Article

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How Alarmed Should You Be About Operator Effectiveness?

In order to optimize control of a water or wastewater treatment plant (WTP/WWTP), it is important to understand what is going on within the process. But as processes and control systems become more sophisticated, maximizing operator effectiveness becomes more complex as well.

A well-planned alarm and control strategy can make a significant difference between giving plant operators valuable decision-making information and confusing them with disjointed, complex data points. This article highlights key strategies for foreseeing problems in advance, fixing them faster, and having a higher success rate by maximizing operator effectiveness.

Manage Multiple Disciplines More Effectively, Under One Unified System

From an organizational perspective, there are four pillars that support maximum operator effectiveness. Evaluating plant operations with these four concepts in mind provides the opportunity to streamline operations, improve plant productivity, reduce risk, and maintain a more qualified workforce in spite of employee turnover (Figure 1).

- **Plant System Integration.** Just because different subsystems have been added to a WTP or WWTP over time does not mean that they can't all be unified under a single control system. Operator consoles having the ability to integrate I/O signals among a mix of programmable

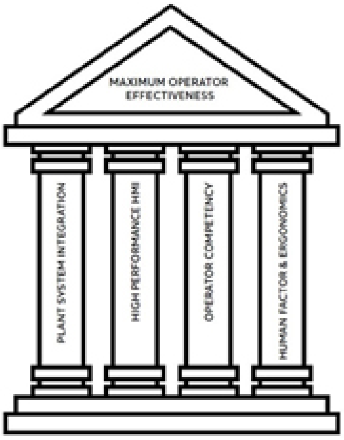

Figure 1. Focusing on four pillars of operator effectiveness can enhance control system performance at any time — from initial system installation through periodic retrofit applications.

logic control (PLC), distributed control system (DCS), and supervisory control and data acquisition (SCADA) installations now make it possible to consolidate equipment from multiple vendors in one user-friendly view. In larger organizations, operators from multiple facilities can also share the same control screens for collaborative troubleshooting or planning sessions.

- **High-Performance Operator Stations.** Well-thought-out human machine interface (HMI) features — such as high-performance graphics and alarm management — make operators more effective by grouping data in the ways that operators need it (Figure 2). Selective use of color can help to prioritize important events by order of priority.

	With traditional HMI	With high performance HMI	Results
Detecting abnormal situations before alarms occur	10% of the time	48% of the time	5 x improvement
Success rate handling abornal situations	70%	96%	37% improvement
Time to complete abnormal situation tasks	18.1 minutes	10.6 minutes	41% improvement

Figure 2. High-performance HMI improves both the recognition of and the success of handling abnormal situations.

Source: High Performance HMI Handbook

- **Operator Competency.** A good way to supplement operator experience gained in the plant is through training and process simulation, which can ensure that the first time an operator experiences an alarm condition is not in the real production environment. This is particularly critical in organizations where retirement of the most experienced operators has eroded institutional knowledge or where fewer operators are expected to do more as a result of automation.

- **Human Factor Ergonomics.** How a control room is organized can simplify or complicate operator effectiveness. Piecemeal control systems that were installed as new plant equipment was added can now be consolidated conveniently within the operator's line of sight to minimize the need to roll chairs across the control room or delay operator reaction. Extended operator workplace (EOW) furniture can reduce operator fatigue during 12-hour shifts. Good lighting design, targeted audio and video alarm signals, and dedicated control-room spaces that minimize distractions from non-essential functions or personnel can all contribute to a more productive control room environment.

An Alarming Retrospective On The Evolution Of Control

In the days before DCS, a dedicated light on an annunciator panel meant something. With limited available panel space, only the most critical factors of operation were represented by alarm indicators. System designers carefully planned which signals were critical enough to make the grade and exactly how they should be organized. With limited space on each panel, subsequent panels had to be constructed for each system within the plant, and as water treatment processes became more sophisticated and the number of treatment systems grew, so did the number of control panels.

With the advent of distributed control systems and digital display screens, however, it was very easy to create an alarm setting on every signal that came from a sensor, instrument, or control device in a WTP/WWTP. As a result, many alarms were set by default, but never prioritized into a control hierarchy.

The proliferation of alarms in DCS installations created unnecessary disruptions. Non-actionable alarms occur when a specific alarm condition arises but the operator does nothing because he or she is waiting for a subsequent, more critical factor to trigger another alarm. Nuisance alarms are triggered when the system goes from "alarm" to "no-alarm" status before an operator can react. Both of these conditions can lead to "alarm fatigue," which can condition the plant operator to ignore alarms altogether or take too long to return the system to normal operation.

Minimize Inefficiency With Better HMI

Better Alarms. One of the more valuable aspects of modernizing control system HMI is using it as an opportunity to review and reorganize alarm information in a more meaningful way. This includes reviewing current alarm history and classifying actionable alarms by priority. Realistic industry guidelines for alarm frequency state that an operator can handle a maximum no more than two alarms every 10 minutes on a long-term basis, and a maximum of 10 alarms per 10 minutes during a plant upset for a short duration. By comparison, some large plants average more than a thousand alarm events a day.

One way to identify unnecessary alarms is to ask, "At the time of that alarm, did the operator have to act, and what were the consequences of not acting?" It is surprising how many alarm conditions require no action or have no direct consequence. Many of those are simply an indication of a change in status and should never have been classified as an alarm when the DCS was initially installed. Undertaking a methodical review will provide an opportunity to identify and reprioritize those unnecessary alarms as well as clean up chattering or fleeting alarms.

Better HMI Displays. Early DCS systems that used screen graphics and animation to mimic piping-and-instrumentation-diagram (P&ID) drawings worked well enough for the electrical design engineer, but not necessarily as well for WTP/WWTP operators. With increasingly powerful DCS systems, displays got away from large painted flow-diagram boards that defined analog control systems, and became a series of individual screens that were not always organized to provide a sequential snapshot of related processes.

Excessive use of color and animation that might have looked sexy as a sales feature (Figure 3) could actually confuse an operator trying to understand what was going on in the system during a process upset. By contrast, today's high-performance graphics incorporate grayscale images to establish the basic process flow and use colors selectively (Figure 4) to highlight critical activity within the operation (e.g., red for Priority One alarms, orange for Priority Two alarms, and yellow for Priority Three alarms). Even when a plant chooses not to employ the grayscale techniques, it is still recommended that darker shades of red and green be used as run/stop indicators while brighter reds and greens depict priority and return to normal conditions.

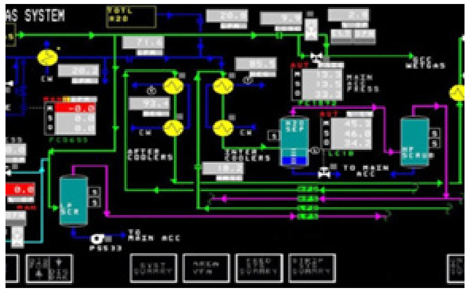

Figure 3. Older highly colored screens with symbolic representations of control logic make it difficult for operators to focus in on the locations and values of alarm conditions.

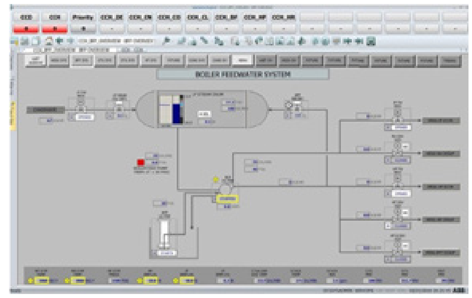

Figure 4. Modern, selectively colored HMI screen features quickly highlight prime areas of concern for the operator, in the context of the actual plant layout.

Another valuable technique is to display trends embedded on graphics to provide a snapshot context of the past few hours of actual WTP/WWTP operation and to show the normal operating range and the alarm limits on the bar graphs — with the priority color and priority number depicted after each respective alarm limit is breached.

Yes, There's An App For That!

To simplify execution of the alarm management strategies outlined here, methodologies that can be used to rationalize alarms from any control system have been incorporated into Alarm Management Tools. The tools provide analysis of the alarm history, which can then be applied toward implementing alarm grouping and suppression, creating a master alarm database, and other steps that have generated time savings of 30 percent to 50 percent in industry applications. ■