Technology Specialists:

The Benefits and Challenges of Hiring Professionals to Improve Control Systems

WOODARD &CURRAN

Technology Specialists: The Benefits and Challenges of Hiring Professionals to Improve Control Systems

Published by Woodard & Curran Inc
41 Hutchins Drive
Portland, ME 04102

Design by Woodard & Curran.
www.woodardcurran.com

ABSTRACT

A technology specialist is the key to a successful municipal control system. The specialist works on three areas to maintain and improve a control system: maintenance and upgrades, continuous improvements and process control adjustments, and finally the planning and execution of capital projects.

Facility operators who don't have the time or the expertise to maintain complex control systems are often losing the significant efficiency gains achieved with a fully optimized system. Maintenance minimizes degradation of the control system while upgrades jump the system back up to the steady state level. The continuous improvement of a control system means a gradual increase in operational efficiency as the plant ages—the opposite of what occurs if the plant is neglected. Improvements to the control system and instrumentation can be a black box to many municipalities. A technology specialist can open that box and find the best solutions. A specialist can inform the plant when it's time to consider putting a capital project in a future budget, particularly if the plant is considering growing, adding operations to the control system, or simply replacing a large section of a control system that has become outdated and past its useful life.

Facility operators who don't have the time or the expertise to maintain complex control systems are often losing the significant efficiency gains achieved with a fully optimized system.

Municipalities are competing with the private sector for a limited pool of technology specialists. The challenge is not only finding a qualified individual but finding the right balance between full-time, part-time, or outsourced support. Best practice suggests that there should be a single point of contact either way—an individual who is an expert in your system and available when needed.

INTRODUCTION

In the city of Haverhill, the municipal water treatment plant faced a dilemma; they could not find qualified operators for their third shift. Like many utility operators, they were compelled to pay overtime to have their current staff cover the shift, which only led to the staff feeling overworked and burnt out. A Technology Specialist from Woodard & Curran worked with the utility to improve their alarming and automated processes. The specialist also implemented SCADA upgrades, developed site-specific procedures, and trained the Haverhill treatment plant staff to use the new technology. These improvements gave the plant operators the confidence they needed to run the plant unmanned during the third shift and provided a more stable and consistent operation. Turning to automation and eliminating the third shift saved the plant $150,000 in staffing and a 29% reduction in overtime costs.

Turning to automation and eliminating the third shift saved the City of Haverhill's municipal water treatment plant $150,000 in staffing and a 29% reduction in overtime costs.

A control system at a municipal utility requires maintenance, upgrades, process improvements, and a plan to implement necessary upgrades in order to operate at

a consistent level, enhance automation, and enable remote operation. A well maintained control system can increase productivity and reduce energy and operating costs. Facility operators who don't have the time or the expertise to maintain complex control systems are often losing the significant efficiency gains achieved with a fully optimized system. Systems degrade over time, reducing the value and reliability the advanced technology can offer.

A full-time, part-time, or outsourced technology specialist can fill the role of maintaining, updating, and improving a control system. There are positive and negative aspects associated with each level of engagement the specialist has at a plant. Before those viewpoints are explored, the need for a plant to fill the critical role played by a technology specialist should be established.

Instrument maintenance and upgrades minimize degradation of the control system while upgrades jump the system back up to the steady state level.

THE ROLE OF A TECHNOLOGY SPECIALIST

Performing Maintenance and Upgrades

The primary role of a technology specialist is to maintain and upgrade the instrumentation and controls to keep the plant running at a consistent operational level. The first task is to acquire an adequate inventory of spare parts and to replace equipment past its useful life. Maintenance minimizes degradation of the control system while upgrades jump the system back up to the steady state level.

A Technology Specialist performs essential maintenance tasks that operators generally don't have time to perform.

Equipment and firmware becomes obsolete and needs to be upgraded to make for smooth parts swap when a device fails.

Maintenance of instrumentation is generally focused on calibration. Instruments need to be accurate and reliable for the control system to be useful. The technology specialist will keep a detailed record of when instruments are calibrated, when they need to be calibrated again, and when they need to be replaced. Depending on the skills of the technology specialist, they will calibrate the instruments themselves or coordinate with a third party to ensure the calibrations are up to date, conform with the manufacturer's recommendations, and comply any regulations associated with the devices.

There are essential maintenance tasks a specialist will perform that operators generally don't have time to perform. For example, communications wiring, transceivers, and receivers (i.e. radios, Ethernet switches, and serial repeaters) should be tested and checked on a regular basis. UPS battery systems should be unplugged and tested at least once a year and replaced on a routine basis (usually every three years). The specialist will verify that all computers are running the same version of software, have the same code, and are backed up to get a system restored and running in the event of a system failure. SCADA software needs to be upgraded to be compatible with the current version of Microsoft Windows and to make sure it is compatible with the programming laptop. Upgrades to computers need to occur every 3-4 years. The computer is the weakest link in a SCADA system, so keeping them up to date and replaced on a routine basis is crucial to preventing unnecessary downtime.

Equipment and firmware becomes obsolete and needs to be upgraded to make for smooth parts swap when a device fails. Instrumentation needs updated firmware to make the installation of a new probe or device easier. Probes can be upgraded to increase accuracy. Analyzers and flow meters are upgraded to deal with obsolete firmware and obsolete communications protocols. PLCs become obsolete and need to be upgraded, as spare parts become scarce and priced out of the market. PLC

programs also need to be well documented so everyone working on the project (now and in the future) understands the program without having to reverse engineer what the programmer did at startup.

The final example of maintenance is record drawings. The P&IDs, control panel drawings, and loop sheets all need to be up to date. Accurate drawings not only help when the system needs troubleshooting but also to help scope out other projects. The more accurate the drawings, the less work to figure out how to modify it to add additional functionality.

Improving the Controls System and Process Controls

Once the system is in steady-state, the technology specialist can focus on improving the control system and process controls. Focusing on operational and utility efficiency, the technology specialist can provide operators with improved instruments, more reliable data, and advanced remote access that the operators can use to adjust and support processes at the plant to make their jobs easier.

Once the system is in steady-state, the technology specialist can focus on improving the control system and process controls. Focusing on operational and utility efficiency, the technology specialist can provide operators with improved instruments, more reliable data, and advanced remote access that the operators can use to adjust and support processes at the plant to make their jobs easier.

Instrument Improvements

There are many improvements to instruments that could enhance plant processes and monitoring. A technology specialist will evaluate a system's probes, analyzers, and transmitters. For example, chlorine monitoring is often performed by using a Hach CL-17 analyzer. The CL-17 uses chemical reagents that need to be replaced every 30 days and only tests the chlorine level every couple of minutes. Changing to a continuous online analyzer could allow for better control of the chemical dosing, reduce chemical costs, and supply better tasting water near drinking water plants. This is accomplished by only adding the chlorine the process or permit requires. For example, if a plant is required to have 1.0 ppm of chlorine, and currently uses 2.0 ppm, better chlorine control allows the setpoint to be set to 1.25 ppm, a 37.5% reduction in chlorine, or 2,738 gallons of chlorine a year at a 10 MGD plant. In addition, more advanced transmitters can tell the state of a probe and other diagnostic information, using either Ethernet or HART communications.

Control System Alarms

Once the instruments are improved, process changes can be made to the control system. The technology specialist will remove or deprioritize nuisance alarms and

adjust timers, as needed. Warning alarms give operators time to react to potentially serious problems before they become serious, but some alarms have timers that are too short and become nuisance alarms. Nuisance alarms cause operators to become apathetic to alarms, and the urgency is removed. The operator really wants to know when the fault condition is occurring.

Reporting Improvements

After alarming, the specialist will implement reporting improvements. Reports should be automated or limit the amount of human data entry required allowing operators to focus on other priorities such as preventive maintenance. For example, see the example below that demonstrates automated data using a PLC.

WWTP Turbidity Data (Plant Is Online)				
Day of Month	Daily Turbidity Values (Based on 30 Minute Samples)			
	24 Hour		> .2	> .5
	Average NTU	Maximum NTU	% of Day	% of Day
1	0.083	0.147		
2	0.093	0.302	2%	
3	0.08	0.129		
4	0.083	0.125		
5	0.089	0.188		
6	0.083	0.112		
7	0.095	0.133		
8	0.103	0.149		
9	0.111	0.192		
10	0.119	0.192		
11	0.12	0.167		
12	0.095	0.273	2%	
13	0.063	0.094		
14	0.051	0.068		
15	0.057	0.078		
16	0.057	0.072		
17	0.066	0.345	2%	
18	0.078	0.514	2%	2%
19	0.073	0.11		
20	0.085	0.223	2%	
21	0.095	0.131		
Monthly Turbidity Values				
Minimum	0.051	0.068		
Maximum	0.122	0.514		
Average	0.083	0.168		

Example:

A common report an operator would use is maximum turbidity in 15 minute intervals. While there is a graph that could tell the operator that information, it takes a lot of work gather and produce in a report. A Programmable Logic Controller (PLC), using historical data, could do the calculation automatically.

In the example at left from a plant in Southern California, the data automatically propagates the average and maximum turbidity in 30 minute intervals calculated in the PLC, only when the plant is actually producing effluent. The spreadsheet then calculates the percentage of days they exceeded the two recordable turbidity levels.

Remote Access

Plant operations are also made easier by improving remote access. Adding remote access to a system can be simple and secure if done correctly. The main advantage of remote access is to support troubleshooting during unmanned shifts. If an alarm comes in, an initial assessment of the situation can be completed before driving to the site. Depending on the operator's trust of the system and the situation, the problem can usually be resolved remotely. This creates several opportunities to save money and to increase operator morale. Remote access is not solely for responding to alarms. For instance, an on-call operator would use remote access to check the system before going to sleep for the night. If the system is currently view-only, it could be changed to read/write control (and even better if the remote accessing computer could get directly onto the PLC to edit the code), giving the operator or specialist advanced remote capabilities.

Plant operators will want assurance that all remote activity is secure. Dialup access was the norm through 2008, but now new security measures and technology have made Internet access a secure and viable option. Two-form authentication, stronger password requirements, and robust encryption all improve the security of remote access to the SCADA system.

Many of these control system improvements cost less than a couple thousands of dollars in material but can have a substantial effect on operations.

Process Adjustments

Additional improvements to the system can be done through process adjustments, usually without any new instrumentation. PID loops control process based on feedback from the output and are one of the hardest things to control. PID loops in municipal applications are usually very slow; as such, it's difficult and time consuming to simulate or create all of the possible disturbances that could occur during the system startup. Tuning a PID loop can improve response time to a disturbance and also decrease cycling of the loop (the output looks like a sine wave when cycling). Generally, better tuned loops will decrease energy costs (e.g. running blowers slower for DO control) or decrease chemical costs (e.g. less caustic and/or acid in pH control or less chlorine in chlorine control). Feedback loops can be shortened by moving the sample point to a more representative, faster responding location or by changing the instrument to one that has a better response time.

Beyond PID loops, other process controls that can be improved are multiple pumps in parallel. If the pumps are on VFDs, there are a number of options. Does the operator want to minimize how many pumps are running; limit pump cycling on and off; or minimize the change in level in the tank the pumps are filling or emptying; or any combination of these? A technology specialist can control the tanks and program the pumps to run automatically to gain the best performance.

There are many opportunities to improve a plant's process and control. The technology specialist can automate and fix those annoyances that operators have—removing any need to run things in manual. The technology specialist can find ways to make complex systems easy to operate and troubleshoot. When operating optimally, the tuned system will save the plant chemical and energy costs. This continuous improvement means a gradual increase in operational efficiency as the plant ages—the opposite of what occurs if the plant is neglected.

Case Study: Chlorine pH Control Using PID Loops

An operator wants to control effluent pH to 6.8. First, the pH value is read, and then the caustic dose is increased or decreased depending on the following: distance from the setpoint, how quickly it's approaching or deviating from the setpoint, and how long it's been away from the setpoint. This control loop controls the dosage of the chemical, not the pump speed. The pump speed should be proportional to the flow rate to ensure the dosage does not change simply by the increase or decrease in flow. The graph below shows pH operating flow paced with trim, and it shows how a change in flow does not affect the dosage, but does affect the pump speed.

Chlorine control, pH control, and DO control are some of the slowest loops in a plant. Some control systems do not even bother adjusting these based on their current values and run them solely proportional to the flow rate (or sometimes the level of the aeration basin for DO control).

Capital Planning and Execution

A specialist can inform the plant when it's time to consider putting a capital project in a future budget, particularly if the plant is considering growing, adding operations to the control system, or simply replacing a large section of a control system that has become outdated and past its useful life. Sound capital planning requires an understanding of how upgrades and maintenance projects should be prioritized, estimated, and funded in upcoming years to keep the system up to date and able to handle future capacity and regulatory requirements. For example, if a control panel was left open in an H2S environment and most of the wire and the controller are damaged, it needs to be replaced immediately. On the other hand, if the goal is to tie in three new pump stations, this is a lower priority, and can be done when the budget permits. If a larger capital project is on the horizon, a technology specialist would help evaluate the control system and instrumentation for the project.

A technology specialist can not only plan a capital project, but depending on the skills of the technology specialist, the specialist can design the project, bid out the work, and then oversee building the system. The major advantage of the plant's technology specialist involvement is consistency.

A technology specialist can not only plan a capital project, but depending on the skills of the technology specialist, the specialist can design the project, bid out the work, and then oversee building the system. The major advantage of the plant's technology specialist involvement is consistency.

A technology specialist can not only plan a project, but depending on the skills of the technology specialist, the specialist can design the project, bid out the work, and then oversee building the system. The major advantage of the plant's technology specialist involvement is consistency. The program scheme will match the rest of the plant. Training and spare parts can be minimized if the new system uses similar instruments as the older system.

Improvements to the control system and instrumentation can be a black box to many municipalities. A technology specialist can open that box and find the best solutions. They will have insight into the optimal use of capital money and will steer capital projects in a direction that will not only move the plant forward, but keep it in line with the standards setup by the plant to ensure consistent and intuitive control.

HIRING A TECHNOLOGY SPECIALIST

Sometimes referred to as a SCADA technician or an instrumentation and controls manager, the titles assigned to the technology specialist change based on the size of the plant and the specialist's role. Regardless of the title, this person supports technology at the plant. Filling that role is not an easy task.

Many municipal plants nationwide are having difficulty recruiting and retaining SCADA and Instrumentation/Control professionals. While it is difficult to screen, hire, and retain qualified professionals, it is clear that the benefits of hiring a technology specialist far outweigh the challenges of finding the right person for the job.

The Get into Water! Project, an alliance of Colorado-based utilities with the goal of promoting employment in the water industry, issued a study called, "A Business Case: SCADA & Instrumentation ." The paper cites how many plants in Colorado have difficulty recruiting and retaining SCADA and Instrumentation/Control professionals and details the challenges of hiring and retaining someone who is knowledgeable in control systems. It also points to the difficulty of screening and hiring qualified professionals.

The problem is nationwide. However, it is clear that the benefits of hiring a technology specialist far outweigh the challenges of finding the right person for the job. The task begins with determining the scope of the position

Part or Full Time

Should the technology specialist be a full-time position or part-time position? Hired or outsourced? If outsourced, an individual or a firm? There are a number of issues

to consider. Most facility operators begin with the question of whether or not the employee should be full time or part time.

Part-time positions can be flexible. A technology specialist could work part time at the water plant and part time at the wastewater plant or any combination of roles. The question generally centers on how much work is needed. Many day-to-day system maintenance and support tasks might be done just once or twice a week. The duties might adjust from month to month. Many plants require more work during some seasons, and others have full-time work during large projects. Some facilities might only need a full-time person when the plant is performing a shutdown for maintenance.

A part-time employee is hard to find to fill all the needs of a technology specialist, unless it is someone who is retiring and wants some additional work to augment his or her retirement benefits. The problem with part-time is three-fold. First, how will a part-time employee handle emergencies? If they are at another plant, can the specialist leave to handle your plant's issues? Second, there are always peaks and valleys of work required. Will a part-time employee have enough time to finish basic tasks? If a plant can't manage the flexibility, then it must look to fill the role with a full-time or outsourced technology specialist.

A full-time employee can prioritize what needs to be done, but a full-time employee's capacity might be excessive. Unless the full-time technology specialist is at a large facility or working for multiple plants, there may not be enough work on an annual basis to justify the cost.

Municipalities are also competing with the private sector for a limited pool of technology specialists. Many professionals with instrumentation and control skills are moving over to oil and gas or other private industries that pay better and have a clear promotional path. It's hard for a municipality to justify hiring and training a full- or part-time employee who will move to the private sector. Because of this, many facilities are considering outsourcing.

Outsourcing

Outsourcing a technology specialist can have many advantages. It provides a facility with the opportunity to hire an expert in their system and current technology with the flexibility to be on call or on site as much as is needed.

The key to a successful technology specialist search is finding someone who understands both current trends and standard best practices. Technology implementation projects are focused on the future. Trends appear on the micro and macro level, and knowing both of these gives an added advantage. For example, Allen Bradley SLC processors are currently being priced out of the market. If the plant currently uses these processors, converting to the next generation of hardware would make spare and replacement parts easier to obtain and more affordable.

Diverse industry or regional experience can be helpful. Utility trends usually follow after manufacturing trends, so a specialist who knows about manufacturing and working inside industrial plants will have a deeper picture of the future of controls and alternative solutions brought from outside the utility industry. Furthermore, simply doing projects outside of the region can expand a specialist's understanding of control systems and technology. With this ideal in mind, it makes sense that there is a benefit to having a specialist engaged in capital projects and work at other plants.

Good Questions to Ask Before Hiring a Technology Specialist:

Considering Part-Time

- How will a part-time employee handle emergencies?
- If part-time and at another plant, can the specialist leave to handle your plant's issues?
- If there are peaks and valleys of work required, will a part-time employee have enough time to finish basic tasks during peaks? Too much time during lulls?

Considering Full-Time

- Can you afford the training required for a new specialist or continuing education for an experienced specialist?
- Is a full-time employee's capacity excessive?
- Is there enough work on an annual basis to justify the cost?

Considering Outsourcing

- Are you more comfortable working with a firm or an individual to fill the outsourced technology specialist role?
- Do you need a single point of contact—an individual who is an expert in your system?
- During an emergency or when operators are on vacation, are there are others at the firm who could support the system when help is needed?

If a new problem at the plant occurs, he or she might have seen it at another facility and know how to address the problem.

Whether outsourcing or hiring in house, it is important to have a dedicated person who knows the facility's system well. If a plant does not have a dedicated technology specialist and just calls someone to fix a problem, there is a learning curve every time someone new comes in (sometimes even from the same company) to provide support. Having a specific specialist dedicated to a facility will provide that individual with incentive to do preventative maintenance and keep the system operating well. It reflects favorably on his or her company and minimizes emergencies. This same performance incentive encourages the training of plant operators, as they are the first line of defense and would be able to fix many problems or perform routine tasks on their own. (Think of a technology specialist as the first person to call for tech support). The technology specialist should also know how to not overload and over-complicate the system, with the understanding that the system needs to be operated when he or she is not on site.

Training a technology specialist is costly and includes many hours of labor and the expense of classes. There is no guarantee that after training a specialist, an employee will not leave for the private sector.

When a plant hires an outsourced technology specialist, this training is done at the specialist's own expense or by their own firm.

Outsourcing Leads to Cost Savings

Another potential advantage of outsourcing is cost savings and flexibility. Cutting costs can start by having a specialist work only once a day. When there is a need to work more, the specialist can come in more often, but only as needed. Having an expert on site once a week could be much more useful than having a junior-level specialist all week.

Outsourcing can also save on capital costs. The learning curve to understand a plant's controls and instrumentation is already done. The specialist understands the design, budget, true costs, and realistic outcomes for a capital project.

Training a technology specialist is costly. Training in this field includes: PLC programming, instrument calibration, security, and communications. There is a steep and long learning curve for these skills. Training costs many hours of labor and the expense of classes. There is no guarantee that after training a specialist, an employee will not leave for the private sector. Having someone outsourced means this training is done at their own expense or by their own firm.

Is it better to work with a firm or an individual to fill the outsourced technology specialist role?

Best practice suggests that there should be a single point of contact—an individual who is an expert in your system—but having a firm behind the specialist has many advantages..

Individual or Firm? Finding a Reliable Single Point of Contact

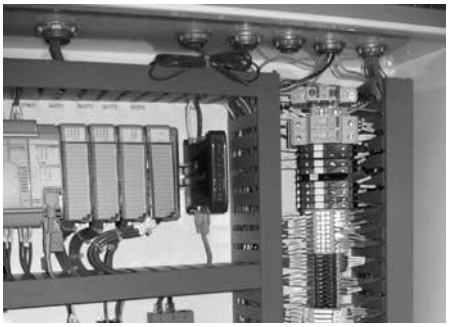
Is it better to work with a firm or an individual to fill the outsourced technology specialist role? Best practice suggests that there should be a single point of contact—an individual who is an expert in your system—but having a firm behind the specialist has many advantages.

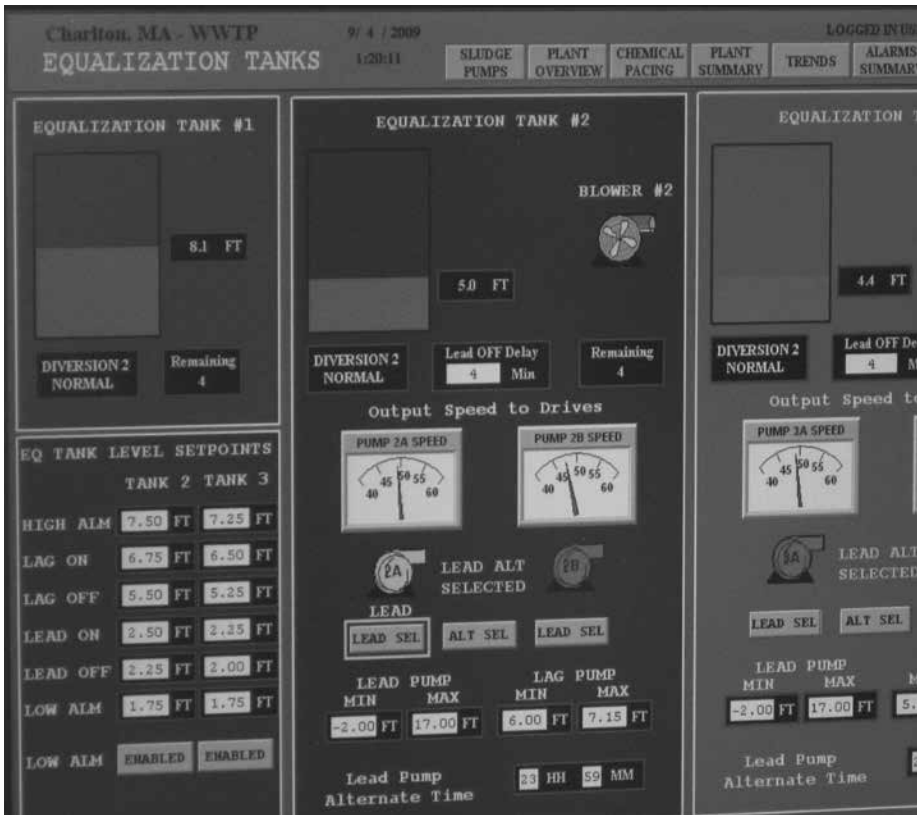
The first advantage is the flexibility of resources. If a plant has seasonal work, outsourcing to a firm can reduce underutilized or overutilized staffing issues. The buffering of staff can be moved to a third party. The plant then only pays the hours they need, when they need them. This means that if a plant needs one person once a week and the following month two people are needed full time for a week, this need can be met by the firm. Also, during an emergency, there are multiple people who can help out. If the point of contact is on vacation, there are others at the firm who could support the system when needed. An individual generally does not have the flexibility to adjust their schedule based on seasonal work, and when they are on vacation, a plant manager will need to find someone else from another firm to help in a pinch. That emergency support specialist from another firm will need to learn

the system before they can actually figure out what is wrong and how to fix it. Some technology specialists are also certified operators. This means that they can also help cover vacation, sick time, and maternity leave for operators as well as another technology specialist's vacations.

24/7/365 Support

The final advantage to outsourcing with a firm is 24/7/365 support. Many firms that have multiple specialists also have someone on call all day and night for emergencies. The on-call specialist can remotely connect to the system and support the operators as they try to resolve the problem. This gives the plant peace of mind that there is always someone to call if something happens.





Municipalities are competing with the private sector for a limited pool of technology specialists.

The challenge is not only finding a qualified individual but finding the right balance between full-time, part-time, or outsourced support.

The ideal specialist is a single point of contact, with a team of technology specialists behind him or her, to support a control system. The best of all worlds is someone who can keep a system up to date, while still working elsewhere to keep their hands in current technology and gather new ideas from other sites.

CONCLUSION

In order to have a stable and continuously improved system, a technology specialist is needed to provide essential maintenance, implement efficiencies, and plan or manage upgrades. The ideal specialist is a single point of contact, with a team of technology specialists behind him or her, to support a control system. The best of all worlds is someone who can keep a system up to date, while still working elsewhere to keep their hands in current technology and gather new ideas from other sites. A facility should also have a backup plan to contact another team of specialists who can provide support if needed.

Need help finding a qualified technology specialist?

Woodard & Curran can help.

Contact us, and we can discuss the right plan for your operations.

Find us online at www.woodardcurran.com.

Woodard & Curran is a 700-person, integrated engineering, science, and operations company. Privately held and steadily growing, we serve public and private clients locally and nationwide. We put our clients' interests first, taking a collaborative approach and giving each project the personal attention it deserves. We assign the right people with the right expertise to the job and provide clients with easy accessibility to senior experts.

We offer the depth of resources of a full-service environmental and engineering firm with the flexibility and adaptability of a small, privately held company. Our work is characterized by responsiveness, resourcefulness, and willingness to do what it takes to get the job done properly.

Our staff are specialists in their fields, offering in-depth understanding of cutting-edge technology, astute problem-solving, multidisciplinary engineering, and expert regulatory guidance. We have ranked among *Engineering News Record's* top 100 environmental firms every year since 2000.

Woodard & Curran
www.woodardcurran.com