations and share best practices. Join your fellow members in the journey forward into the virtual realm.

Have a wonderful Fall / Winter season, and let's all continue to stay safe and healthy.

Warmest Regards,

Don Dickinson
WWID Director (2020-2021)
ddickinson@phoenixcontact.com

Newsletter Editor's Welcome
(continued from Page 1)

…We start off with an opinion piece by Jeff Miller, a first-time author of us, who talks about the care and trust that are essential to the successful operation of SCADA systems. Jeff is a senior process control and automation engineer with the North-East Ohio Regional Sewer District (NEORSD).

This is followed by an article about Situational Awareness HMI design by John Hacker from Signature Automation. In his article, John talks about the many benefits that come with High Performance HMI design, when it comes to situational awareness, reducing human error, and increasing operator effectiveness. This is paired by a piece by Maurice Wilkins that talks about the impact of ISA's very own ISA101 HMI Design standard when it comes to High Performance HMIs.

Don Dickinson has provided an article about the benefits of open automation platforms. This is a follow-up the last issue's article about OPAS, the Open Process Automation Standard.

Our last technical article is a case study about a control system upgrade for a municipal groundwater well with free-chlorine based disinfection. This is an article that I have been working on for the past year and a half, so I am very happy to finally see it appear in print.

At my water utility, we embarked on a project in 2018 to rewrite our SCADA system design and programming standards based on input provided by WWID members and the ISA112 SCADA Systems standards committee. The article talks about the process how we developed our own SCADA design and programming templates, and how we applied them to the first of several capital projects. During the course of the work, it re-confirmed several existing design/programming practices, but it also resulted in a complete re-think of several design/programming practices we had been doing for years. It was a learning experience. . While the resulting article is a bit longer than a usual technical piece, I wanted to share some of the design decisions we made and why. I hope you find the article as interesting as the SCADA team at my utility did.

Getting back to the newsletter, you will also read about our upcoming 2021 WWID Student scholarship. Up to $2000 USD of scholarship money is up for grabs this year. If you are a student, I encourage you to apply! Scholarship applications are due January 31, 2021.

Stay safe and keep looking towards a bright future.

Keep your stick on the ice,

Graham Nasby, P.Eng.
WWID Newsletter Editor
graham.nasby@guelph.ca

WELCOME

Director Elect's Welcome

Manoj Yegnaraman, Carollo Engineers Inc.

Greetings to ISA Water Wastewater Industries Division (WWID) members! I hope you all have been doing well and staying safe. As we continue to live through this pandemic, we acknowledge that the awareness and continuing education that we would typically achieve through everyday face-to-face interactions are reduced. But, we still ought to keep up with the current automation trends in our W/WW industry, in order to efficiently provide our services. Our ISA WWID recognized these challenges, and has a plan in place to provide the best value to our members.

At the heart of our business plan, we have the goal to inform and equip our WWID members with the necessary knowledge via several platforms (webinars, newsletters, annual conference, training, etc.), and via ISA's broad range of resources. Examples of the latter include ISA training, standards/publications and certifications. Furthermore, we have identified key division initiatives for 2021, which are in complete alignment with the above goals, and help support to ISA's overall strategic plan.

In our Spring and Summer 2020 newsletters, I gave you an update regarding the changes to the 2020 ISA activities, specifically regarding our annual Energy and Water Automation Conference (EWAC). The EWAC committee contains volunteers from our WWID and from the Power Industries Division (POWID).

The EWAC committee has put together several online webinars during Summer and Fall 2020. At this point, the committee conducted two webinars as part of the ISA virtual events – Process Control and Instrumentations program:

Taking Action on Cybersecurity Risks in the Water Sector by Kevin Morley (July 28, 1-2 PM ET)

Control System Cybersecurity for Water/Energy Utilities by Jonathan Grant (September 22, 1-2 PM ET)

More details on the above webinars can be found here: https://isaautomation.isa.org/virtual-events-program-process-control-and-instrumentation/. If you had registered for the above, but were unable to attend the webinar, please send an email to Kim Belinsky at kbelinsky@ISA.org to receive the audio recording.

If you have any questions, or want to be involved in our ISA WWID division activities, please let me know. Thank you and take care.

Manoj Yegnaraman, PE
2020-2021 Director-Elect, ISA WWID
2019-2020 General Chair, ISA EWAC
Associate VP, Carollo Engineers, Inc.
myegnaraman@carollo.com

WWID WEBINARS

ISA & WWID Continue to Provide Virtual Events and Plan for 2021 and Beyond

From the WWID program committee

With the unprecedented cancellations of in-person events due to the covid-19 pandemic, our industry has had to pivot to providing online events. Both the WWID and ISA as a whole, has been actively working to adapt to this new format.

For the WWID, this has meant providing a series of technical webinars for our members. We started off with two webinars in July and September 2020. The Webinars are free, so we encourage you to register and attend future events. Keep an eye on the ISA website for more announcements.

In addition to WWID-associated events, the ISA has also embarked on providing a wide range online programming:

These include:

- Virtual Conferences
- Cybersecurity Series Webinars
- IIOT & Smart Manufacturing Webinars
- Digital Transformation Webinars
- Process Control and Instrumentation Webinars
- Division-Specific Webinars
- ISA Connect Live Events

Please visit www.isa.org/virtualevents for more information.

WWID SCHOLARSHIPS

2021 WWID Scholarship Applications

By Kevin Patel 2021 Scholarship Chair

The ISA Water/Wastewater Industry Division (WWID) is pleased to announce our 2021 ISA WWID Michael Fedenyszen Memorial Student Scholarships. The scholarship is named to honor the contributions of long-time WWID volunteer Michael Fedenyszen who passed away in 2017.

Eligible students can win up to $2000 USD in scholarship money to help them pursue higher education.

Students can apply by filling out the application form, accompanied by:

- 200-word essay on why they should win
- a copy of their academic transcript
- confirmation of enrollment form/letter

The application deadline is January 31, 2021

The division is pleased to continue to provide up to $2000 of scholarship money to encourage WWID members and their sons/daughters to pursue higher education. In addition, winners will receive a complementary 2-year student ISA membership.

Applications are due by email by January 31, 2021. Winners will be notified by February 28, 2021 via telephone and email. Winners will be required to provide a photo and short biography that can be used for publicity reasons. Scholarship money will be distributed by check and mailed after the winner is contacted and has supplied the required photo/bio.

Scholarships will be awarded at the sole discretion of the WWID scholarship committee, with preference being given to students enrolled in technical programs that lead to careers in the water/wastewater sector.

Download and view the student scholarship application form at www.isawaterwastewater.com or our online ISA Connect community at www.isa.org/wwid .

Please email completed application form, along with 200 word essay, confirmation of enrollment and copy of academic transcript to:

scholarship@isawwsymposium.com
AND
knpatel@sig-auto.com

All applications must be submitted by email (PDF scans of documents). Please do not send submissions by postal mail.

ISA Water/Wastewater Industry Division

ISA Launches New Online Member Community: "ISA Connect"

By WWID Committee

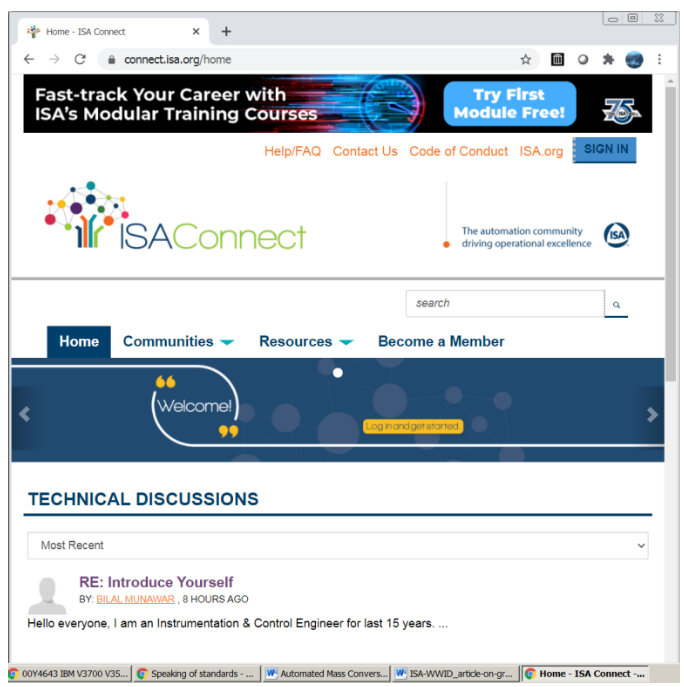
In August 2020, the ISA launched what is now a new ISA member benefit: The "ISA Connect" online community. Based on the popular Higher Logic online collaboration platform, ISA Connect provides a new online experience for ISA members.

The new ISA Connect collaboration platform is open to all ISA members and can be accessed at http://connect.isa.org . Simply log in with your ISA account or register online with your ISA member number/

ISA Connect offers a number of features and online communities for ISA members to become involved with. Some of the features include:

- Participate in an online Technical Discussion forum
- Visit your local section's ISA Connect community
- Visit your technical division ISA Connect communities
- Listing and ability to contact volunteer leaders from their local section and technical divisions
- Access technical content, papers and articles, posted by technical divisions
- Read about society-level, section, and division announcements
- Ability to contact other ISA members
- Post an online profile for other ISA members
- And additional soon-to-be released features

Find out more at http://connect.isa.org



Setting the Standard for Automation™

Water & Wastewater Division

2021 WWID Michael Fedenyszen Memorial Scholarship

APPLICATION FORM

The ISA Water & Wastewater Division (WWID) is pleased to award up to $2000 of scholarship money to encourage WWID members and their sons/daughters to pursue higher education. Students recommended by a WWID member may also apply. Winners will also receive a complementary 2-year student ISA membership, which includes a print subscription to ISA *InTech* magazine. Applications will be accepted via email through January 31, 2021. Winners will be notified by February 28, 2021 via telephone and email, and will be required to provide a digital photo, a 3-4 sentence biography, and a 1-2 sentence "thank you note" that can be quoted for publicity purposes. Scholarships will be dispersed by check and mailed after the winners are selected and the required documentation is received. Scholarships will be awarded at the sole discretion of the WWID scholarship committee with preference being given to students enrolled in technical programs that lead to careers in the water/wastewater industry.

Eligibility (check one)

- ☐ WWID member, ISA Member # ______________
- ☐ WWID student member, ISA Member # ______________
- ☐ Parent/Guardian is a WWID member, Parent Name: ______________ & ISA Member # ______________
- ☐ WWID member recommendation (letter attached), Member Name: ____________ & ISA Member # ____________

Other criteria (check off each one)

- ☐ Currently attending 2-4 year university/college curriculum
- ☐ Confirmation of enrollment letter (or scan of student card) attached
- ☐ 200 word essay about "Why I should win the scholarship" attached
- ☐ Copy of previous year's academic transcript attached

Applicant's Name: ____

Program of Study: ____

Institute Name: ____

Institute Address: ____

Dean of Admissions Name: ______________________________________

Institute Phone: ____

Address While At School

Street: ______________________Apt. _______

City: ________________________________

State: ________________________________

Zip Code: ___________ Country:__________

Phone: ________________________________

eMail: ________________________________

Home Address

Street: ______________________Apt. _________

City: ________________________________

State: ________________________________

Zip Code: ___________ Country:__________

Phone: ________________________________

eMail: ________________________________

Applications must be submitted as scanned PDFs and emailed to the scholarship committee at:
scholarship@isawaterwastewater.com AND knpatel@sig-auto.com

APPLICATIONS MUST BE RECEIVED BY JANUARY 31, 2021

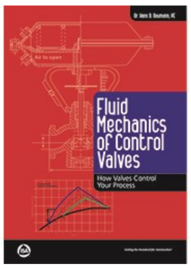
www.isa.org/wwid

ISA PUBLISHING

Fluid Mechanics of Control Valves: How Valves Control Your Process

From ISA Books Catalog

Ever wondered how the process engineers select and size their valves? Or, at least how they are supposed to do it? If so, this is a great book to read. This up-to-date work on final control elements presents theoretical and practical information in an easy, conversational style, which makes it an excellent reference for experienced instrument and process engineers as well as students who are new to the field.



Fluid Mechanics of Control Valves: How Valves Control Your Process

Copyright: 2019
Length: 134 Pages
ISBN: 978-1-64331-004-6
Formats: Paperback, ePub, Kindle
Publisher: ISA

The book begins with a basic explanation of the function and purpose of control valves, explaining the various types of valves that are available along with their various features and limitations. It also provides:

- Directions for selecting the best valve for a given service and the right flow characteristics
- Simplified equations for sizing control valves for liquids and gases under normal and special conditions, such as turbulent, flashing and laminar flow
- Directions for minimizing environmental problems, such as noise produced by turbulent or cavitating fluids and aerodynamic noise
- Solutions to dynamic instability problems
- Methods for improving control loop stability
- Discussion on related safety issues such as “fail-safe” action and cybersecurity

Many reference tables provide information that will be invaluable in valve selection, such as valve materials, temperature ratings, and valve dimensions. Also, for the benefit of international readers, examples and equations are presented in metric as well as U.S. customary terms and measurements. To purchase a copy, visit www.isa.org/books

About the Author:
Hans Baumann, is a world-renowned expert on control valve technology. He has written this book to focus on how changes in control valve technology have brought about new information that will help engineers who design control valves avoid adverse or destructive effects, such as cavitation or excessive sound levels

ISA STANDARDS

New ISA Cybersecurity Standard Published

From ISA news release

A new standard in the ISA-62443 series of cybersecurity standards has just been published. The new standard, ISA/IEC 62443-3-2: *Security Risk Assessment for System Design*, defines a comprehensive set of engineering measures to guide organizations through the essential process of assessing the risks associated with IACS’s (industrial automation control systems) and identifying and applying security countermeasures to reduce that risk to tolerable levels.

The new standard can be effectively applied across all industry and critical infrastructure sectors that depend on secure IACS operations. Moreover, it provides much-needed guidance to all key stakeholder categories, including asset owners, system integrators, product suppliers, service providers, and compliance authorities.

“Currently, there is wide degree of variability in how industry defines and conducts IACS risk assessments,” says John Cusimano of aeSolutions, who led the ISA99 subgroup that wrote the standard. “ISA/IEC 62443-3-2 establishes fundamental requirements for an IACS risk assessment without being overly prescriptive. The result is a standard that will bring uniformity across industry while still allowing IACS owners and operators to apply any methodology that is compliant with the standard.”

The new standard is the latest in a string of notable milestones in the ongoing development and growing global application of the ISA/IEC 62443 series. This included a decision by the United Nations Economic Commission for Europe to integrate the widely used standards into its Common Regulatory Framework on Cybersecurity, which serves as an official UN policy position statement for Europe. These include:

- ISA/IEC 62443-4-1, *Product Security Development Life-Cycle Requirements*, which specifies process requirements for the secure development of products used in an IACS and defines a secure development lifecycle for developing and maintaining secure products.
- ISA/IEC 62443-4-2, *Technical Security Requirements for IACS Components*, which provides the cybersecurity technical requirements for components that make up an IACS, specifically the embedded devices, network components, host components and software applications.

Other standards in the ISA/IEC 62443 series cover terminology, concepts, and models; establishing an IACS security program; patch management; and system security requirements and security levels. All may be accessed at www.isa.org/findstandards.

For more information on ISA99 and the ISA/IEC 62443 series of standards, contact Eliana Brazda, ISA Standards, at ebrazda@isa.org or +1-919-990-9200.

ISA STANDARDS

Tales from the trenches by ISA volunteers setting the standard for automation

By Renee Bassett, ISA Staff

Modeling the boundaries between enterprise systems and control systems. Defining automation and batch processing with an object-oriented design pattern. Putting industrial cybersecurity on the map. Developing the first safety instrumented systems standard for the process industries. Creating standards and technical reports for alarms, human-machine interfaces, continuous process procedures, and more. On all these topics and more, ISA has set the standard for industrial automation.

ISA standards help automation professionals streamline processes and improve industrial safety, efficiency, and profitability. Since 1949, ISA has been recognized as the expert source for instrumentation, control, and automation consensus industry standards. Today, as the Society celebrates its 75th anniversary, there are more than 150 ISA standards and technical reports reflecting the expertise of 4,000 industry experts around the world.

ISA standards committees welcome participation from automation professionals across the globe. One of the many benefits in volunteering is to help craft consensus, balanced standards that move industry forward. Visit www.isa.org/standards for more information on participating.

The following stories from ISA standards leaders highlight standards that have had great impact over the years.

- The ISA-95 Enterprise-Control System Integration standards
- ISA-5.1, Instrumentation Symbols and Identification
- The ISA-88 Batch Control standards
- The ISA-99 Industrial Automation and Control Systems Security standards
- ISA-84.1, Application of Safety Instrumented Systems for the Process Industries
- ISA-18.2, Management of Alarm Systems for the Process Industries
- ISA-101.01, Human Machine Interfaces for Process Automation Systems
- ISA-108 and ISA-112: In development for intelligent device management, SCADA systems
- ISA-106, Procedures for Automating Continuous Process Operations
- ISA-76.00.02-2002: NeSSi

Contributors and contacts

- **ISA-5.1** Tom McAvinew
- **ISA-18.2** Nicholas P. Sands
- **ISA-76** James F. Tatera
- **ISA-84.1** Angela Summers and Paul Gruhn
- **ISA-88** Dennis Brandl
- **ISA-95** Chris Monchinski
- **ISA-99** Eric Cosman
- **ISA-101.01** Maurice Wilkins
- **ISA-106** Bill Lydon
- **ISA108** Ian Verhappen
- **ISA-112** Graham Nasby and Ian Verhappen
- Charley Robinson, ISA Standards

More information: https://www.isa.org/standards-and-publications/isa-standards

For more information on ISA Standards, contact Charley Robinson, ISA Standards, crobinson@isa.org .

TECHNICAL ARTICLE

Trust and Care of SCADA Systems

By Jeff Miller, Northeast Ohio Regional Sewer District

Trust is the backbone of every SCADA system in the world across every division, not only Water/Wastewater. Once trust is lost in a SCADA system, a level of risk has been introduced into the operation. The Operator might choose not to use the SCADA and rely on manual process.

How is trust gained and lost between an Operator and their plant SCADA? There are many reasons an Operator might lose faith in a SCADA system: maintenance neglect, communication issue between Operation and Maintenance, lack of understanding, or lack of training.

SCADA systems are not meant to be set and walked away from; they require maintenance through tuning, calibrating, and repairing when instruments and controlling elements need replacement. If the maintenance staff does not routinely care for a SCADA system, consistently inaccurate readings and unmanageable controls will quickly leave an Operator leery of SCADA system reliability.

There are many interconnecting elements in a control system that might not be obvious to everyone involved. It is crucial to identify and notify Operations of possible disturbances they might see when Maintenance work is being done. Even if the issues the Operator might notice are minimal such as loss of a transmitter reading for a short amount of time, unless the Operator knows there was work being done on a said instrument, they might begin to believe they cannot trust that reading anymore.

When designing a control system, it is essential not to over complicate the process. Most of the time, the simpler, the better; you are not the one that is going to have to repair the system at 2:00 AM, and the Engineer that is will not appreciate your overly complex code to save two rungs of logic. It will also make it difficult for said Engineer to reverse-engineer what he thinks the system is doing to report to the Operations when they ask, resulting in a lack of trust in the Engineer and the SCADA system. In addition to the overly complex code that can mislead and confuse personnel, lack of documentation and failure to update documentation over time will be a huge culprit in everyone's understanding of the system and their trust.

When SCADA training is not utilized, the Operators might misunderstand how something is supposed to work. A misunderstanding can lead to thinking the system is not working even though it is operating as designed. It can also lead to maintenance neglect. If an Operator doesn't know how a piece of equipment is supposed to work, it might never be reported as broken.

When a SCADA system is no longer trusted by the people who run the plant, it can become dangerous. It will take time, money, and an understanding of where the trust was lost and how it can be regained. It should not be taken for granted and should be considered throughout the life of the SCADA system.

About the Author

Jeffrey E. Miller is a Senior Process Control & Automation Engineer with the Northeast Ohio Regional Sewer District (NEORSD), and currently pursuing an MBA at Cleveland State University. He has been actively involved with the automation community since 2012, and has a Bachelor Degree in Electrical Engineering Technology from Cleveland State University. Mr. Miller lives in Greater Cleveland, Ohio, USA. Contact: MillerJeffreyE@outlook.com

SOCIETY NEWS

ISA Members Elect 2021 Society Officers

From ISA news release

Fall is time for leadership changeover within the International Society of Automation, so ISA members are welcoming a new executive board for 2021. The executive board is the managing body of the Society and as such sets the strategic direction for ISA, approves the annual budget, and acts on matters of policy to advance Society objectives as specified by the bylaws.

The makeup of the board includes four Society officers: president, president-elect secretary, past president, and treasurer. For 2021, Eric Cosman becomes past president, allowing Steve Mustard to take on the mantle of president. Carlos Mandolesi joins the presidential chain as president-elect secretary, and the fourth officer is treasurer Scott Reynolds.

The rest of the board is made up of six members with experience in geographic aspects of ISA, three members with leadership experience in operational aspects of ISA, three members with leadership experience in technical aspects of ISA, up to three at-large members, an executive board parliamentarian, and ISA executive director Mary Ramsey.

Look for more information about them and other executive board members in the coming months. In the meantime find out more about society governance groups at https://www.isa.org/governance.

TECHNICAL ARTICLE

The Path to Situational Awareness HMI- A Case Study from Arlington Water Utilities

By John Hacker, PE, Signature Automation, LLC

Have you ever been curious about what it takes to implement Situational Awareness for a HMI, Human Machine Interface, system? Have you ever wondered if it is really beneficial? The City of Arlington, Texas, USA has started down the path, and they are excited!

Situational Awareness Defined

The concept of Situational Awareness, or the ability to perceive, comprehend, and project the future status of one's environment has always been a part of supervisory control and data acquisition (SCADA), systems. However, the increasing advances in computer hardware and software, instrumentation, and networking have led to larger amounts of information available to operators. The increased amount of data has placed a much greater strain on operations staff to make decisions based on this abundance of data presented to them. Additionally, HMI systems have advanced along with computer graphics, processing ability, and display resolutions to provide more detailed animation with more data. Today, many systems are commissioned with multiple monitors adding to the amount of information in front of an operator while they try to determine the actions they should take. Perhaps counterintuitively, this is not necessarily more helpful, as it can be especially overwhelming for new, inexperienced personnel. They have the challenge of quickly learning how to filter the important information from the unimportant and how to appropriately respond to abnormal situations before they become critical.

Often, HMI screens are overcrowded, and over time operations personnel learn to focus their attention on the critical data required to adequately monitor and control the treatment processes. An example of one of these overcrowded displays is shown below. Without a doubt, it provides a significant amount of information, but deciphering the entirety of the data that is provided can be extremely time consuming for an experienced operator, much less a new one learning the system.

Figure 1 - Existing Plant Overview Display

Numerous sources define situational awareness as "the perception of environmental elements with respect to time and/or space, the comprehension of the meaning, and the projection of their status after some variable has changed." To put it simply, situational awareness is being more aware of your surroundings so that you can use that information to predict what will happen next and respond accordingly. From a process controls perspective, being able to project what will happen next allows for a more predictive approach rather than the reactive limitation of traditional HMI displays.

The goal of a Situational Awareness focused HMI, then, is to allow an operator to quickly, intuitively, and efficiently identify, understand, and project the appropriate actions that must be taken. These actions may be aimed at enhanced operational controls or to prevent abnormal situations from occurring. In doing so, Situational Awareness HMI leverages the advantages of computer automation to lessen the load on operations staff so that they can perform their duties more safely, effectively, with fewer errors, and with reduced impact when errors do occur.

Arlington Water Utility's Path to the Future

When the City of Arlington embarked on their current capital improvement projects, they saw an opportunity to document and update their SCADA system with a more user friendly HMI using Situational Awareness techniques while also implementing alarm management to help relay information more clearly to their operators. Andrew McBride, Assistant Director of Treatment for Arlington Water Utilities (AWU), championed the vision to utilize this philosophy as part of the project. "As the municipal utility industry continues to trend toward more automation and fewer persons actually operating, striving for the right balance of real-time relevant information versus nuisance data overload becomes increasingly important," McBride said. "To ask an operator, even 10 years ago, to run a 50, 60, or 100 Million Gallon per Day (MGD) facility with only one or two operators on shift would have been almost impossible. We now see that scenario occurring with regularity."

Figure 2 – Existing main control room operator console

In Figure 2, pictured is Andrew McBride, Assistant Director of Treatment for Arlington Water Utilities, who stands beside the existing SCADA displays and security monitors inside the control room at the John F. Kubala Water Treatment Plant in Arlington, Texas, USA.

He added: "The City of Arlington's Water Department recognized substantial operational challenges almost a decade ago and began working on a comprehensive treatment master plan. The prioritization of these challenges culminated in a substantial capital improvements program that will see approximately one hundred and fifty million dollars being invested over the next five years. With projects touching so many areas of the process, from the raw water pump station, to major chemical feed improvements, to new clearwells and high service pump stations, very few areas at the two treatment plants will go untouched. The complexity of operation and the necessity to ensure proper integration of the new equipment into the current SCADA platform led the team to propose a SCADA integration project."

Signature Automation worked on several previous SCADA projects with AWU, and McBride felt that Signature Automation's experience implementing Situational Awareness HMI on previous projects with other utilities across the state provided a roadmap for AWU to follow. Additionally, he said, "Having the ability to coordinate all aspects of our SCADA system with a single consultant, Signature Automation, is proving to be a major key to our continued success."

In 2015, the ISA released ANSI/ISA-101.01-2015 "Human Machine Interfaces for Process Automation Systems." Commonly known as ISA101, the standard covers the philosophy, design, implementation, operation, and maintenance of HMIs for process automation systems. It defines the terminology and models to develop a HMI and the work processes recommended to effectively maintaining a HMI throughout its full lifecycle. This standard provided general guidance to the design and implementation of the new Situational Awareness HMI.

As illustrated from the HMI lifecycle chart from ISA101, system standards were first developed to guide the initial and future plant improvements. The standards for the HMI encapsulated various items throughout the entire life of a system, such as the initial design using Situational Awareness principles, implementation, and change management.

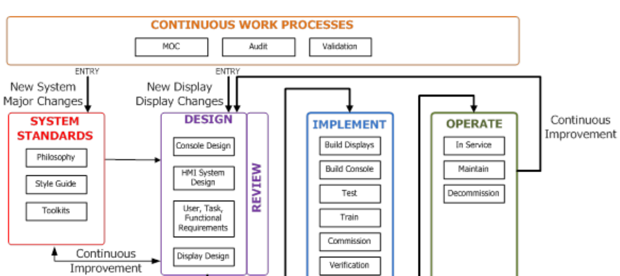


Figure 3 - ISA101 HMI System Life Cycle

Some of Signature Automation's personnel were heavily involved in ISA's efforts when this standard was developed and brought forth an understanding of ISA101 as well as the benefits of implementing its features. Furthermore, Signature Automation also had helped several other utilities migrate to situational awareness style HMI graphics. These factors along with AWU's previous experience working with Signature Automation led to their selection to develop HMI standards that were based on situational awareness philosophies.

Workshops were initially held with AWU to determine the changes needed to bridge the gap from their current system to one that maximizes Situational Awareness concepts. These workshops allowed AWU's staff the opportunity to provide input into the HMI design based on examples of situational awareness style graphics that were presented. Additionally, utilizing this approach allowed for operations personnel to gain a sense of ownership in the final product because many of the final decisions on the layout of the graphics were made by them and tailored to their preferences. Having developed the standards in document format, they are now being used as the basis for implementing several construction projects. For each project, operators are able to preview the new graphics and give feedback to ensure the solutions provided meet their needs.

A major consideration on the path to Situational Awareness HMI is the selection of the software package. Signature Automation's senior programmer, Marcelo Avendaño explains: "When implementing Situational Awareness HMI, there will be a trade-off from using off-the-shelf software solutions. They can provide built-in Situational Awareness features but may require a major change replacing your current system or limit the customization you may want. In the case of the Arlington project, we have been able to develop a series of custom objects using their existing software package to provide the functionality that AWU desires within the limitations of the software."

AWU has been using GE's iFix software for several years. The latest version of this product also includes more Situational Awareness HMI features, but others had to be customized to accommodate the needs of the AWU operations staff. Another benefit of continuing with the current HMI system was to allow for the phased implementation of new graphics along with the existing system.

Numerous features of Situational Awareness HMI philosophies have been incorporated into the AWU system. One that is helping tremendously is the embedding of trend objects on various displays where the analog transmitter is shown. This allows operators to more easily view the recent history of the analog value as well as the direction it is trending. This greatly enhances the operators' ability to predict what may happen next. Additionally, alarm priorities and shelving of nuisance alarms have been added to further aid in the decision making and response time.

Another result of the workshops was the desire to help improve communication of system status between maintenance and operations staff and between shift changes. To address this, Signature Automation added custom animation to allow personnel to enter notes associated with equipment and instrumentation objects. The information symbol appears next to the object and a pop-up reveals the details including user ID and timestamp.

Drawing from experience implementing Situational Awareness HMI for other utilities, Signature Automation programmers developed a suite of new animated display objects for AWU coded with Situational Awareness features. For example, an equipment icon will animate as off-white when running from the light gray off state, rather than a bright red outline or solid green as seen in the previous system. Bright, saturated colors are reserved for different priority level alarm states to allow the operator to better notice and respond appropriately to the condition. The muted colors and simplified animation of a Situational Awareness HMI may seem like a backward step in computer animation capability considering the number of colors that are now available with today's graphics cards. However, the beneficial effect in only highlighting critical information with bright colors becomes dramatic as operators can efficiently scan for abnormal conditions as they stand out more against the surrounding grays and off-whites.

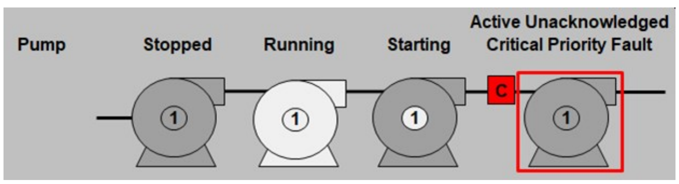


Figure 4 – Re-Designed Pump Symbols, for Situational Awareness

Figure 5 – Old Pump Symbols (for comparison)

Figure 7 – Old HMI overview screen (for comparison)

As with any paradigm shift, however, there are challenges in the implementation and adoption. Considering that the various capital improvements projects were scheduled to occur in phases over several years, it was determined the most cost effective approach to implement the new standards onto the existing system was to apply HMI updates gradually as each project is executed. The benefit of this incremental transition is giving AWU personnel time to adjust to the new approach as each process comes online.

Benefits Realized

As AWU implements their new HMI standards using situational awareness, they are seeing several benefits. First and foremost, as expected, situational awareness principles improve the ability of their staff to identify and prevent potential problems due to its predictive nature. Mr. McBride notes, "The trend objects allow us to more easily track how our critical processes are doing in relation to their alarm limits and historically." It also highlights important information by having abnormal conditions in vibrant colors and normal conditions in grayscale. This allows the abnormal conditions to stand out and not get lost in the 'noise' as what often

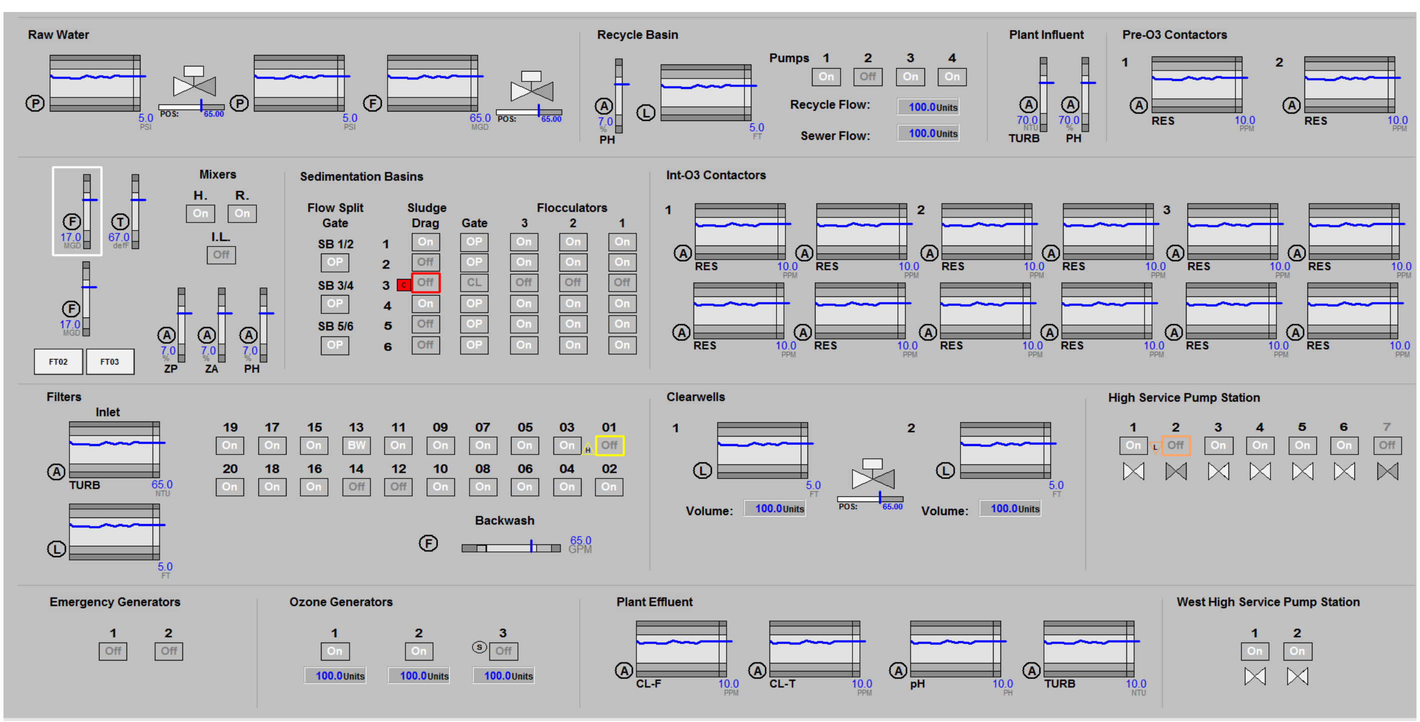


Figure 6 - Redesigned Plant Overview Display using Situational Awareness HMI design techniques

happened with the previous generation HMI. These factors will improve operational response time and shift the focus from reaction to prevention of problem situations. “The new alarm indications help the operators to quickly notice what needs attention,” McBride said. Furthermore, utilizing this philosophy allows for more efficient training of new personnel because they are taught immediately that when something stands out on the screen, an operator action is likely necessary to prevent unwanted control actions or fault.

Although the numerous construction projects that are part of AWU’s capital improvements are ongoing, it is already clear that these simple changes to the graphical layout will provide great benefits to AWU today and well into the future. In particular, cost savings will be gained due to increased efficiency of operation and predicting failures before they occur. McBride excitedly said, “After analyzing the cost benefit, it was a no-brainer! It was a small add-in to the overall project, but with the potential to be a game-changer for years to come.”

About the Author:

John Hacker, P.E., is a licensed control systems engineer at Signature Automation with over 8 years of experience in the design, programming, testing, and commissioning of controls systems primarily in the water/wastewater and industrial dust collection industries. He is a member of the ISA Water & Wastewater Industries Division. Contact: jrhacker@sig-auto.com

ISA STANDARDS

Impact of the ISA101 HMI Design Standard

By Maurice Wilkins, Yokogawa

ISA-101.01-2015 was being cited even before its release. It is now the go-to standard for HMIs for process automation systems, especially in North America. ISA-101.01 has helped people to move away from classic HMI designs toward more intelligent, high-specification HMIs. Guidelines from the Abnormal Situation Management (ASM) Consortium and the Engineering Equipment and Materials Users Association (EEMUA) in the U.K., including the latest edition of EEMUA 201 – Control Rooms: A Guide to their Specification, Design, Commissioning and Operation, cite ISA101 in several places. Greg Lehmann and I have contributed to the review process.

I joined the ISA101 committee in 2008 as a basic committee member and became co-chair with Joe Bingham in 2009. Joe was later replaced by Greg Lehmann. We needed some “glue,” so Greg and I—with the help of a wonderful group of ISA108 clause editors (Bridget Fitzpatrick, Dale Reed, Tracy Laabs, Dawn Schweitzer, David Lee, Beth Vail, Mark Nixon, Nicholas Sands, Ian Nimmo, and John Benitz)—developed a life cycle for the proposed standard based on ISA-18.2 and ISA-84. This helped us to organize the standard, and things flowed from there. We received many thousands of comments as the standard developed, but we eventually decided to make it the “what” and moved all of the “how” into proposed technical reports. The standard was successfully released in July 2015. After that, four working groups were set up—Philosophy and Style Guide; Usability and Performance; HMI for Mobile Platforms; and HMI for Machine Control. The purpose of the working groups is to develop technical reports (TRs) intended to show how to implement the standard.

The initial standard had said that mobile/small platforms were excluded, but by the time the standard was released, these platforms had become ubiquitous. David Board and Ruth Schiedermayer drove the development of the Usability and Performance technical report (TR) on a fast timeline, doing most of the work themselves. That TR was released in 2018 and provides a very good companion to the standard. The other TRs are at various stages of development. The standard itself is now out for a reaffirmation vote, with the plan to submit it to IEC for development as a global standard.

ISA-101.01 was approved for development/adoption as an IEC standard in early 2020, which will enable it to become more globally accepted. The IEC standard is being developed by TC65/SC65A WG19, *HMI for Process Automation Systems*, and the standard will become IEC 63303. I am co-convenor along with Dave Board. The draft is being developed from ISA-101.01, and the ISA101 committee has an IEC C liaison with WG19. This will allow ISA101 to be involved in the development of the IEC standard. ISA101 Co-chair Greg Lehmann is the liaison coordinator. We anticipate this joint ISA/IEC work to be completed in late 2021

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TECHNICAL ARTICLE:

Declare Freedom from Legacy Control Systems, Boost Resilience, and Future-Proof Your Utility

By Don Dickinson, Phoenix Contact USA

Ensuring the availability and reliability of critical water and wastewater systems can be a significant challenge when the automated systems controlling critical processes have become outdated or even obsolete. Legacy systems are expensive to operate and maintain, and increase the likelihood of failure – reducing the resilience of the utility. One utility addressed this challenge by completely modernizing an obsolete end-of-life, plant-wide control system, reducing maintenance costs, boosting its resilience, and preparing for the future.

Benefits of updating legacy systems

- Reduce maintenance and operational costs relieving COVID-stressed budgets
- Enhance the reliability and resilience of critical water processes.
- Empower lifecycle management to maximize value of capital expenditures
- Enable advanced monitoring and control functions for IIoT applications

The number one challenge for U.S. water sector utilities is dealing with aging water and wastewater infrastructure. This includes the automated and partially-automated control systems that monitor and control critical processes. Outdated, or even obsolete control systems are difficult and expensive to maintain. Anecdotal accounts of running a plant with parts from eBay is more common than imagined. Of greater concern, a failed component can debilitate essential water processes for an extended period negatively impacting water quality or the environment.

The New Freedom Borough WWTP, located in Railroad Pennsylvania USA, treats and sanitizes wastewater generated by the residents of four townships and boroughs in southern Pennsylvania. The New Freedom facility faced a common problem as described by John Smith, its Director. Per Mr. Smith, "*The original equipment that was put in during the 1990's is quite antiquated, and it's getting harder and harder to find replacement parts. In addition, it's getting harder and harder to find programmers that can work on the DOS binary system to make changes*." The PLC system controlling the plant was obsolete, creating a high-risk situation. A failure of any kind could be disastrous, and negatively impact the environment.

The Phoenix Contact USA Engineering Services Team led the effort to replace the aging control system with a state-of-the-art, plant-wide control system. To minimize any interruption in the plant's process, the migration from the old system to the new required the new system be installed, and tested before seamlessly switching it over as the primary control system. Once the Site Acceptance Test (SAT) was completed and the new system operational, the old system would be removed.

The first step of the migration process was to duplicate the code of the original system which was no small task given the lack of documentation. Roughly 40% of the original code was poorly documented or lacked documentation altogether.

Replacing a control system on a continuous process is always challenging, even more so when that process is complex. "*Like any treatment plant we use a combination of biological and chemical treatment processes to convert raw wastewater into clean water. This being an SBR plant – which means Sequential Batch Reactor, there are many, many more moving parts than in a traditional plant*." said Mr. Smith.

The project was proceeding as expected despite the challenges of writing and verifying an extensive amount of code, and installing and testing the new system with thousands of wiring terminations alongside the legacy system. However, a potentially calamitous event occurred during the SAT. The old PLC had a fatal error rendering it inoperable. Fortunately, the new control system was quickly brought online without significant interruption to the process.

The fortuitous turn of events unscored the importance of replacing legacy systems before they fail, and negatively impacting operations. However, replacing outdated control systems brings more benefits than just ease of operation and increased resilience. For New Freedom, the conversion delivers on an important expectation of the client. As expressed by John Smith, "*I want a reliable, redundant PLC that's going to be able to take this plant into the future*." The New Freedom facility has exactly that. The new control system will enable advanced monitoring and control functions needed to address the changing needs of the industry well into the future.

The control system features redundant PLC controllers connected on a plant-wide, fiber optic ring. The controllers employ ProfiNet Media Redundancy Protocol (MRP) to provide fault recovery time in milliseconds for the controllers and remote I/O stations on the ring, providing the highest level of resilience for control and communications. To further enhance system resilience, each station on the ring has a DC UPS battery backup for power redundancy.

Another benefit of the conversion was a dramatic improvement in the operator interface devices. Pilot devices and single-purpose displays were replaced with touchscreen Human-Machine-Interfaces (HMIs). Operators now can quickly assess system status and alarm conditions providing enhanced situational awareness for plant operation.

An additional benefit of the conversion is the significant enhancement in asset management through control system lifecycle management, critical for continuous processes expected to operate for twenty or more years. Effective lifecycle management maximizes the return on capital expenditures by deriving the greatest value from assets while minimizing the total cost of ownership. As an example, one aspect of lifecycle management is the integration of existing and future peripheral systems into the main control network. Legacy systems often have limited or no provisions for communications using industrial Ethernet protocols that are now the standard. New Freedom's control system now offers a wide range of options for communications using current protocols, and is adaptable to future communications as well.

Lastly, the conversion from an obsolete legacy system to a modern control platform enables advanced monitoring and control functions that will allow implementation of new functions and capabilities that go far beyond the traditional scope of industrial control systems.

The Industrial Internet of Things (IIoT) holds the promise of enhanced asset management and process efficiencies by gathering and analyzing data from a wide range of industrial devices. Artificial intelligence and machine learning will augment applications such as predictive maintenance and energy management. Control platforms such as the one at New Freedom WWTP are the foundation of IIoT architectures, and provide the connectivity required for edge-computing and cloud-based solutions, along with security for mission-critical operations.

In summary, the staff at the New Freedom WWTP realized many benefits from replacing the plant's obsolete control system. However, the biggest benefit is ensuring the availability and reliability of a critical water process for the residents of New Freedom Borough for many years to come.

Figure 1- Old – end-of-life non-redundant controller

Figure 2 - Old – buttons/lights/switches field interface

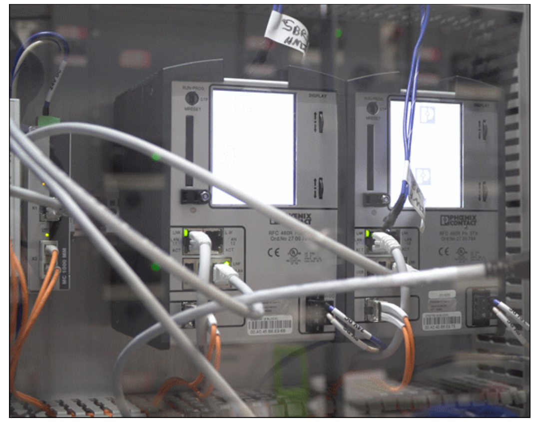


Figure 3 - New – Modern fully redundant controllers

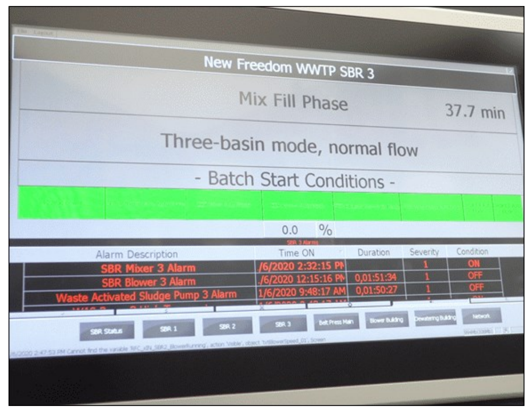


Figure 4 - New – Modern touchscreen field interface

Figure 5 - New – high-density spring clamp terminals

About the Author

Don Dickinson Don Dickinson has more than 35 years of sales, marketing and product application experience in Industrial Automation and Controls, involving a wide range of products and technologies in various industry segments. In his current role, Don is the Senior Business Development Manager for the Water Sector, Phoenix Contact USA. He is an active member in various industry groups including ISA, AWWA, and WEF. Contact: ddickinson@phoenixcontact.com

TECHNICAL ARTICLE

Case Study – New Control System and HMI Screens for a Municipal Ground Water Well

By Graham Nasby, City of Guelph Water Services

In 2018, Guelph Water Services embarked on a project to upgrade one its key groundwater wells. Located within city limits, the Emma Well provides approximately 35 liters/sec (550 us-gal/min) of reliable drinking water to the residents of Guelph. This article provides an overview of how a new SCADA (supervisory control and data acquisition) control system and HMI (human machine interface) was implemented as part of an overall facility upgrade.

About Guelph Water Services

Guelph Water Services is a publicly owned/operated drinking water utility located in Guelph, Ontario, Canada. In operation since 1879, Guelph Water Services provides drinking water and fire protection water for a population of 140,000 people in the City of Guelph and the adjacent Gazer-Mooney Subdivision in Puslinch Township. The Guelph system consists of approximately 49,000 service connections, 2,900 fire hydrants, 21 groundwater wells, 3 water towers, and several pumping/monitoring stations. In all the system has approx. 600 km of water mains ranging from 4” to 30” serving three pressure zones. It also includes an 8km (5 mile) piped gravity aqueduct from the Arkell Spring Grounds wellfield. Guelph Water Services is one of the largest groundwater based drinking water systems in North America.

The Guelph Water SCADA system consists of 35 facilities linked together using a private MPLS fiber-optic network. This is supplemented with secondary private MPLS 3G/LTE wireless links, which are setup to restore connectivity within 45 seconds in the case of a fiber cable break. The control system uses a PLC+HMI architecture that consists of approximately 55 PLCs, 2 SCADA datacenters, and 15 view nodes located throughout the city. In each SCADA datacenter, the servers are fully virtualized using multiple physical hosts running VMs and multiple storage array networks (SANs). An automated back-up system backs up server images four times a day. Three redundant store/forward datalogging systems record process data from the field. After-hours call-out alarms are handed by two redundant call-out servers. In all, the Guelph Water SCADA system has approx. 750 instruments, 75 large pumps, 65 motorized valves, and a network of flow/pressure sensors in the distribution system. The system is staffed Mon-Fri 8am-4pm with an after-hours on-call operator.

Motivation for the Upgrade

First drilled in 1931, the Emma Street Well has been in continuous use for almost 90 years. Coming from a bedrock aquifer, the well delivers water of very high quality that has historically required minimal treatment. To comply with regulatory requirements, the site has used both free chlorine (via sodium hypochlorite addition) and UV (via a packaged UV system) for primary disinfection. For secondary disinfection, the free chlorine addition is also used to satisfy Ontario’s O.Reg. 170 regulatory requirements with respect to ensuring that a sufficient amount of secondary chlorine residual is maintained throughout the distribution system.

In 2017, the facility’s existing UV treatment system – due to the type of control system technology used in the UV vendor panel – had reached end-of-life and needed to be replaced.

A study was undertaken to do a cost-benefit analysis of two options: (a) replacing the existing UV treatment system with a new UV system, or (b) removing the existing UV system and replacing it with a new underground contact chamber (to increase the free chlorine contact time). Due to the cost of electricity in Ontario and the characteristics of the well, it was determined that it would be more cost effective in the long term to remove the UV and install a new underground contact chamber. This became the Emma Well Upgrade project.

In addition to removing the UV system and adding a new underground contact chamber, the project was also used as an opportunity to upgrade the site’s automatic control system and HMI (human machine interface) operator control screens.

Post-Upgrade Process Block Diagram

A block diagram of the newly upgraded treatment process for the Emma Well can be seen in Figure 1. The well itself uses a 60 HP submersible well pump to provide approximately 35 L/s of raw water. Upon leaving the pump, the water passes through a pilot-operated backpressure valve which functions as a one-way check valve.

The well is equipped with a well level transmitter, pump discharge pressure transmitter, and a flow transmitter to track pump performance over time. The well flowmeter is also used to ensure the well is operating within its Ontario Permit to Take Water (PTTW) in terms of maximum flow rate (L/s) and maximum allowed daily water taking (in cubic meters).

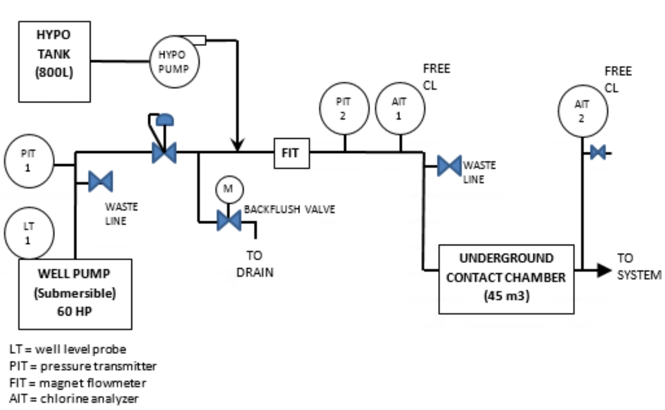


Figure 1 – Emma Well Process Block Diagram (post-upgrade)

After the water passes through the backpressure valve, the “hypo” (a 12% sodium hypochlorite solution) is injected as a source of free chlorine. The hypo is used for both primary disinfection and to maintain a secondary residual chlorine concentration leaving the station. The hypo dosing rate is controlled by the PLC using flow-pacing, based on the well's flow rate and a target chlorine dose setpoint.

A baffled underground contact chamber provides the contact time needed to satisfy a regulatory requirement of a 2-log virus reduction. Sizing of the contact chamber was done per the Procedure for Disinfection of Drinking Water in Ontario from the Ontario Ministry of the Environment Conservation and Parks (MECP) to ensure an adequate contact time (CT) could be achieved even under worst case conditions. The underground contact chamber is actually sized so that it can achieve up to a 6-log virus reduction to allow for potential future capacity increases and/or increased regulatory treatment requirements in the future.

To aid in starting up the station, a motorized backflush valve is used as part of an automated start-up sequence to flush out any stagnant water from the contact chamber (which may have a degraded chlorine residual) before the well pump is started. The station's pilot-operated backpressure valve is used to ensure that flow from the well pump only flows from the well, and not back into the well. The pilot-operated backpressure valve and the motorized backflush valve were re-used from the site's previous UV disinfection system.

At the station outlet, also known as the point-of-entry (POE) into the water distribution system, the site is equipped with a free chlorine analyzer and a system pressure transmitter. The POE chlorine analyzer serves multiple purposes. It enables the free chlorine residual leaving the station to be monitored and logged. It enables for the control system to implement both a high-chlorine and low-chlorine shutdown interlocks. And it also enables the SCADA system to do real-time CT calculations to prove the 2-log virus disinfection requirement is being met whenever water is being produced.

Verified As-Found Electrical Drawings as a Design Tool

To assist with planning/executing both the design and construction phases, the project scope was purposely defined to include creating full sets of both *verified* "as-found" and "as-built" electrical drawings. This was to fully document the before and after details of all electrical aspects of the station, including: power distribution, electrical layout/elevations, lighting panel schedules, lighting/receptacle locations, emergency lighting locations, motor starter wiring / connections, motorized valve wiring/connections, and PLC panel details. Also included were a full set of ISA-5.4 style connection/loop drawings for all devices and instrumentation.

Taking the time to create a set of verified "as found" drawings --- *before* the main station upgrade design work was undertaken -- -greatly simplified the electrical design process and significantly reduced the amount of risk during the construction phase. Looking back on the project, it was well worth the time investment to create a good set of "as-found" drawings to feed into the station upgrade design work. Guelph Water has since implemented the step of creating as-found electrical, P&ID and facility layout drawings as a design prerequisite for all capital projects moving forward.

It goes without saying that having high-quality/accurate as-built drawings at the end of a project makes operating, maintaining, and troubleshooting a facility much easier. Verification of both the as-found and later as-built drawings was done by yellow-lining. Yellow-lining is a technique in which the drawings are printed and each wire is highlighted with a yellow highlighter on the drawing as it is checked on site; any updates are noted on the drawing using a red pen.

SCADA Coordination with the Design Team

One of the main reasons for the success of the Emma Well project was that the SCADA team was able to be involved with the design of the station all the way from project charter development, writing of the consultant terms of reference, to preliminary design and detailed design, as well as during the shop drawing review, construction and commissioning phases. Like any successful project, it was important the various project stakeholders and project disciplines worked as a team.

Construction Phase

Physical construction work at Emma Well began in the spring of 2018 and was completed by the fall. This involved taking the facility offline, replacing the UV reactor with a straight-through piece of piping, installing a prefabricated underground steel contact tank, adding a new post-contact chamber chlorine analyzer, and reconfiguring yard piping for the facility. Figure 2 shows the construction crew setting the new epoxy-coated steel underground contact chamber into place.

The construction work also included correcting a number of existing control wiring inconsistencies in the well pump starter, adding in missing "status monitoring" I/O, and labelling previously undocumented wiring. The site's existing point-of-entry (POE) chlorine analyzer was also repurposed to measure the pre-contact chamber free chlorine residual, and the additional new free chlorine analyzer was installed with a sample line to measure the post-contact chamber / POE value.

Figure 2 – Installation of the underground contact chamber

SCADA Software Development

During the preliminary design phase of the project, the decision was made to retain the existing PLC and PLC panel. The existing PLC was of high quality and still had many years of useful life left in it. (Under the facility's asset management plan, the PLC was not scheduled to be replaced for another 10 years.) The existing field wiring was also in good condition, so it was retained as well. By not trying to do a full PLC hardware/panel replacement project at the same time as a full software reprogramming effort, the project team was able to considerably reduce the amount of risk / complexity / unknowns associated with the project. Thus, it was possible to limit to the controls scope of the project to only include a rewrite of both the PLC and HMI code, correcting known deficiencies with the existing I/O wiring, and installing new I/O wiring as needed for new equipment.

Software development began in July 2018, so that the new PLC/HMI code would be ready by the time physical construction work had been completed in late-September. A decision was made to do all the PLC/HMI software development "in-house" at Guelph Water Services, with a summer SCADA co-op student doing the bulk of the work. This ensured that any issues with the then newly-released Guelph Water SCADA programming standards could be quickly identified and resolved on a same-day basis. Having the programming work done in-house also meant that daily checks could be done on the new PLC code and HMI screens as they took shape.

New City of Guelph Water SCADA Standards

As a precursor to the Emma Well Upgrade project, the SCADA group at Guelph Water undertook a project to develop a new set of Guelph-Water-specific SCADA Design and Programming Standards. These standards, developed in-house, have the goal of taking best practices from utilities across North America, as well as best practices from other industries, and putting them into an implementation that best fits Guelph Water's needs for reliably, functionality, and ease of troubleshooting. There was also a strong desire to reduce the amount of "custom-code", which is both time-consuming to write and difficult to maintain.

Another major source of input into the new Guelph Water SCADA standards was the preliminary work by the recently formed ISA112 SCADA Systems Standards Committee, as well as other published ISA standards such as ISA101 (HMI Design), ISA18 (Alarm Management), ISA62443 (Cyber Security) and ISA95 (Enterprise Integration). Best practices and lessons-learned from other process industries were also incorporated into the new Guelph Water SCADA Standards.

Work to develop the new Guelph Water SCADA standards took place from Jan-July 2018. From an asset management point of view, developiong a new set of SCADA standards was long overdue, as the previous version of the Guelph Water SCADA standards had not been updated in over 15 years. A lot had changed with respect to available technology and industry best practices since 2002!

The newly developed Guelph Water SCADA design and programming standards now consist of the following parts:

- An overarching SCADA philosophy document
- Standardized workflows and milestones for undertaking SCADA projects, and workflows/milestones for project managers to use for capital projects that involve SCADA
- Approved standardized PLC hardware and HMI software
- Approved standardized equipment/instrumentation lists
- Standardized PLC panel design templates
- Standardized loop drawing/connection drawing templates
- I/O Design templates including standardized I/O for each type of starter/actuator/instrument
- PLC Programming guides and templates, for both the new standardized "modern technology" PLC hardware and for updating already-installed legacy PLC hardware
- HMI screen design guides and templates
- Standardized tagging for HMI data tags
- Alarm design guidelines and templates
- Example code (PLC/HMI) for fully programmed sample sites, one for each type of facility that Guelph Water uses
- Process Control Narrative (PCN) templates and examples.
- Templates for various documents, drawings, and check sheets that are used at the various stages of design, programming, testing and commissioning.

The entire package of standards has been developed to work together as a set. For example, the format and structure of the new standardized PCN format is tailored to line up the with new standardized code structure.

One feature that is unique to the Guelph Water SCADA standards is that they include design/programming guidelines for <u>*both*</u> how to use new modern PLC hardware, <u>*and*</u> for how to update legacy PLC hardware while it is still in service. The intent is the standards could be used both for complete PLC/HMI replacement projects and for projects where the existing PLC hardware is being re-programmed in conjunction with the development of new HMI screens.

The first version of the new Guelph Water SCADA design and programming standards was released in July 2018.

Testing out the New Guelph Water SCADA Standards

Three capital projects were used to test out the newly-released Guelph Water SCADA Standards. Two existing well stations, Emma Well and Water St Well, were selected to test out using the standards for re-programing legacy PLC hardware. A new-build project, the Burkes Well Upgrade – which involved the complete replacement of all process equipment and the associated control system – was used to test out applying the new Guelph Water SCADA standards on a new-build project with new modern standardized PLC hardware.

One of the major goals behind the Guelph Water SCADA standards is that once a site with legacy PLC hardware has been re-programmed with new PLC/HMI code, the HMI screens would not need to be modified again when the legacy PLC is replaced in the future – instead, only the HMI data tags will need to be repointed to the new memory addresses in the replacement PLC. This approach is the one that was used for the Emma Well project, with its existing legacy PLC hardware that is still in good condition. So, in 5-10 years from now when the legacy PLC hardware at Emma Well is replaced with a new PLC and new PLC programming, the only HMI programming required will be re-pointing the existing HMI data tags to the new memory addresses in the new PLC.

High Performance HMI Design Techniques

A major goal of revamping the Guelph Water SCADA Standards in 2018 was to incorporate High Performance HMI (HPHMI) design techniques as much as possible. HPHMI has undergone significant development during the past 20 years. These techniques are well explained in resources such as The High Performance HMI Handbook (Hollifield et al, 2008), the ASM's Effective Operator Display Design (Burns et al, 2013), Alarm Management for Process Control (Rothenberg, 2008), the EEMUA 201 standard (UK-HSE, 2010) and the ISA's very own ISA101 HMI Design Standard published in 2015.

Highlights of High Performance HMI techniques include:

- Using a written end-user HMI philosophy document as a steering document to guide the design, programming, use and maintenance of Human Machine Interface systems.
- Development of end-user HMI Style Guides and Programming toolkits to promote uniformity of the look/feel of the HMI system and reduce the amount of custom programming needed to make changes/additions.
- In normal conditions, reducing the use of colors as much as possible on screens, and instead using shades of grey to make "normal elements" on screens more muted.
- Reserving the use of bright colors for alarms, rather than for showing status. For example, showing pump/valve running status using white (running/open) and grey (stopped/closed), rather than the traditional choices of bright green and red.
- Avoiding graphical detail as much as possible on HMI screens, and instead using simplified icons and shapes
- Avoiding the use of moving icons to convey status. For example, not showing rotating pumps, spinning fans, moving conveyors, turning clarifiers, etc.
- Using redundant coding to show the status of process equipment, e.g., showing the status of pump using both color and On/Off text.
- Having a dedicated alarm display, or at least a dedicated alarm banner area on all screens that is always visible.
- Having a controlled way for operators and maintenance staff to temporarily disable alarms due to malfunctions or system maintenance. Thus, there should be methods built-in the HMI to do both Alarm Shelving and to place an alarm into an Out-of-Service state. Alarm Shelving is a controlled/logged way for operators temporarily disable alarms. Alarm Out-of-Service is controlled/logged way to mark alarms out-of-service for maintenance. Ideally support should be a built-in feature of the HMI software.
- Breaking up depictions of process status into separate HMI screens of increasing detail. For example, level 1 (system overview), level 2 (facility overview), level 3 (process overview), and level 4 (unit detail view), etc.
- Having a dedicated Level 1 system overview screen to provide situational awareness to operators at all times
- Making use of embedded chart/graphs to show context in place, rather than making users navigate away from process screens to look at separate trend screens.
- Showing the context of process values whenever possible, by way of showing normal operating ranges, embedded trends, trip values, etc. along with the current eading.
- Removal of unnecessary non-process details from screens
- Adding additional task-oriented screens to assist operator with undertaking activities involving multiple processes.
- Managing the HMI system using a long-term lifecycle approach to ensure screens are kept up to date, maintained, and regularly reviewed for effectiveness. That is to move away from the "project-oriented" approach of the past, as in reality HMI systems tend to be continually used/updated throughout their lifecycle.
- Using revision control and management of change procedures for managing changes made to the HMI.

An example of a HPHMI Level 3 process overview screen from the High Performance HMI Handbook can be seen in Figure 3.

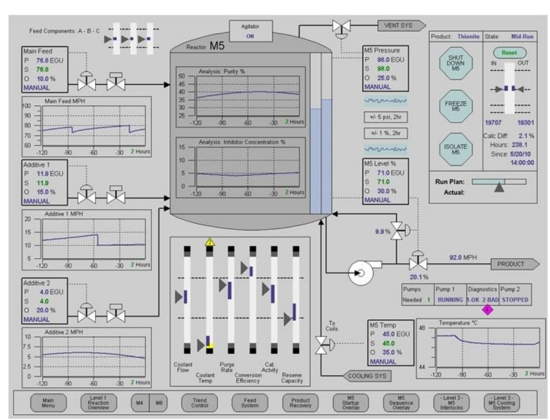


Figure 3 – High performance HMI Level 3 Screen Example (Source: High Performance HMI Handbook)

Adapting High Performance HMI Design to Guelph Water

When it came to applying High Performance HMI design techniques, Guelph Water decided to use a modified approach.

To try to roll out all of HPHMI features/techniques all at once would have resulted in considerable changes to the existing HMI system that the operations team is familiar with, and could have resulted in significant push-back from operators.

Instead, a conscious decision was made to roll out the High Performance HMI design techniques gradually so the operations team had time to get familiar with the new screens, and the associated updated PLC Programming.

A fully integrated approach was also taken to HMI design, as many of the new HPHMI features are only possible to implement if the associated data tags to drive them are also implemented in the PLC code. Thus, as part of the Guelph Water SCADA Standards update, both the new HMI screen templates and PLC code templates were developed in parallel.

When selecting which High Performance HMI (HPHMI) techniques to use, the features Guelph Water decided to use were based on what would provide the most immediate benefits for the operations team, and what would make the best use of the built-in features of the current HMI software.

The following is a list of the HPHMI design decisions that were made by Guelph Water as part of developing its new SCADA design and programming standards:

- The Operations Team was used to having HMI screens with a certain look and feel. Trying to institute radical changes all at once would have resulted in significant resistance/confusion, so a gradual approach for updating the appearance and functionality was used.
- Rather than using the usual High Performance HMI grey background, a neutral light-blue color was selected. The light blue also tied in well with a "blue = water" theme.
- The existing use of the colors Green (running/open) and Red (stopped/closed) was retained, as the operations team was used to using a "traffic-light oriented" color scheme.
- At this time, there are no plans to move to the newer HPHMI scheme of white (running/open) and grey (stopped/closed). However, the Guelph Water SCADA standards do require that pump/valve status be shown with redundant coding of using both color and On/Off (Open/Closed) text.
- Site-specific overview screens for sites, such as Emma Well, will be created as Level 3 screens, and will look like a simplified version of Process Flow Diagrams.
- The more advanced HPHMI design techniques, such as presenting process data with sliders, radar charts, embedded charts, and normal operating envelopes/trip values, will be reserved for use on Level 1 and 2 overview screens. Level 1 and 2 screens, as well as task-specific screens, are being developed as part of the overall HMI system and not as part of any site-specific upgrade. In the future, the plan is to implement Level 1 and 2 screens to use the HPHMI white/grey color schemes, rather than the red/green statuses used on Level 3 screens.
- Overall, current HPHMI design efforts will be concentrated on removing unnecessary graphical elements from screens and developing standardized toolkits using a muted grey color scheme, as much as possible.
- A clear distinction will be made between how status indicators, alarm indicators, faults, interlocks, and permissives are shown on screens.
- Status signals will be shown as raw status signals. Alarms will be shown as alarms. The old practice of using a single indicator to show both status/alarm will no longer be used, as alarms almost always have additional filtering, such as trigger delays, latching and state-based masking.
- The use of "alarms" for purposes other than notifying an operator of an abnormal situation requiring a timely response will no longer be permitted. Alarms will *not* to be used to show status or to act as interlocks.
- The concepts of "Control Scheme", "Permissives" and "Interlocks" for controlling equipment will be built into the design of the HMI and clearly depicted as such.
- Each device in the system will be programmed so it will have its own collection of numbered permissives and interlocks for detailing with abnormal situations, plus a list of numbered alarms that are specific to that device.
- The Guelph Water Design/Programming standards will contain both written guidelines and programming templates, along with fully-functional programmed PLC+HMI examples for each type of facility. The intent is to make following the standards programmer-friendly.

A trade-off also had to be made between what graphic elements were "easy" to do in the existing HMI software package and which would require additional custom programming. Some of the more advanced HPHMI techniques, such as zoned analog sliders, radar plots, and auto-masked screen elements were used sparingly, and only on Level 1 & 2 overview screens, to reduce the amount of custom code. Fortunately, the current HMI software package made it possible to embed process trends on both screens and pop-ups. The current package also contained tag-substitution macro-files which made using standardized pop-up windows easier.

The main difference between a pure High Performance HMI design approach, and what is being used for Guelph Water's design standards, is the color scheme.

Thus, for now, Guelph Water continues to use a traffic-light based color scheme:

- Red = Stopped/Closed
- Green = Running/Open.
- Yellow = Valve partially open/closed
- Magenta = error / fault / alarm indicator

In 5-10 years the color scheme will be re-evaluated. At that time there may be more interest in converting to the muted-grey HPHMI colors. In the meantime, operators continue to “obey traffic lights” – Red means stop and Green means go.

Using the New Guelph Water HMI Design Standards

The design of the new Guelph Water HMI is structured around the concept of a station overview screens. Each station will have its own overview screen, which provides and overview of the station and various buttons/icons that can be clicked to view/access additional details. This is then accompanied by a set of overall system-level screens that provide system level overviews, trend screens and various other screens for troubleshooting purposes.

The new Level 3 overview screen for the Emma Well station can be seen in Figure 4.

List of Screens & Pop-up Windows for Emma Well

The following new screens and pop-up windows were developed for the Emma Well upgrade project:

- Emma Overview Screen (Level 3 screen, full screen)
- Trend screen, selectable set of Emma pens (full screen)
- Device Pop-Up Windows (Pop-Ups)
    - Well Pump
    - Motorized Backflush Valve
    - Hypo Pump (12% NaOCl peristaltic feed pump)
- Analog Measurement/Alarm Windows (Pop-Ups)
    - Well Level
    - Well Pump Discharge Pressure
    - Well Pump Discharge Flow / POE Flow
    - Hypo Tank Level
    - Pre-Contact Free-Chlorine Analyzer
    - POE / Post-Contact Free-Chlorine Analyzer
    - POE / Distribution System Pressure
    - Building Temperature
- Control/Setpoint Pop-Up Windows (Pop-Ups)
    - Station Permissives & Interlocks
    - Flow and Runtime Data
    - List of Alarms (list of all configured alarms)
    - Station Setpoints
    - Hypo Dosing Setpoints
    - Interlock Setpoints
    - CT Calculator (real-time contact time calculator)

The Guelph Water SCADA standards make use of a set of Guelph-Water-specific re-useable pop-up window templates that are used throughout the SCADA system using easily-programmed tag-substitution scripts/macros Tag-substitution scripts are a common feature in most modern HMI software packages, and they make deploying standardized pop-up window much easier to program and maintain.

Through the use of tag substitution scripts and macro files, Guelph Water has been able to customize the standardized pop-up windows at each site, while at the same time reducing the amount of custom code that needs to be written.

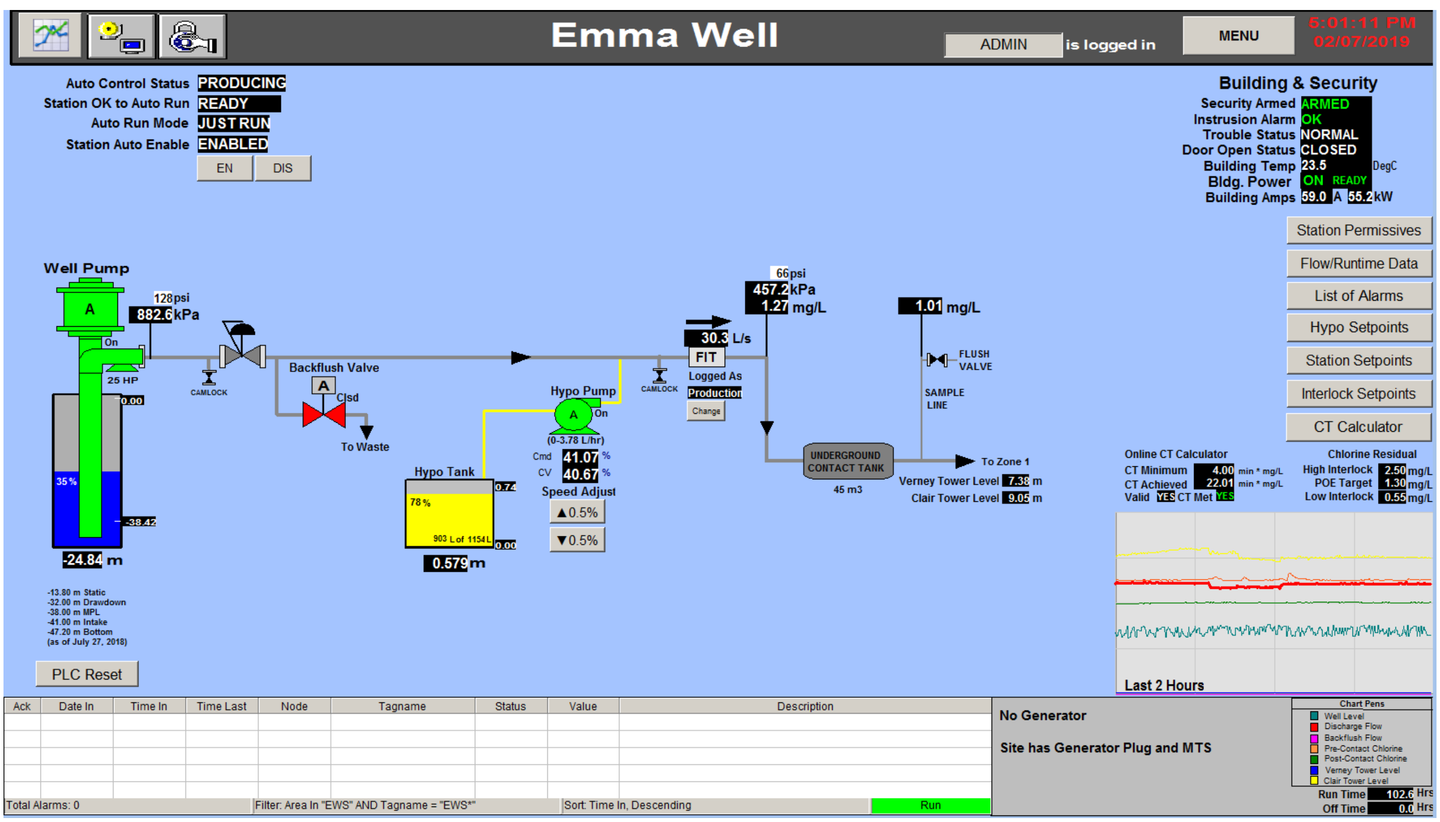


Figure 4 – Emma Well Overview Screen (Level 3 HMI Screen)

Standardized HMI Data Tags

Within the Guelph Water SCADA system, a standardized tagging scheme is used for all of the HMI data points. In the HMI software that Guelph Water uses, a real-time database is used to define each tag, which PLC memory address it points to, and a polling frequency. For most tags, a polling frequency of 2000 milliseconds (syncing values every 2 seconds) is used as this provides a reasonable trade-off between screen updates / response-to-operator input vs. load on the system.

One of the benefits of the HMI software package that Guelph Water uses is that the update frequency of each tag can be explicitly defined/tuned for each tag. (Some systems do not provide this feature). Each tag also has both an alphanumeric tag identifier and text description field, along with a field for the tag's engineering units. Each tag can also do value scaling, in case this is not already handled within the PLC code.

Guelph Water data tags are either 12 or 16 characters long, depending on the complexity of the associated device/instrument/item. Data tags may be associated purely with a device/instrument, or may represent a setting, setpoint, status or condition within the control system itself. The 12 character tags are made up of 5 separate tag fragments, whereas the 16 character tags use 6 fragments. The tags are arranged so they are "big-endian", meaning that they can be easily sorted from general-to-specific when read from left-to-right. The tags also always start with a letter, contain no spaces or dashes, and are always the same length. Only letters, numbers and underscores are used. This makes it easier to sort/manage data tags in both the HMI software package and in other systems that use the HMI data tags to do reporting.

The 12-character data tags, consisting of five fragments, are used for simple equipment and are structured as follows:

- AAA = site code
- BBB = equipment type (e.g., RES = reservoir, G00 = well pump
- x = equipment number, starting at 1 for the site, or 0 for all
- CC = aspect (e.g., 00 for device, FI = flow, LI = level, etc.)
- D = signal type (e.g. S = status, E = alarm, Q = analog, etc.)
- EE = signal meaning (e.g., RS = run status, 01 = value, etc.)

For example, for tag: EWSDL01AIQ01

- EWS = Emma Well
- DL01 Discharge Line 1
- AI = chlorine analyzer (on discharge line)
- Q = analog value
- 01 = scaled engineering value (0-5 mg/L)

For more complex equipment, the 16-character data tagging scheme is used, consisting of six fragments:

- AAA = site code
- BBB = equipment type (e.g., RES = reservoir, G00 = well pump
- x = equipment number (e.g., starting at 1, or 0 for all of type)
- CCC = sub-equipment type (e.g., DV0 discharge valve)
- y = sub-equipment number (e.g., starting at 1)
- DD = aspect (e.g., 00 for device, FI = flow, LI = level, etc.)
- E = signal type (e.g. S = status, E = alarm, Q = analog, etc.)
- FF = signal meaning (e.g., RS = run status, 01=value, etc.)

For example, for tag: BKSFLT1MV01ZIQ01

- BKS = Burkes Well
- FLT1 = Filter 1
- MV01 = motorized valve 1 (on the filter)
- ZI = position feedback
- Q = analog value
- 01 = scaled engineering value (0-100% open)

To guide software developers using the Guelph Water SCADA Programming standards, both a Tagging Convention document (that defines the valid codes that can be used for each fragment) plus a Tagging Examples document (that provides examples of valid tags made from fragment combinations for a variety of applications) are provided. Used together, the two documents help avoid a lot of the ambiguity that is often present in SCADA data-tagging standards.

The above 12 character (5 fragment) and 16 character (6 fragment) tagging schemes were developed for backwards capability with existing tags in the system. Like ISA-5.1 based schemes, the Guelph Water scheme is based on the function of each instrument/device. However, unlike ISA5.1-based scheme is more easily alphabetically sorted by equipment.

Features of the Emma Well Overview Screen

The Emma Well overview screen has been designed with several standard screen elements that appear on every Level 3 screen as part of the Guelph Water SCADA Standards. The idea is to provide a consistent Level 3 HMI screen interface that the operations team can get used to working with.

The parts of a Guelph Water Level 3 overview screen include:

1. Top Information Bar (top)
2. Station Status & Control (top left)
3. PLC Reset Button (bottom left)
4. Alarm Banner Area (bottom)
5. Building Security/Temperature/Power Status (Top Right)
6. Buttons to bring up site setpoint/status pop-ups (Right)
7. Real-time Online CT Calculator (Right)
8. Chlorine Residual Target, Hi/Lo Interlocks (Right)
9. Embedded Station KPI Trend (Bottom Right)
10. Generator/Power Status Information (Bottom Right)
11. Station Run Time vs. Off Time in Hours (Bottom Right)

Top Information Bar: The Top status bar provides navigation buttons to return the SCADA system's main menu screen, bring up the full-screen alarm summary display, bring up the full-screen trending tool, and for a user to login/logout. It also provides the title for the current screen, the username of the currently logged in user, and the current date/time. An example of the top status bar can be seen in Figure 5.

Figure 5 – Top Information Bar

Station Status & Control: On the top-left, station status indicators provide overview information as the status of how the station is working as a whole. The station's automatic control status gives a quick Producing / Idle status in terms of if the site is producing water. The "Station OK to Auto Run" provides a status if all the station permissives have been met to allow the station to run automatically (noting that Permissives only refer to prerequisites for the station to able run, and not the core automatic control scheme). The "Auto Run Mode" provides information as to what type of automatic-control mode the station is using, whether it be "Just Run", "Tower Level Mode" or "Pressure Transmitter Mode". Lastly, the "Station Auto Enable" setting allows an operator to quickly Enable/Disable the station, by clicking the EN/DIS buttons and then answering "Yes" to a confirmation dialog box that comes up. This can be seen in Figure 6.

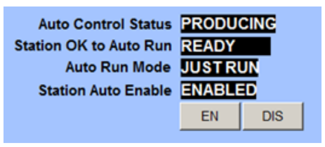


Figure 6 – Station Status Indicators

The PLC Reset Button: On the bottom left of the overview screen is a "PLC Reset" button. Each site has two master PLC reset buttons – the first is a physical reset button that is mounted the PLC panel and the second is the clickable "PLC Reset" button that on the overview screen. These buttons are used to reset any activated interlocks (which will latch into place if they have shut down a pump/valve) and to unlatch any latched alarms (if latched alarms are used as part of a site's programming.)

Bottom Alarm Banner: Each overview screen also has an alarm banner area at the bottom, which displays any alarms for the site. It has a filter applied so alarms from other sites are not shown. The banner features columns for the date/time of the alarm, the alarm tag, its current status, and the alarm tag's description. This can be seen in Figure 7.

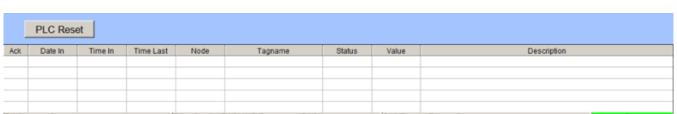


Figure 7 – PLC reset button and bottom alarm banner

Building Status: The top right corner of the overview screen is used to show the status of the station building itself. Reading from the top, this includes the site's security system (armed, intrusion alarm, trouble/low-battery, and door open). This is then followed by the building temperature.

During the past 5 years, Guelph Water has moved away from using Hi/Lo temperature switches. Instead, all buildings are now equipped with a low-cost building temperature transmitter, with a local LCD readout. This allows building temperatures to be monitored over time, and adjustable alarms to be configured to alert operators to overheating in the summer (exhaust fan failures) and winter freezing (heating failures). Having real-time building temperatures has also made it easier to avoid overly heating buildings in the winter.

The building status screen also displays the building's real-time electricity usage in Amps and Watts from the building's digital power monitor. If s station's smoke detector, flood switch, and/or hatch switches are activated, indications would appear in this area as well.

There are also two indicators with respect of current status of power at the station: The ON/OFF indicator shows if building power is currently available on site; whereas the Ready/Not-Ready indicator shows if the building power has been on and stable for at least 2 minutes. The station's PLC programming will not attempt to auto-restart any equipment until the power has been stable for a minimum of 2 minutes. The determination of the building power status is done via a *PLC panel power feed status relay* that is located inside the PLC panel. A close-up screenshot of the Building Status indicators can be seen in Figure 8.

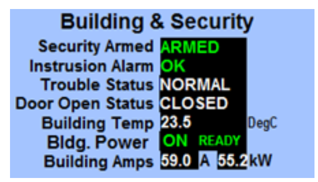


Figure 8 – Buiding Status Indicators

Navigation Buttons: Buttons to bring up pop-up windows for the stations' pop-up windows, not associated with specific devices or analog measurements, are located on the right side of the screen. A standardized ordering and labelling of these buttons is used. User-based security is used to ensure that certain buttons only work when a user with appropriate permissions has logged into the HMI. See Figure 9.

Figure 9 – Right-hand side Navigation Buttons

Each device and analog measurement has its own pop-up window which is accessed by clicking on the associated icon.

The top information Menu bar, also contains buttons to navigate to the SCADA system's main menu screen, trend screen, and full-screen alarm display.

Real-Time Online CT Calculator: The right-hand side of the site overview screen contains summary information from the online CT Calculator. This consists of displaying real-time key performance indicators (KPIs) for the disinfection process. This includes the Required CT, Achieved CT, and an indicator if the Required CT is currently being met or not. A Calculation Valid/Invalid indicator is also shown to remind the user that the CT numbers are only valid once the well pump has been running for several minutes and all of the various analyzers/transmitters have had a chance to achieve steady state after start-up. This is shown in Figure 10.

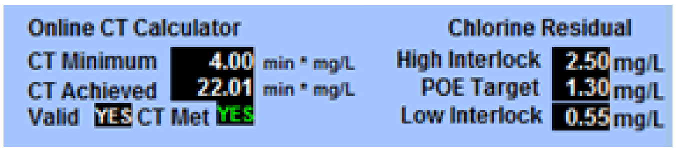


Figure 10– Online CT Caculator and Chlorine Residual KPIs

Chlorine Residual Target & Interlocks: In addition to the Online CT Calculator, the current Hypo dosing target setpoint (in terms of mg/L of free chloride), and the worst case Hi and Lo chlorine shutdown interlocks are shown. This provides a handy on-screen reference for the operator while they are operating the station.

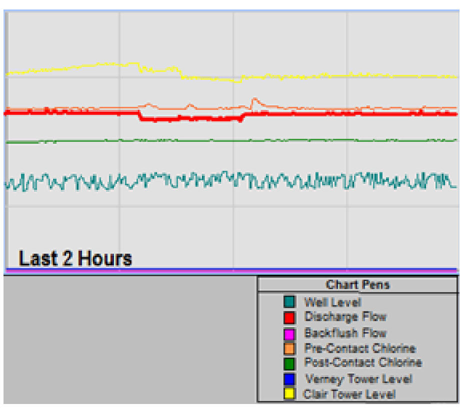


Figure 11 – Embedded Summary Trend of KPIs

Embedded Summary Trend: On the bottom right of the screen is an embedded summary trend that contains the key performance indicators (KPIs) for the site. This includes: well level, discharge flow, backflush flow (used during start-up), pre-contact-chamber chlorine and post-contact-chamber chlorine. The display also contains the level of two water towers in the distribution system that the well pumps into.

By default, the summary trend displays a 2 hour time period but the user can click on the time scale text to toggle between the last 2 hours, 12 hours, 24 hours, 48 hours, and 7 days. The intent of this graph is for the operator to quickly be able to scan for anomalies by looking at the “shape” of the lines. If needed, a more detailed analysis of trends can be undertaken using the full-screen trend screen (accessible by the Trend button on the top-left of the site overview screen).

Generator Status: Also on the bottom right part of the screen is a grey-backgrounded information area for the site’s back-up power generation. If a site has a manual transfer switch (MTS) and a generator hookup, like Emma Well does, this standby power information will be shown here. This can be seen in Figure 12. As Guelph Water has 35 different facilities, having this information readily available on the HMI overview screen for each facility is a helpful reminder for operators.

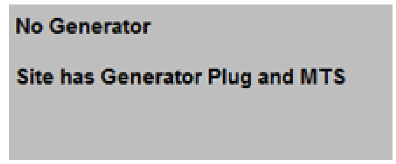


Figure 12 – Emma Well Standby Power information

If a site had permanently installed standby generator and automatic transfer switch (ATS), these details will be shown on the bottom right of the site’s HMI overview screen. How the generator plus ATS info would appear is shown on Figure 13, which is a screenshot from the Burkes Well facility.

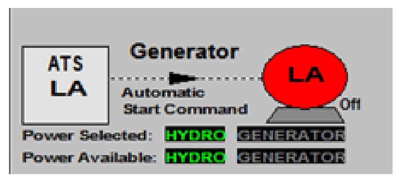


Figure 13 – ATS and Generator status indicators from another Guelph Water site (Burkes Well)

In the Burkes Well example, notice how the status indicator “LA” (instead of “L”) is used to show that both the ATS and Generator are in a “local auto” mode, in that they are automatically controlled by a local controller (and not the site PLC, and not using locally mounted hand switches). One of the interesting quirks about Canada is that the term “Hydro” is used to mean utility power, since most electricity in Canada traditionally comes from hydoelectric power stations.

Station Run Time vs. Off Time: On the extreme bottom right of all screens there is are hours counters that shows how long a site has been producing water continuously or how many hours the site has been shut down for. These two hour counters, which are driven by the PLC, give operators a quick view of how long the station has been operating or offline. For some stations, there are special sampling and/or flushing requirements as part of a restart procedure if the station has been offline for more than a certain period of time. These two counters make it easier for operations staff to determine if these additional station re-start steps are needed or not.

Figure 14 –Station Run Time vs. Off Time Display

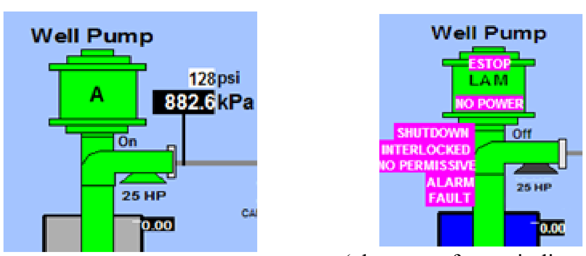
Process Overview Area: In the centre of the Emma Well Overview screen, the process details are shown using a simplified right-to-left and top-down process flow diagram. Visual cues are put on the screen to remind operators of the piping configuration on the site, such the pilot-operated backpressure control valve and camlock connections with hand valves. Each one of Guelph Water's 35 facilities is slightly different from each other, so it is not reasonable to expect the human operator to memorize all the piping details at each site. Thus, the visual cues are provided on the HMI screens to remind operators of major piping details, with printed copies of each site's Process Flow Diagram being readily available if further investigation is ever needed.

Well Pump Icon on the Overview Screen

The main piece of process equipment at the Emma Well is the well pump itself. Though the pump is a submersible pump, it is shown as a motor-on-top pump to make it easier for the operators to visualize. The pump is colored to show its status: Green for running and Red for stopped. The pump also has the status text "On" and "Off" to make its status even more clear.

The size of pump motor in horsepower is noted in static text ("25 HP"). The use of kW for motor size is avoided, since kW can be easily confused with the actual electric power usage.

The pump has a letter on it to show its current control mode (A= SCADA automatic control, M = SCADA manual control, or L = local control via the hand-off-auto switch at the pump starter). The use of A, M, L are the standardized control modes used throughout the Guelph Water SCADA system. (As noted earlier, a different set of modes, LA = local auto and L= local, are used to show statuses of generators and ATS's.)



(run mode) (close-up of error indicators)

Figure 14 – Well Pump Icon with Status Indicators

Under the pump discharge icon there is a small triangle shape, with just its base showing, that is used to show the current command being sent to the pump by the PLC (Green = pump is being commanded to run, Red = pump is not being commanded to run). For all Guelph Water pumps, 2-wire control is used – that is, pumps are always sent a maintained run command. Separate start and stop commands are not used. This ensures that if a PLC were to fault or lose power, the run commands to pumps will drop out instantly. Thus, three-wire control, consisting of start and stop commands, is not used.

The well is equipped with a water level transmitter. The level transmitter consists of a submersible hydrostatic pressure transmitter that has its 4-20mA signal in the PLC scaled according to the insertion depth of the transmitter down from the well's baseplate. Guelph water uses a standardized 0.39" diameter 0-100 psi hydrostatic probe, that is has a raw scaling of -70.39 to 0.00 mH20, with an offset applied in the PLC according to the probe's insertion depth. By using a standardized 0-100 psi probe for all of Guelph Water's 22 production wells, it has allowed for a single type of probe to be used regardless of the well's individual depth. This has made spare parts management for well level probes considerably easier (and cheaper) for Guelph Water.

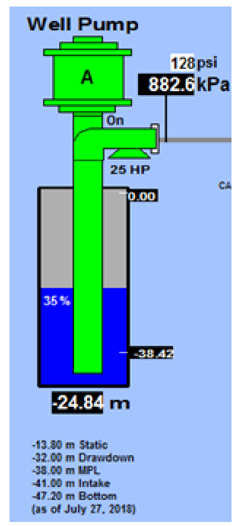


Figure 15 – Well Water Level and Discharge Pressure Transmitters

On the right-side of the well graphic, the insertion depth of the probe is shown, along with a reminder that the "zero reading" of the probe is at the well base plate. Well level measurements are negative, in meters below the well base plate. The percentage readout of the usable span of the probe is also shown, along with a "fill animation" in the well itself. Lastly, the actual well level reading is shown, along with a visual reminder that the well level probe does not go down as far as the pump's intake. Below the pump are the construction details of the well, along with the maximum pumping level, and static/drawdown levels from the last pumping test that was carried out. This information is updated annually.

All Guelph Water well pumps are equipped with discharge pressure transmitters. These transmitters, which are a low-cost 0-300 psi pressure transmitter, are installed directly on the pump discharge before any isolation valves or check valves, in order to get the true discharge pressure of the pump. In the SCADA system, since Canada is a metric country, the pressure is shown in kPa; however, an additional readout in PSI is also provided for those operators more familiar with the older Imperial pressure units. Clicking on the kPa pressure readout will bring up an analog value pop-up window with more information about the instrument and user-adjustable LoLo/Lo/Hi/HiHi alarms which can be set to provide alarm notifications if needed for operational reasons.

Standardized Analog Pop-up Windows

As part of the new Guelph Water SCADA standards, a new standardized analog measurement alarm/diagnostic window was developed. This is shown in Figure 16.

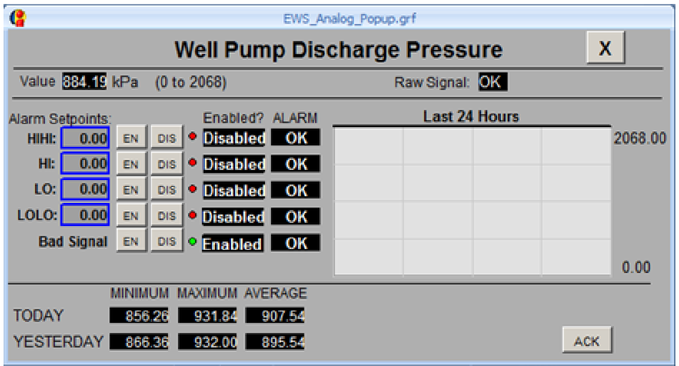


Figure 16 – Analog Measurement Pop-up Window Example

The analog measurement pop-up window provides a standardized way for operators to enable/disable and adjust the Lo, LoLo, Hi and Hi-Hi alarms as needed. The setpoint and enabled/disabled status of each alarm is clearly shown. The in-place trend display makes it possible for the operator to view the analog value trend without having to go another screen. The "Last 24 hours" text can also be clicked with a mouse to toggle between showing a 2 hour, 6 hour, 12 hour, 24 hour, 7 day, or 30 day time period.

It must be emphasized that as part of the Guelph Water programming standards, alarms are no longer used to implement shut-down interlocks or permissives for any process equipment. Instead each piece of equipment will have its own device-specific numbered permissives and interlocks that are specific to that device.

Station Control vs. Sequencer Control vs. Device Control

As part of the Guelph Water SCADA standards, control of a station is broken down into several hierarchical levels, which are as follows:

- **Station Control** – controls when a station is called upon to produce water. For a groundwater well this can include several modes including: "Off," "Just Run," "Tower Level Control," and "Pressure Control". The "Just Run" mode is exactly what it says: the station just runs.

- **Station Sequencer** – controls how the station automatically starts-up, shuts-down, and automatically re-starts after a power outage or loss of station-level permissive. The sequencer receives a call to run command from the Station Control module. The Station Sequencer module will typically have programmed states like: Off, Waiting-for-Permissive, Backflushing, UV Warming-Up, Starting-Up, Producing, Idle, Restart-wait-on-Permissive, and Shutdown-on-Interlock. The statin sequencer will also have of Station-level Permissives that inform it when it is safe to attempt to automatically start the station.

- **Unit Control Module (only sometimes used)** – controls an individual unit process within a station, consisting of several devices working together under a control scheme. For example, a pressure filter at a large treatment site would have its own dedicated control module in the PLC, which will receive commands from the station sequencer. For a small facility like a groundwater well, a Unit Control Module would not be used.

- **Device Level Control** – control of an individual device, which the device being under SCADA-Auto, SCADA-Manual or Local control, as outlined in the next section.

Device Control Modes

In the Guelph Water SCADA system, three control modes are used for controlling devices such as pumps and motorized valves. They are as follows:

- **A = SCADA Auto**, the Hand-Off-Auto switch (or Local-Remote switch) on the device has been set to Auto, so the PLC is in control The PLC is controlling it automatically with using the PLC's automatic control program.

- **M = SCADA Manual**, the Hand-Off-Auto switch on the device has been set to Auto, so the PLC is in control. The PLC is controlling the device based on a fixed command setting in the PLC, entered in by an operator via the HMI.

- **L = Local**, the Hand-Off-Auto switch on the device has been set to Off or Hand. Any commands from the PLC to the device will be ignored by the device. The device is being operated locally using the device's local switches.

For equipment that has its own local controllers (and is not controlled by the SCADA PLC), they are depicted as being in "Local" or "Local Auto" mode. In "Local", the device is being controlled using its local switches. In "Local Auto", the device is being controlled based on a standalone local controller. Examples of this type of control would be a Generator-ATS system, or motorized discharge valves on large pumps that are typically controlled by the motor starters.

In fact, it is a requirement at Guelph Water that any control devices, such as a motor starters or motorized valves, must be equipped with physical local Hand-Off-Auto (HOA) switches.

The installation of devices without HOA switches (or Remote/Local switches) is not permitted. At Guelph Water, there must always be an option to run equipment "in hand" using switches, without relying on the SCADA system, so in the case of a SCADA failure the station be run in hand.

Control Schemes and Abnormal Condition Handling

One of the central tenants of the Guelph Water SCADA standardization strategy was to standardize how normal and abnormal operating conditions are handled as part of the overall control strategy.

In the Guelph Water SCADA system, automatic control is modular in nature and broken down into two sets of programmed rules: The first is the "control scheme", which is how the automatic control is to work under normal conditions. The second is the "exception handling", which takes the form of a set of numbered permissives and interlocks that are specific to the device.

The following terminology is used:

- **Control Scheme** – A control scheme is the basic control for a device (pump or valve) when under automatic control, such as level-based control for emptying or filling. A control scheme may involve one or more devices under automatic control.

- **Permissive** – A permissive is a condition that must be true in order for a device to run and/or start. If a permissive is lost when a pump is not running, no action is taken other than that the device is prevented from starting. However, if a permissive is lost while a device is running, the device will stop. Once all of its permissive condition becomes true again, the device will auto-restart according its control scheme. Each device has its own set of device-specific numbered permissives.

- **Interlock** – An interlock is an abnormal condition that prevents a device from running (or a valve opening). If an interlock occurs while a device is not running, no action is taken other than preventing the device from starting. However, if an interlock is tripped while the device is running, the device will stop and remain stopped until the interlock is reset by an operator. (The interlock reset must be done via the PLC Panel Reset button on site or via the HMI "PLC reset" button on the site's overview screen.) Each device will have its own set of numbered interlocks.

  Interlocks do not generate alarms – instead there is a special device-specific latching alarm for each device called the "device shutdown on interlock" that is triggered when a device has been shutdown due to an interlock eing tripped while the device was running.

- **Alarm** – An alarm is a notification of an abnormal condition that requires a timely Operator Response, so that the Operator's actions can avoid a likely negative outcome (if the operator did not respond). Each device will have its own set of numbered device-specific alarms. In the Guelph Water SCADA standards, alarms are only used for operator notification – they are not used to implement interlocks, permissives or control schemes.

For motorized pumps, the first five numbered device alarms are standardized as: fail-to-start, fail-to-stop, uncommanded-start, uncommanded-stop, and shutdown-due-to-interlock. Likewise, for motorized valves, the first five numbered device alarms are standardized as: fail-to-open, fail-to-close, uncommanded-open, uncommanded-close, and closed-due-to-interlock. Additional numbered alarms for a device are implemented as needed. Commonly implemented additional numbered alarms for a device are "device power off", "device e-stop activated", "valve position feedback bad signal", etc..

For each set of permissives, interlocks and alarms, arrays of numbered tags are used, thus avoiding the need for "custom tags". For example, for the Emma well pump device, the tags used are: EWSG001_PERMxx, EWSG001_ILOCKxx, and EWSG001_ALRMxx, with xx being the number. The "description" field of each tag is then used define what the numbered permissive, interlock, and/or alarm is for. Permissives, Interlocks and Alarms are also implemented as numbered arrays within the PLC code.

If there is a genuine need for an "Inhibit" (that is, a condition to prevent a device from starting but not to stop a device that is already running), this is implemented as a specially programmed permissive. For example, at Guelph Water Booster Pumping stations each booster pump will have a permissive to prevent it from starting if another pump at the station has already started or stopped within the last 10 minutes – this is to prevent transient pressure waves.

Standardized Device Pop-Up Windows

As part of the Guelph Water SCADA programming templates, a set of standardized pop-up templates has been developed to support the overall control strategy of: control schemes, permissives, interlocks, and alarms when it comes to devices. This can be seen in the default view "rolled-up version" of the well pump device pop-up window in Figure 17.

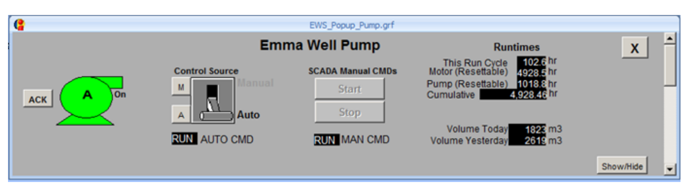


Figure 17 – Well Pump Pop-Up Device Control Window (shown in the default "details rolled up" view)

When a pump device pop-up is called up by a user by clicking on a pump icon on the overview screen, the pop-up will appear in its default rolled-up form. Most operators will only use the pop-up this way. However, a “Show/Hide” button is provided so the details of the device’s permissives, interlocks and alarms can also be shown in “rolled-down” view. In this view, the pump pop-up becomes a powerful troubleshooting tool. However, let us first go over the screen elements of the normally-viewed top part of the pop-up window.

Pump Device Pop-Up Window – Top Part

The top part of the pump device pop-up window has been designed to give the operator a quick way to view key status information and be able to remotely control the pump via the HMI. The features of this top part of the device pop-up are, from left to right, as follows:

Ack Button: On the far left of the top part of the screen is a device-specific “Ack” button that is used for acknowledging pump-specific alarms and resetting pump-specific interlocks. (This is an alternative to using the station-wide “PLC Reset” button that is on the station’s overview screen.)

Pump Icon: This is followed by a Pump Icon that colored to show its status (Green = running, Red = stopped) and has pump status text “On” and “Off” beside it. Colors and text are used to provide redundant coding/display to the operator. The error condition indicators, namely: NO POWER, ESTOP, SHUTDOWN, INTERLOCKED, NO PERMISSIVE, ALARM, and FAULT, which also appear on the associated pump icon on the overview screen, are also replicated here.

Error Indicators: The error indicators, which are standardized and appear as white text on a bright pink/magenta background, are defined as follows:

- E-STOP = e-stop has been pressed
- NO POWER = motor starter has not power
- SHUTDOWN = pump was shutdown on an interlock
- INTERLOCKED = an numbered interlock is active
- NO PERMISSIVE = a numbered permissive is not met
- FAULT = overload/fault status from the starter
- ALARM = one of the pump’s numbered alarms is active

Mode Indicator: Just like on the overview screen, the pump icon has a mode letter inside of it, which can be A = Auto, M = Manual, and L = local. In Local Mode, the pump is being controlled locally via the HOA switch on the motor starter.

Command Status: The base of the pump icon (the triangle that the main pump icon sits on) is colored to show the current command being sent to the pump from the PLC’s digital output card. Green Base = pump run command being sent, Red Base = no run command being sent to the pump.

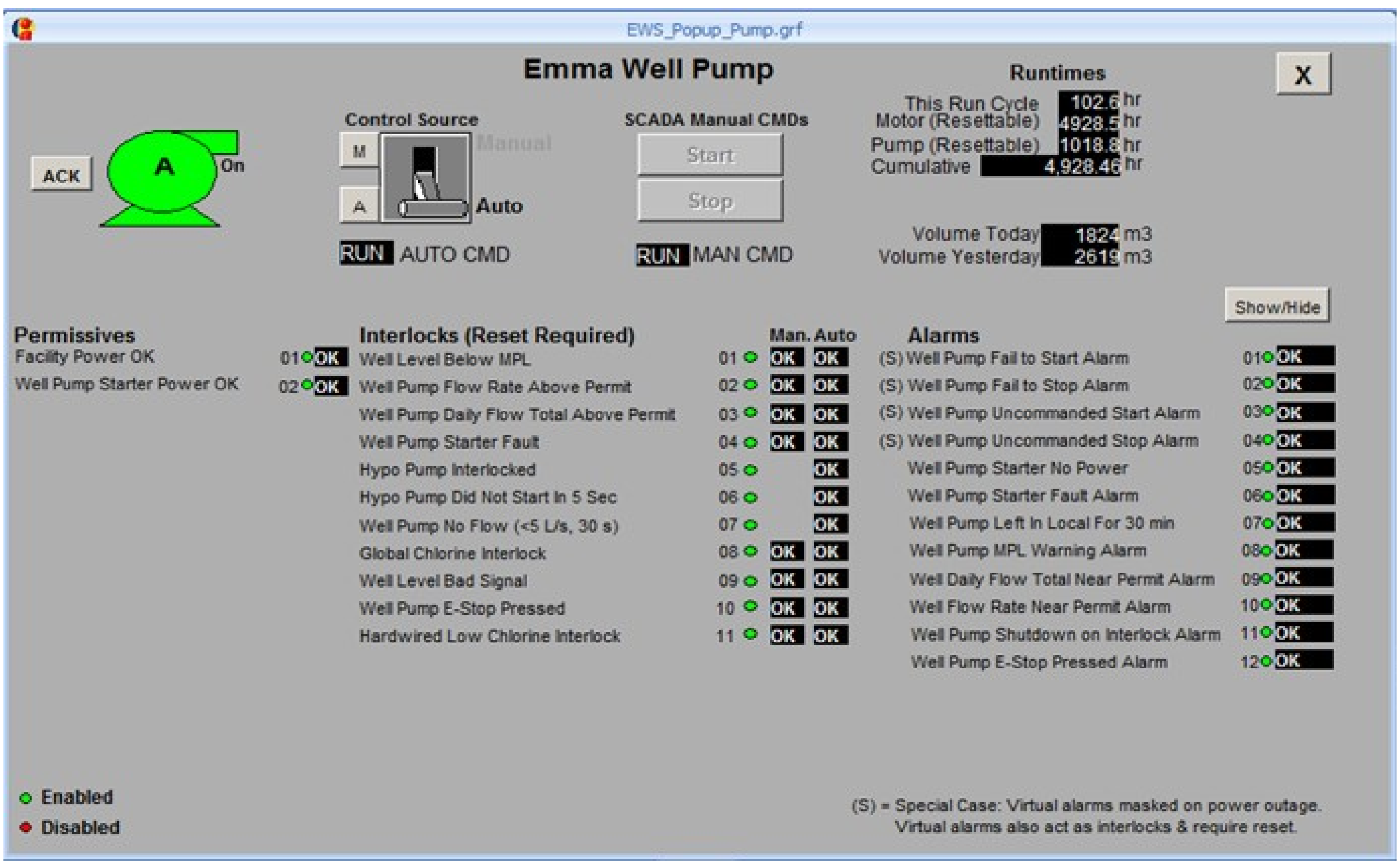


Figure 18 – Well Pump Pop-Up showing numbered device Permissives, Interlocks and Alarms (un-rolled-up view)

Mode Selection: The large toggle switch icon displays the PLC control mode for the pump, namely if it is in to 'SCADA-Auto" or "SCADA-Manual" mode, per the setting in the PLC. The Toggle Switch icon and the text "Auto" and "Man" are used to provide redundant coding/display to the operator.

Buttons, with labels "A" and "M", are provided to set the device remote control mode in the PLC. When either of the A or M buttons is clicked, a confirmation dialog window comes up for the operator to confirm they want to make the change.

The reason for providing separate A and M buttons for changing the mode, rather than the traditional approach of clicking on the toggle switch, is to avoid the problem of an impatient operator rapidly cycling the remote control mode by repeatedly clicking on the toggle switch.

Note that the Auto/Manual selection indicators and A/M buttons are always visible, even when the pump is in local mode. This allows the operator to set what mode (Auto or Man) the pump will return to after it leaves local mode. When the pump is in Local, a large text indicator "LOCAL" is shown, in addition to an "L" in the center of the pump icon.

SCADA Manual Start/Stop Buttons: When the pump is in SCADA-Manual mode, "Start" and "Stop buttons are made available for the operator to manually start and stop the pump. They too have confirmation dialog boxes. When the pump is in Auto or Local mode, the Start/Stop buttons are greyed out. In figures 17 and 18, the start and stop buttons are shown as greyed-out because the pump is in SCADA-Auto mode.

One of the great mysteries that operators have in many SCADA systems, is knowing what a device will do when it goes into SCADA-Auto or SCADA-Manual mode. This problem is avoided in the Guelph Water SCADA system by providing the "AUTO CMD" and "MAN CMD" indicators on the pump pop-up window. On the pump pop-up, the AUTO-CMD and MAN-CMD indicators show the operator, exactly what command would be sent to the pump if the pump was put into "Auto" mode or "Manual" mode, prior to the operator putting the pump into those modes.

The PLC has also been programmed, so that when the pump is in SCADA-Auto, the SCADA-Manual command will automatically follow whatever the SCADA-Auto command is doing. This allows the operator to seamlessly switch the pump from Auto-to-Manual mode, without the pump suddenly starting or stopping.

(A similar approach for "bumpless" speed control is used for the SCADA-Auto and SCADA-Manual speed commands on the VFD-version of the pump device pop-up window).

Runtimes & Flow Totals: The indicators on the far right side of the top part of the pump pop-up are purely for displaying status information. The first are the pump's runtime indicators, which are calculated by the PLC based on the pump's running status signal. See Figure 19.

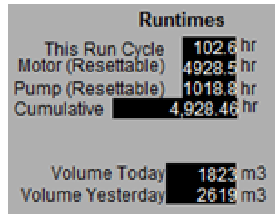


Figure 19 – Well Pump runtime and flow statistics

One of the common problems with resettable runtime counters in most SCADA systems is that operators can never remember when (date-wise) when they last reset the runtime. To counter this problem, the Guelph Water SCADA standards use a cumulative runtime counter, which is only set to zero when the station was commissioned. After that, it is never reset. The cumulative runtime counter, in hours, is also stored as a floating point number in the PLC so there is no risk of it overflowing. (In older SCADA systems, if a traditional signed 16-bit integer number was used as a runtime calculator, it would overflow at approximately 32767 hrs, which translates to just over 3.75 years runtime.) Lastly, the runtime is calculated in 6 minute increments so an operator can easily see the runtime counter advancing as the pump is running.

With that said, two resettable runtime hour counters are provided so the maintenance team can use them for calculating maintenance intervals for the pump's electrical motor and mechanical pump parts if they wish.

Overall, the following runtime readouts are provided:

- **This Run Cycle** = how long the pump has been running for; this is automatically set to zero when the pump stops
- **Motor (Resettable)** = resettable runtime counter for the pump's electric motor
- **Pump (Resettable)** = resettable runtime counter for the pump's mechanical pump part
- **Cumulative** = cumulative runtime since the station was commissioned; this value is never reset.

If the pump has a flowmeter on its outlet, daily flow totals for the current day and previous day are also provided. If there is no flowmeter (or not a dedicated flowmeter for the pump), this part of the device pop-up is blanked out.

One of the design decisions in the Guelph Water SCADA standards was not to create the code and tags to calculate the number of pump starts/stops inside the PLC. Instead, this information can be readily determined from analyzing logged data in the historian, without having to spend the effort to write/maintain extra code the PLC and HMI for this.

Pump Device Pop-Up Window – Bottom Part

On the bottom part of the device pop-up window, see Figure 18, the details of each of the device's various numbered permissives, interlocks and alarms are shown. Each is numbered, so it can be easily communicated over the phone to other operators and/or a support person (E.g., An operator can report that a certain pump is stuck on Interlock 5).

Beside each of the device-specific numbered permissive, there is a status indicator. When a permissive has been satisfied, a white-on-black "OK" indicator is shown. When a permissive has not been satisfied, a white-on-bright-pint/magenta "BAD" indicator is shown. Permissives, due to their programming in the PLC, will automatically switch between the OK and BAD status based on their satisfied/non-satisfied condition.

For each device-specific numbered interlock, a similar OK/BAD indicator is shown. However, if an interlock is tripped (goes BAD) while a device is running, the BAD status will latch in PLC as part of the PLC programming. As noted earlier, this must then be reset but the operator by clicking the Ack/PLC-Reset button the HMI or by pushing the "PLC Reset" button on the station's physical PLC Panel. Have the latched Interlock, provides information to the operator as to what interlock it was the stopped the pump.

Similarly, for each device-specific numbered alarm, the status indicators will show on either the white-on-black OK status, or a white-on-bright-pint/magenta ALARM status. Depending on the alarm, some alarms may require resetting by an operator using the Ack/PLC-reset button.

Beside each Permissives, Interlock and Alarm is a little circle that is colored either Green or Red. For Permissives and Interlocks, a Green circle beside it indicates that the permissive/interlock has been enabled; a Red circle indicates it has been bypassed PLC. Likewise, a green circle beside a numbered alarm indicates that it is enabled, whereas a red circle indicates that it has been disabled in the PLC. (The setting of permissive/interlock bypasses and device alarm disables is set in the PLC code itself, and is managed by the SCADA group using a change control process.)

The use of preconfigured bits/tags in the PLC/HMI for implementing bypasses makes the process of commissioning and troubleshooting stations much easier and much less error prone. The red/green indicators also ensure that if bypass has been activated or a device alarm has been disabled, it is clearly shown on the pop-up window so it is not forgotten.

Why numbered permissives, interlocks and alarms?

As noted earlier there are several benefits of using numbered permissives, interlocks and alarms. These include:

- It eliminates the need for custom data tags for each type of interlock/permissive. Simple numbered tags can be used, instead of having to create custom interlock and permissive specific alphanumeric tags for each condition.
- It allows for simple numbered arrays to be used when programming the PLC data structures.
- It also, most importantly, makes writing Process Control Narratives much, much easier to write and understand. Tables with numbered entries to describe permissive, interlocks and alarms can now be used. Figures 20, 21, and 22 show the PCN tables for the well pump at the Emma Well. Note how the use of tables makes the PCN much more compact, precise and easier to understand.

Permissives – Required to Run. Auto Restart Possible			Applies to			Other
#	Name	Description, Logic, Setpoints, Timers	SCADA Manual	SCADA Auto	Local	
1	Facility Power Ok	- Facility Power must be online	X	X	X	
2	Well Pump Starter Power Ok	- Well Pump starter power OK signal	X	X	--	
Plus	No Interlock Conditions are True	- None of the interlocks in the following table can be active	X	X	--	

Figure 20 – Example Numbered Permissives Table for Well Pump

Interlocks – Stops the Pump, Manual Reset Necessary			Applies to			Reset Type		Other
#	Name	Description, Logic, Setpoints, Timers	SCADA Manual	SCADA Auto	Local	Via HMI button	at PLC Panel	
1	Well Level MPL Interlock	- Well Level dropped below $\boxed{-37.00m}$ for 30 seconds	X	X	--	X	X	
2	Well Daily Flow Total Max Exceeded	- Daily Well Flow Total Reaches 3100 m3 for day	X	X	--	X	X	Totalizer resets at midnight
3	Well Max Instant Flow Exceeded	- Max Instantaneous flow is above limit of 35.8L/s for 60 seconds	X	X	--	X	X	
4	Well Pump Starter Fault	- Fault signal from Well Pump Starter	X	X	X	X	X	
5	Hypo Pump Interlocked	- Hypo Pump interlocked	--	X	--	X	X	
6	Hypo Pump did not run	- Hypo Pump did not start within 5 seconds, after Well Pump Started	--	X	--	X	X	
7	Well Pump No Flow	- Less than 5 L/s of flow for 30 Seconds	X	X	--	X	X	r
8	Global Chlorine Interlock active	- Encompass all interlocks related to both chlorine analyzers. HI LO Cut out, Analyzer Fault and Analyzer Bad Signal for both Pre and Post Chlorine Analyzers.	X	X	--	X	X	
9	Well Level Bad Signal	- Feedback signal outside of 4-20mA Range	X	X	--	X	X	
10	E-Stop Pressed	- Well Pump or Building Hardwired E-Stop Pressed	X	X	X	X	X	
11	Hardwired Chlorine Interlock	- Hardwired interlock from pre contact Chlorine Analyzer active	X	X	X			
Plus	Well pump Virtual alarms	- Well pump fail to start, fail to stop, uncommanded start, uncommanded stop	X	X	--	X	X	Masked if power outage

Figure 21 – Example Numbered Interlocks Table for Well Pump

#	Alarm Description	Alarm Logic	Purpose	Consequence if Ignored	Operator Action	Time to Respond
1	Fail to Start	Standard alarm	Acts as interlock	Loss of production	Investigate	2 hours
2	Fail to Stop	Standard alarm	Acts as interlock	Loss of production	Investigate	2 hours
3	Uncommanded Start	Standard alarm	Acts as interlock	Loss of production	Investigate	2 hours
4	Uncommanded Stop	Standard alarm	Acts as interlock	Loss of production	Investigate	2 hours
5	Starter No Power	Status from starter, mask if no station power	Notify that site cannot run	Loss of production	Investigate, if sustained	4 hours
6	Left in Local for 30 mini	HOA not in Auto for 30min	Notify operator	Not available for auto-control	Investigate on site	4 hours
7	Starter Fault Alarm			Loss of production	Investigate to re-start	2 hours
8	Well Level near MPL	Level below - 35.00m for 5min	Pre-trip warning	Loss of production	Adjust flow rate on site	4 hours
9	Daily Flow Total Near Permit Warning	Daily flow total above 3500 m3 since midnight	Pre-trip warning	Loss of production soon if it hits interlock value	Adjust flow rate on site	2 hours
10	Daily Flow Rate Near Permit Warning	Flow rate above 40 L/s for 60 seconds, pump on for 5min	Pre-trip warning	Loss of production soon if it hits interlock value	Adjust flow rate on site	2 hours
11	Well Pump Shutdown on Interlock Alarm	Well pump shutdown due to interlock	Notification site shut down	Loss of production	Investigate to re-start	1 hour
12	Well Pump E-Stop Pressed Alarm	e-stop button status	Notify that e-stop activated	Onsite assistance needed	Call field operator	5min

Figure 22 – Example Numbered Alarms Table for Well Pump

Other Standardized Device Pop-Up windows

The Guelph Water SCADA system standards also provide a set of pre-built device pop-up window templates for a wide variety of device types. For example, the standardized pop-up window for a motorized valve device pop-up can be seen in figures 23 and 24.

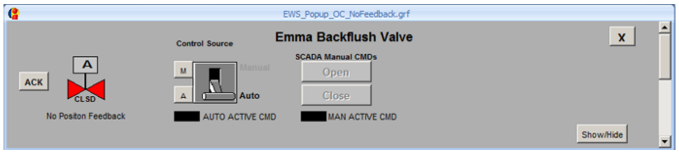


Figure 23 – Motorized Valve Device Pop-Up (default view)

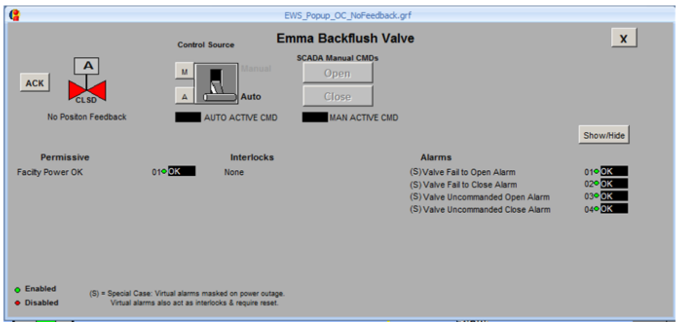


Figure 24 – Motorized Valve Device Pop-up (rolled-down view)

A similar standardized device pop-up window is used for a chemical feed pump. For hypo pumps, Guelph Water uses a standardized speed-controlled peristaltic pump, which has provides both speed feedback and a number of status contacts, including its mode, running status, general fault and tube-leak fault. The Hypo pump device pop-up window from Emma well can be seen in Figure 25 and 26.

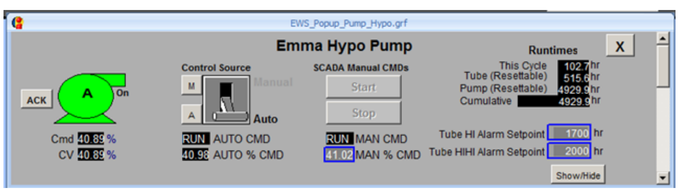


Figure 25 – Hypo Pump Pop-up (default view)

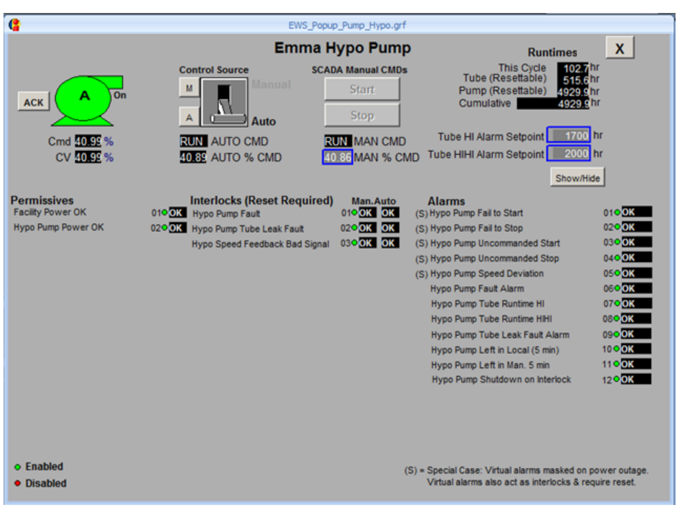


Figure 26 – Hypo Pump Device Pop-up (rolled-down view)

Show Tank and Reservoir Level & Storage Status

One of the features of the Guelph Water SCADA standards is to pack a lot of detail into a screen in such a way that is visible but avoids making the screen seem cluttered. In Figure 27 the Hypo storage tank for 12% NaOCl solution is shown. The level of the tank is shown in meters, the percent full is shown, the tank is animated to show the fill level in yellow, and both the tank total volume and volume remaining are shown. On the right side of the tank, the min-max limits of the 4-20mA signal for the level transmitter are also explicitly shown.

For water storage at reservoirs and water tower sites, a similar approach is used to show the current level, percent full, total and filled volume, the overflow level, and the min/max range of the level transmitter, plus the status of any float switches.

(HPHMI design purists will notice that the tank icons do not include a trend line to show how the level has changed over time. Due to constraints in the current HMI software package, it was decided it was not worth the programming effort to add a trend line inside the tank. Instead operators can navigate to another screen to see hypo tank level trends.)

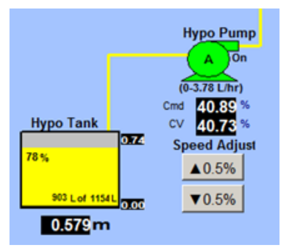


Figure 27 - Hypo Storage Tank with level, % level and volumes

Figure 27 also shows the standardized way of showing a speed controlled device, which consists of the device icon plus the Speed Command (“Cmd”) signal being sent to the pump, the Speed Feedback (“CV”) signal coming back from the pump, and informative text showing the normal flow range for the pump. It should be noted the “Speed Adjust” buttons are not part of the pump icon, but instead part of the automatic control scheme for the pump when it is in SCADA-Auto mode.

Speed Units: Hz for Water Pumps and % for Hypo Pumps

For the control of VFD (variable frequency drive) water pumps, Guelph Water has adopted a policy of using Hz units for pump speed, and not percentage. In practice, it has been found that percentage speed is too vague and leads many communication problems during the design, construction, commissioning and operation of water facilities. The problem with using percentage for speed is that is unclear if it refers to (a) percentage of the full 0-60Hz range, (b) percentage of a 30-60Hz speed range, (c) percentage of a usable pump speed range, e.g., 40-60Hz, or (d) some other arbitrary speed range. By standardizing on using Hz for the water pump speed units, using 4-20mA = 30-60Hz for all speed reference signals, and using 4-20mA=0-60Hz for all speed feedback signals, Guelph Water has been able to avoid many of the common problems associated with commissioning and operating VFDs.

Station-Level Permissives and Interlocks

At the station level, the Emma Well has a set of station-level auto-control permissives and interlocks that are used to ensure the Station Sequencer module does not attempt to start-up the station in automatic mode unless all the equipment is ready for an automated start-up. For the particular Emma Well overall automatic control scheme, a "global chlorine interlock" was implemented to ensure station would not attempt to run automatically if there was an issue with either of the chlorine analyzers. The station permissives and global interlocks had to all satisfied in order for the station to be able to start-up and run automatically. A listing can be seen in Figure 28.

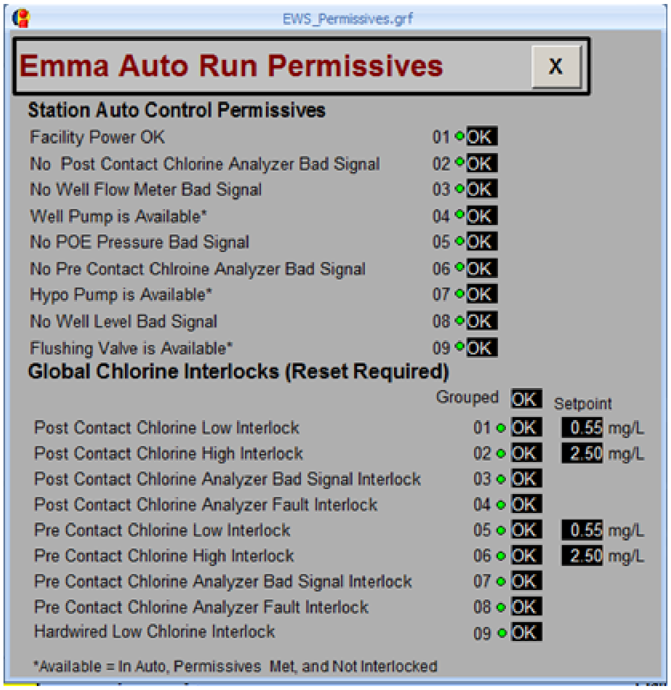


Figure 28 – Station-level permissives and interlocks

One of the automatic control system goals for the reprogrammed Emma Well site was to enable it to be able to automatically re-start without operator assistance after a minor issue, such as a brief power outage. The station-level permissives (auto-restart is possible) and station-level interlocks (automatic re-start not possible) are used by the Station Sequencer Module for managing station re-starts.

Station Control Module & Station Sequencer Module

Apart from the overview screen, analog measurement pop-ups, device pop-ups, and station permissives/interlocks, two major parts of the Emma Well's automatic control system are the Station Control Module and the Station Sequencer Module.

As mentioned earlier, the Station Control Module looks after when the station is called to produce water, while the Station Sequencer Module manages the start-up, shut-down, and automatic re-start of the station. The setpoints associated with these two modules can be seen in Figure 29.

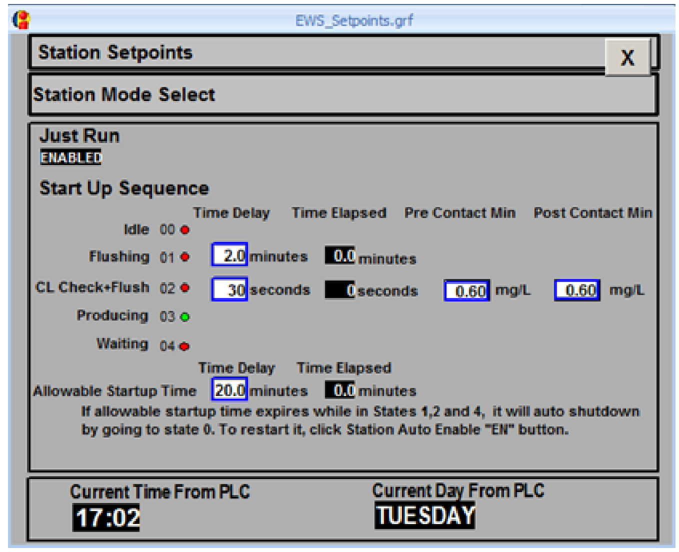


Figure 29 – Station Control & Station Sequencer pop-up

Because the control scheme for Emma Well is relatively straight-forward, and the well is only used in the "Just Run" mode, a single pop-up window is used by operators for entering in the setpoints for both the Station Control Module and the Station Sequencer Module.

The pop-up window in Figure 29 shows the various numbered steps that the Station Sequencer uses to start-up the station. The station shutdown sequence is fairly simple, the well pump is shutoff, the hypo pump shut off, and the PLC ensures the backflush valve is also closed.

From Figure 28 it can be seen there are a number of process conditions, including loss of power, which can cause the Emma Well to auto-shutdown. In the case of an auto-shutdown, the Station Sequencer Module will then attempt for the next 20 minutes to auto-restart the station by continually checking the status of the various station-level permissives and interlocks. If the sequencer is not able to re-start the station within 20 minutes, a "failed to auto-restart" call-out alarm will be triggered, so an operator can come investigate as to what the issue is and take corrective action.

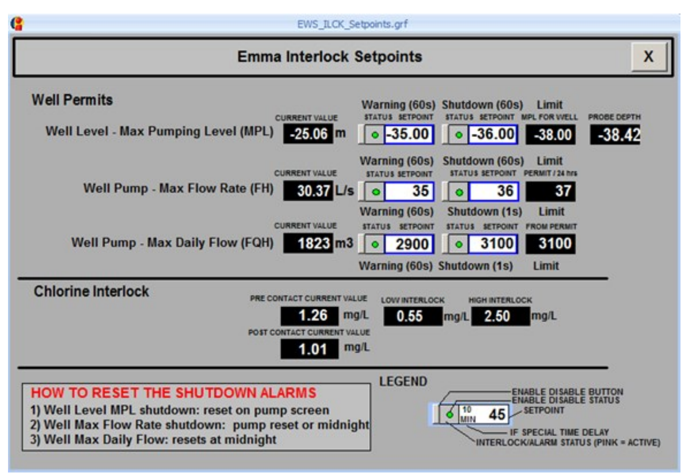


Figure 30 – Well Pump Interlock Settings pop-up

Well Pump Interlocks and Hypo Pump Automatic Control

As the control of the well pump is very straight-forward, in that it is simply commanded to run once the start-up sequence is complete, there are no well-pump specific control setpoints. The well pump does, however, have several interlock setpoints associated the well's PTTW (permit to take water), operational well level draw down limits, and regulatory limits for high/low chlorine. This on a pop-up shown in Figure 30.

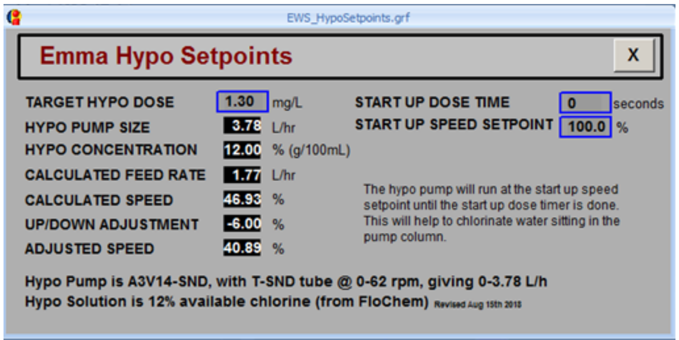


Figure 31 – Hypo Pump Automatic Control Setpoints Window

For the automatic control of the Hypo pump, a dedicated setpoints pop-up window is used to contain it various setpoints, including the target hypo dose setpoint, the calculated feed rate, and the current operator initiated up/down speed adjustment. There is also a setting to give the system a brief shot of extra hypo solution on startup, though in practice, this setting is rarely needed. The Hypo Pump automatic control settings pop-up can be shown in Figure 31.

Better Flow Total, Flow Accounting and Runtimes

Providing better and more standardized flow totalizations and runtime calculations were two goals of the new Guelph Water SCADA programming standards. A standardized pop-up window design is now used for all sites to show both daily flow totals and runtime calculations, as shown in Figure 32.To avoid floating point math errors, flow totalization is only done on a daily basis. Other software tools, as part of the SCADA system's reporting software, are used to add up the daily flow totals. The "yesterday flow total" is generally used in calculations as it always reflects all the flow for the day before, rather than the "today flow total" which accumulates as the day progresses.

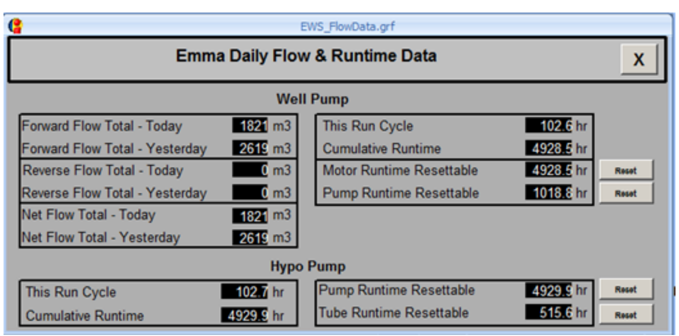


Figure 32 – Daily Flow totalization and runtime calculations

As an extension to the daily flow totalization, a second set of flow totalizers is also used to track how much well water is sent "to production" vs. how much is sent "to waste" due to well flushing activities. The "to production" and "to waste" daily totals have proved to be very useful for when doing end-of-year water balance flow total accounting for revenue vs. non-revenue water for the utility. The flow-accounting pop-up window can be seen in Figure 33.

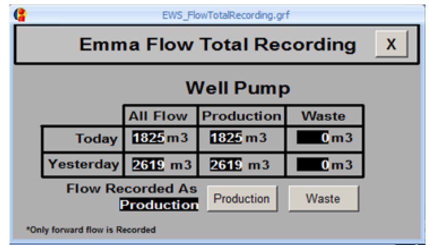


Figure 33 – Production vs. Waste flow accounting pop-up

The flow accounting programming works as follows: By having a flowmeter mounted on the discharge of the well pump, prior to the two valves for "to system" vs. "to waste", the flowmeter can record all flows from the well. As part of standard operating procedures, the operator on site can then use the buttons tell the SCADA system where the water is being sent to. The flow accounting buttons are available on all the SCADA View nodes, as well as the touchscreen displays mounted on the PLC panel at each Guelph Water facility.

Automatic Online CT Calculator

Part of the new Guelph Water programming standards is to include an online CT Calculator at all sites that use chlorine for primary disinfection/treatment. The calculator provides a number of key numbers that are needed to demonstrate the required CT is being met. The CT Required is calculated based on Ontario Procedure for the Disinfection of Drinking Water. The CT Achieved is calculated based on the current process conditions. The CT is considered met as long as the CT Achieved number is higher than the CT Required. The "CT Calculation Valid" will show Yes once the well pump has finished starting up and the process has settled down into steady state before the online CT calculation is ready for use.

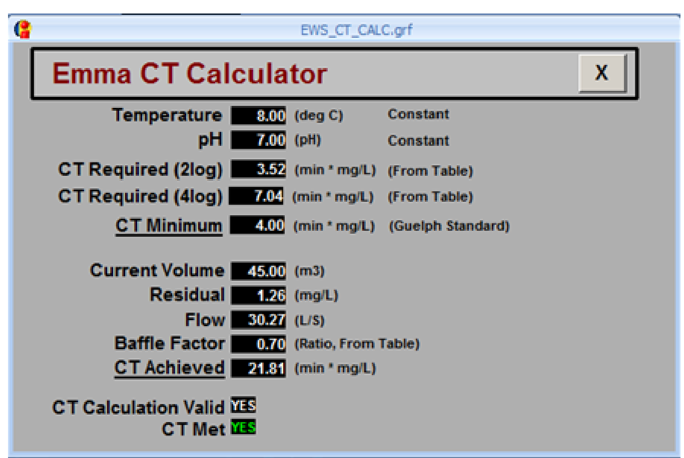


Figure 34 – Online CT Calculator

List of All Alarms (and their Enabled/Disabled Status)

Lastly, as part of the Guelph Water SCADA Standards, a dedicated pop-up window is provided for each site that lists all of the configured alarms for the site, along with their enabled/disabled status. This screen allows for an operator to quickly see what alarms a site has configured, to check that the enabled/disabled status reflects what should be set for the station's current operating conditions. An example from the Emma Well can be seen in Figure 35.

One of the major benefits of having a pop-up window with a listing of all of the station's alarms readily available is that it makes it very straight-forward for an operator to find out what alarms are configured for a particular station. This is especially helpful as each of Guelph Water's facilities has a different set of configured alarms based on the facility's age, scope of automation, and nature of its specific process.

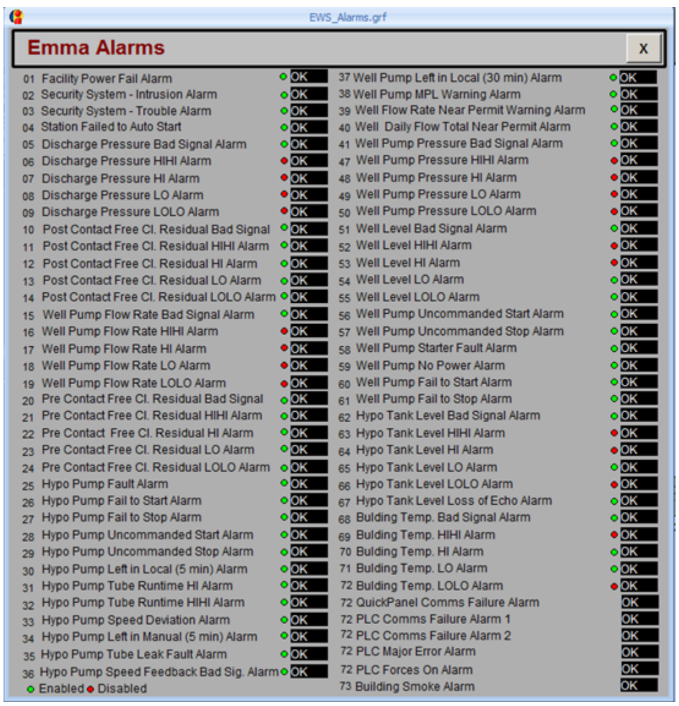


Figure 35 – List of All Station Alarms Pop-Up

An astute reader will notice that the Emma Well seems to still have quite a few alarms for a newly-programmed station. This is because the station's alarms are still in the process of being rationalized, but that can be subject of another article about the challenges of applying alarm management to water facilities.

Summary

You've made it to the end! Congratulations! I hope you have found this article informative, as it has provided an in-depth tour of what the new automatic control system and HMI screens can look like for a recently modernized/re-programmed SCADA system for a municipal well.

Do the Guelph Water SCADA standards represent a true High Performance HMI (HPHMI) implementation? I will be the first person to say that they do not. But what they do demonstrate is that they show how a municipal water utility can use key concepts from HPHMI design theory to develop a much improved set of SCADA design and programming standards, in order to provide a SCADA system that offers much improved functionality while also striving to reduce the "shock" to operators who are more familiar with traditional SCADA system designs. As a plus, Guelph Water was also able to leverage its existing investments in SCADA software.

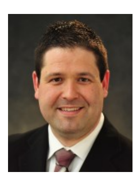
As the Guelph Water SCADA standards continue to develop, it is anticipated that additional HPHMI concepts will be incorporated over time. In the meantime, the focus is to implement the newly developed standards across the current roster of 35 existing water facilities. By the time the new programming has been fully deployed, each of these sites will be much easier to monitor, control, operate and troubleshot than they were with the old code.

The Emma Well Upgrade project was wrapped up in early 2019. The HMI screenshots for this article were taken in July 2019, after the newly upgraded station had been running for several months. Since then, the Guelph Water SCADA standards have undergone several iterative revisions and have been used to develop new PLC+HMI SCADA code for 10 more facilities. Work continues to deploy this new control system programming onsite, and to rewrite the programming code for the remaining Guelph Water facilities. Several nearby water utilities have also started using the Guelph Water SCADA standards to update their SCADA systems as well.

I would like to thank the members of the ISA112 SCADA Systems standards committee for providing me with a wealth of ideas and suggestions that have now made their way into the Guelph Water SCADA standards. Not heard about ISA112 yet? Take a look at www.isa.org/isa112 to find out more.

In practice, I have found that end-user SCADA standards are very much application, use-case, and organization specific. One size does not fit all. In this article, I have attempted to show how the new Guelph Water SCADA standards have been built around our specific needs. For all the end-users out there, I hope you have found this article helpful. The design concepts presented here are also not software specific, so they can be adapted to almost any SCADA platform out there. Feel free to adapt (or reject) the ideas contained here. That's the beauty of end-user-developed SCADA standards – you have the flexibility to tailor them to your needs. That's what we did, and I encourage you to do the same.

About the Author



Graham Nasby, P.Eng, PMP, CAP holds the position of Water SCADA & Security Specialist at City of Guelph Water Services, a publicly-owned/operated water utility located in Guelph, Ontario, Canada. Prior to joining Guelph Water, he spent 10 years in the engineering consulting community after completing his B.Sc.(Eng.) at the University of Guelph. He is senior member of the International Society of Automation (ISA) and co-chair of the ISA112 SCADA System Standards Committee. Contact: graham.nasby@guelph.ca

AUTO-QUIZ: BACK TO BASICS

PID Loop Tuning Error Question

This automation industry quiz question comes from the ISA Certified Control Systems Technician (CCST) program. CCSTs calibrate, document, troubleshoot, and repair/replace instrumentation for systems that measure and control level, temperature, pressure, flow, and other process variables

Question:

The greatest probability of error being introduced into the “open-loop” method of tuning comes from determining the:

A. process time constant
B. reaction equilibrium
C. actual dead time
D. system gain

Answer:

The answer is *C*, actual dead time. In open-loop methods of tuning, like Ziegler-Nichols, the dead time derived from the open-loop response is a part of the calculation of all of the tuning parameters for P-only, PI, and PID (proportional, integral, derivative) controllers. Often, the dead time is small (flow and pressure loops), and defining the quantity of the dead time from response curves can be tricky. Depending on how the tangent to the response curve is drawn, a very small dead time may be off by a factor of two or more, leading to an inaccurate calculation of the tuning parameters. Because the dead time is in the denominator of the equation for the proportional gain, the difference between 0.1 and 0.2 minutes can be insignificant on the response plot but would yield gains that differ by a factor of two.

Because the values of the process time constant and system gain are usually quite significant, those quantities can be determined with open-loop methods fairly accurately.

Reference: Sands, Nicholas P. & Verhappen, Ian, "A Guide to the Automation Body of Knowledge", Third Edition*,* ISA Press, 2019.

ISA CAP and CCST certification programs provide a non-biased, third-party, objective assessment and confirmation of an automation professional’s skills.

The CAP exam is focused on direction, definition, design, development/application, deployment, documentation, and support of systems, software, and equipment used in control systems, manufacturing information systems, systems integration, and operational consulting.

Certified Control System Technicians (CCSTs) calibrate, document, troubleshoot, and repair/replace instrumentation for systems that measure and control level, temperature, pressure, flow, and other process variables.

Question originally appeared in the ISA Certified Automation Professional; (CAP) program column of InTech. Reprinted with permission.

INDUSTRY NEWS

ISA Report: 63 Percent of Automation Engineering Professionals Surveyed Believe Industry Standards Will Be 'Extremely Important' in the Future

From ISA News release in July 2020

The ISA recently surveyed 290 people in the automation engineering field to discover their thoughts on industry standards. The survey shows that 63 percent of respondents believe that standards will be “extremely important” in the future.

Conducted in June 2020, the online survey received 290 responses from automation engineering professionals, primarily from the United States, Europe, and Canada. 42 percent of respondents described themselves as engineers, 21 percent as consultants, 15 percent as managers, and 8 percent as executives. The remaining 14 percent reported as a mix of technicians, operators, salespeople, marketers, or other roles. Survey respondents most commonly worked at system integrators (35 percent), asset owners (30 percent), or automation providers (22 percent).

Most survey respondents (77 percent) said they are ISA members. 41 percent of respondents said they have more than 30 years of experience in their field; 26 percent said they have 20 to 30 years of experience; 21 percent said they have 10 to 20 years; 12 percent said they have 0 to 10 years.

Key findings include:

- An overwhelming majority of survey respondents believe that, in the future, standards will be “extremely important” (63 percent) or “important” (33 percent)
- Most respondents (87 percent) believe that industry standards make processes and facilities safer
- Most respondents (81 percent) believe that industry standards help companies prove compliance to regulations
- Most respondents (67 percent) believe that industry standards make it easier to train and cross-train people in technical jobs
- Most respondents (63 percent) believe that industry standards make processes and facilities more cyber-secure

The survey also asked questions specific to ISA standards. Survey takers were asked whether they agreed, disagreed, or had a neutral stance on statements regarding characteristics of ISA standards.

- 89 percent of survey respondents agreed with the statement, “ISA’s standards are relevant and valuable to multiple industries;” 9 percent were neutral and 1 percent disagreed
- 85 percent of survey respondents agreed with the statement, “It’s important for ISA standards to be harmonized and accepted by a global body;” 10 percent were neutral and 4 percent disagreed
- 76 percent of survey respondents agreed with the statement, “ISA’s standards are unbiased and do not favor any single supplier;” 20 percent were neutral and 3 percent disagreed
- 72 percent of survey respondents agreed with the statement, “The importance of standards in general is well-known and understood within my company;” 21 percent were neutral and 7 percent disagreed
- 68 percent of survey respondents agreed with the statement, “ISA’s standards development process is open and transparent;” 29 percent were neutral and 3 percent disagreed

The findings of the ISA survey confirm that automation engineering professionals rely on industry standards. Survey respondents suggested that standards are essential to maintaining excellence in their work. In general, respondents have a positive outlook about standards, and they believe that standards will continue to be just as critical, if not more so, in the future.

“In creating this survey, ISA wanted to demonstrate the value of standards to the automation community,” said Dr. Maurice J. Wilkins, executive advisor at Yokogawa Marketing HQ, ISA Fellow, former vice president of ISA’s Standards and Practices Department, current co-chair of the ISA101 Human-Machine Interfaces Standard Committee, and member of the ISA Executive Board’s Industry Reach & Awareness work group. “We are grateful to the many automation engineering professionals who took the time to tell us how standards are helping them, their employees, and their organizations.”

ISA has been recognized as the expert source for automation and control systems industry consensus standards since 1949. ISA’s more than 150 standards reflect the comprehensive knowledge and hard work of more than 4,000 automation industry experts worldwide. These individuals, along with more than 140 committees, sub-committees, work groups, and task forces, collaborate on the development and maintenance of ISA standards. ISA standards cover areas as diverse as the safety of electrical equipment used in hazardous locations to cost-savings measures for interfaces between industrial process control computers and subsystems.

SOCIETY NEWS

Reaching Our International Aspirations

By Eric Cosman 2020 ISA Society President

In considering a possible theme for this month's message, I have been thinking about one of the essential characteristics of our Society. It is embodied in the word "international." Please indulge me as I reflect on the implications of this word for our society, as well as for its stakeholder groups—from staff and members, to customers and those in our profession. I am certain that each of us has a slightly different understanding of the term as well as its connotations. The details of this definition are much less important than the need to engage all perspectives.

This begins with elected and important leaders. At this time each year, we gather together the members of the Executive Board for the current year and next year to prepare incoming Board members for their new role, review the status of our strategic plan, and make plans for the future. As with other meetings and conferences, this year's event is being conducted as a series of online meetings.

It was in one of those meetings that I led the group in a discussion of what I called "**Putting the 'I' into ISA**," with a focus on incorporating specific recommendations in the strategic plan. These recommendations were presented to the Board by a task force that was chartered in 2016 and delivered its report in 2017. In discussions with members and leaders, there is a consensus that we must strive to provide support, products, and services to members, customers, and our profession in **virtually all regions of the world**. As with most aspirations, making the statement is generally much easier than achieving the goal. This is particularly true in this case, as the goal speaks more to how we operate and conduct our business than any specific services or products.

As I said, I am certain that we all have our own views on what constitutes effective operation of a truly international society. It is important that we consider all views and have **open discussions** about our needs, relative priorities, and specific goals. In the context of our strategic plan, internationalization is not a separate objective, but rather a major factor in defining the goals within the existing strategic elements.

It is overly simplistic to assume that responsibility for meeting these goals rests solely with the Executive Board, other leaders, and staff. It can be tempting to take a more passive role, waiting for "someone to change things," but this will not accomplish the level of change that we need. Acting as a truly international society involves much more than providing products and services tailored to regional needs. It also requires that we **examine our own behaviors** and understand that we can each contribute in our own way.

When we look for prospective mentors or mentees, we should look beyond the usual model of pairing more and less experienced members, and welcome opportunities to broaden our appreciation of regional, national, and cultural differences. We can be more sensitive to the use of language or regionally specific idioms and expressions, as these may not have the same meanings and connotations for those with different backgrounds. Our Society is a **diverse community** with a common interest in advancing our profession. It provides many opportunities to participate in teams or committees with people from other regions who can help us better understand broader needs and expectations. Simple measures like understanding and respecting differences and constraints related to time zones, languages, accents, and holidays can go a long way toward promoting and achieving a more international culture.

Tools, technology, and the constraints placed upon us by developments such as the COVID-19 pandemic provide an opportunity to improve our performance in becoming an international community. I believe that one of the more exciting tools now available is ISA Connect. It allows us to have meaningful discussions on an unlimited range of topics spanning countries, time zones, and cultures. We are already seeing increased use of this tool, and I fully expect this to continue. Even when we are once again able to meet face-to-face, we will be able to use this and similar tools to keep conversations going between events, building consensus, and learning from our colleagues.

This can be the beginning of a new level of collaboration, allowing us to progress in our journey to becoming an international community. I encourage to explore the options available to you, be open to learning, and be willing to share your knowledge, experiences, and perspectives with your fellow members.

As always, you can contact me at president@isa.org with your thoughts or questions on this or any other topic. Stay safe and well, and I look forward to continuing this dialog throughout 2020.

Eric Cosman
2020 ISA President

About the Author

Eric C. Cosman is a chemical engineer with more than 35 years of experience in the process industries. He is the founder and principal consultant at OIT Concepts, LLC. Eric contributes to—and has held leadership positions in—various standards committees and industry focus groups. He is a member of Control Magazine's Process Automation Hall of Fame as well as an ISA Life Fellow. Eric has served as ISA's vice president of standards and practices, and he is a member of the ISA Executive Board. He was a founding member of a chemical sector cybersecurity program team focused on industrial control systems cybersecurity, and he was also one of the authors of the chemical sector cybersecurity strategy for the U.S. Eric is a founding member of the ISA99 Committee on Industrial Automation and Control Systems (IACS) Security, where he currently serves as the co-chair, in addition to serving as the co-chair of the MESA Cybersecurity working group. Eric speaks and writes on topics ranging from automation cybersecurity to systems architecture development and industrial transformation, and he is the author of the cybersecurity chapter of the *ISA Guide to the Automation Body of Knowledge* (3rd edition).

Call for Newsletter Articles

The WWID newsletter is published four times a year (winter, spring, summer, and fall) and reaches the WWID's 2,000+ members. Each issue is approximately 16-32 pages long, and is electronically printed in color PDF format. A notification email goes out to all WWID members and it is available for public download at www.isawaterwastewater.com.

We are always on the lookout for good articles, and we welcome both solicited and unsolicited submissions.

Article submissions should be 500-2000 words in length and be written for a general audience. While it is understood that the articles are technical in nature, the use of technical jargon and/or unexplained acronyms should be avoided. We actively encourage authors to include several photos and/or figures to go along with their article.

We actively welcome articles from all of our members. However, we do ask that articles be non-commercial in nature wherever possible. One or two mentions of company and/or product names for the purposes of identification are acceptable, but the focus of the article should be technical content and not just sales literature. If you are unsure of whether your article idea is workable, please contact our newsletter editor for more information – we are here to help.

Some examples of the types of articles we are looking for include:

- Explanatory/teaching articles that are meant to introduce or explain a technical aspect of automation and/or instrumentation in the water/wastewater sector.
- Biographical stories about personalities and/or leaders in the water/wastewater sector.
- Case Studies about plant upgrades and/or the application of new technologies and techniques. This type of article must include at least two photos along with the article text.
- Pictorial Case Studies about a plant upgrade consisting of 4-6 photos plus a brief 200-500 word description of the project undertaken. The article should ideally include one to two paragraphs about lessons learned and/or advice for other automation professionals.
- Historical reflections on changes in technology pertaining to specific aspects of instrumentation or automation, and how these changes point to the future.
- Discussions about changes in the water/wastewater sector and how these affect automation professionals.

Once we receive a submission, we will work with you to edit it so it is suitable for publication in the newsletter.

Article submissions can be sent to the WWID newsletter editor Graham Nasby at graham.nasby@grahamnasby.com.

WWID Newsletter Advertising

The WWID newsletter is an excellent way to announce new products and services to the water/wastewater automation community. With a distribution of 2,000+ professionals in the automation, instrumentation and SCADA fields, the WWID newsletter is an effective targeted advertising tool.

The WWID newsletter is published quarterly, on the following approximate publication schedule:

- Winter Issue – published in January/February
- Spring Issue – published in April/May
- Summer Issue – published in July/August
- Fall Issue – published in October/November

Advertising in the newsletter is offered in full page, half-page and quarter page formats. Advertisements can be purchased on a per issue basis or for four issues at a time. The newsletter itself is distributed as a full-color PDF, so both color and black/white artwork is acceptable.

The current advertising rates are as follows:

Per Issue:
- Full page, full color (7" x 9"): $500
- Full page, full color, (8.5x11") , with bleed $600
- Half page horizontal, full color (7"x4.5"): $350
- Half page vertical, full color (3.5"x9"): $350
- Quarter page, full color (3.5" W x 4.5" H): $250

Per Year: Apply 20% discount if purchasing 4 ads at a time

Other sizes of advertisements are available, but are priced on an individual basis. Contact us for more information.

Please book advertising space as early as possible before the intended publication date. Artwork for advertisements should be submitted a minimum of two weeks prior to the publication date; earlier is always better than later. Artwork for advertisements can be submitted in EPS, PDF, PNG, JPG or GIF formats. EPS, PDF and PNG formats are preferred. Images should be at least 300dpi resolution if possible. A complete list of ad specs can be found at www.isawaterwastewater.om

The ISA Water/Wastewater Industry Division is run on a non-profit basis for the benefit of its members. Monies raised from the sale of advertising in the newsletter are used to help offset the cost of division programming and events. Like its parent organization, the ISA, the WWID is a non-profit member-driven organization.

For more information, or to discuss other advertisement sizes not outlined above, please contact the WWID newsletter editor Graham Nasby at graham.nasby@grahamnasby.com.

WWID Board Member Contacts

Director (2020-2021)
Don Dickinson
Phoenix Contact USA
Cary, North Carolina, USA
Tel: (919) 633-0147
ddickinson@phoenixcontact.com

Director-elect
& 2020 Conference Contact
Manoj Yegnaraman, PE, CP/CE(Profibus)
Carollo Engineers Inc.
Dallas, Texas, USA
Tel: (972) 239-9949 ext. 44424
myegnaraman@carollo.com

2020 Assistant Symposium Contact
Hassan Ajami
PCI Vertix
Detroit, Michigan, USA
Tel: 313-874-5877
hajami@pci-vetrix.com

Secretary Treasurer
David Wilcoxson, PE
Stantec Consulting Inc.
Concord, California, USA
Tel: (925) 627-4561 –
david.wilcoxson@stantec.com

Past Director
Pavol Segedy, PE
HDR Inc.
Raleigh, North Carolina, USA
Tel: (919) 427-5313
pavol.segedy@segedyfam.com

Membership Chair
Colleen Goldsborough
United Electric Supply
Lancaster, Pennsylvania, USA
Tel. (717) 392-8500
cgoldsborough@unitedelectric.com

Program Chair
Joe Provenzano
KPRO Engineering Services
Naugatuck, Connecticut, USA
Tel: (203) 560-1816
provenzano2@comcast.net

Newsletter Editor
& Co-Chair, ISA112 SCADA Systems Standards Committee
Graham Nasby, P.Eng, PMP, CAP
City of Guelph Water Services
Guelph, Ontario, Canada
Tel: (519) 822-1260 ext. 2192
graham.nasby@grahamnasby.com

ISA Water/Wastewater Industry Division

Scholarship Committee Chair
& Asst. Newsletter Editor
Kevin Patel, PE, MBA
Signature Automation
Dallas, Texas, USA
Tel (469) 619-1241
knpatel@sig-auto.com

Committee Member
David Hobart, P.Eng, CAP
Hobart Automation Engineering
Tel (802) 253-4634 – Portland, Maine, USA
dghobart@gmail.com

Student Scholarship Committee Members
Kevin Patel, Signature Automation (chair), knpatel@sig-auto.com
Sean McMillan, Jones & Carter, sean.mcmillan@jonescarter.com
Steve Valdez, General Electric, svaldez1210@gmail.com
Thomas C. McAvinew, I&C Engineering, tcmcav@gmail.com
Wally Ingham, Consultant, wally1234ingham@gmail.com

ISA Staff Contacts – Division Services
Andrea Holovach, Rachael McGuffin,
Karen Modrow, MaChelle Beason
ISA Headquarters, 67 T.W. Alexander Drive, PO Box 12277, Research Triangle Park, North Carolina, 27709, USA
Tel: (919) 990-9404
Fax: (919) 549-8288
divisions@isa.org

ISA Water/Wastewater Division Links:
Website: www.isawaterwastewater.com
Blog: www.isawaterwastewater.com/blog/

ISA Microsite: www.isa.org/wwid/
ISA Connect: connect.isa.org
LinkedIn: https://www.linkedin.com/groups/2031271/
Facebook: https://www.facebook.com/ISAWaterWastewater/

ISA Customer Service
ISA Headquarters - Raleigh, North Carolina, USA
Tel: 1 (919) 990-9404
Fax: (919) 549-8288
Email: info@isa.org

About the ISA Water/Wastewater Industries Division

The ISA Water / Wastewater Industry Division (WWID) is concerned with all aspects of instrumentation and automated-control related to commercial and public systems associated with water and wastewater management. Membership in the WWID provides the latest news and information relating to instrumentation and control systems in water and wastewater management, including water processing and distribution, as well as wastewater collection and treatment. The division actively supports ISA conferences and events that provide presentations and published proceedings of interest to the municipal water/wastewater sector. The division also publishes a quarterly newsletter, and has a scholarship program to encourage young people to pursue careers in the water/wastewater automation, instrumentation and SCADA field. For more information see www.isa.org/wwid/ and www.isawaterwastewater.com