Operations Advisory Systems: *A Safety Perspective*

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White Paper

The role of the typical control room operator has changed dramatically over the years. New types of automation technology, increasing process complexity, increased number of control loops all increase the real-time demands on an operator. While Distributed Control Systems (DCS) allow the operator a better view of and improved interface with the plant facility, there is still a strong requirement for improvement in the way operators interpret and act upon plant operating scenarios. Couple this with the configurations of alarms in which little thought has been given to operator response, much less how the operator determines the root cause, and you will gain a view of the extreme challenges facing operators today.

Fortunately technology, which provides operations personnel enough specific information to determine the root cause and apply an appropriate, effective and consistent response to the condition, exists to complement the DCS environment. This technology is available through an Operations Advisory System (OAS) configured to utilize best practices for reliability and operations excellence. An OAS System is used as a predictive and preventative solution to provide an advisory to the operator prior to the event occurring and long before the DCS system detects a problem and generates an alarm. The DCS alone does not provide this capability.

Excess Alarms Impact Operator Effectiveness

In one scenario[i], an operator becomes aware of a process problem after an alarm is generated in the control system. A single alarm may occur at this point, or several alarms may be posted on the operator station screen.

For example, let's examine a simple alarm on a high level in a volatile solvent tank. The operator must assess the alarm in context of the other alarms, establish a plan for response and take the best action possible. This action is based on the operating experience in his/her skill set or pulled from some procedural document found on another computer or in the operating manual. The high level alarm told the operator part of a story: "the tank is high in level at 60%". The operator must interpret the true story of the process upset. If the tank goes to 65%, will it overflow? Will it allow flammable vapors to escape into an undesirable area of the process? Perhaps the operator has seen this alarm before and remembers the action taken at that time was satisfactory in resolving the alarm. Perhaps the operator on the previous shift experienced the same alarm and documented the action taken in the shift logbook.

Now that the operator has developed a mind's eye view of the level control, which is normally maintained by flow out of the tank with a feed flow control upstream of the tank; the operator might take action to slow the feed rate. This may mitigate the problem, but the alarm will not clear immediately. Other alarms require the operator's attention while this rising level slows, stops or even begins to recede. Perhaps the previous shift slowed the feed rate once already. Will slowing it more get the level to begin to fall? Assume a more experienced operator goes one step further by reducing the level setpoint so that the level control valve output must open at a faster rate and greater output. Perhaps the problem is solved, and within a few minutes, the level comes back into control. Only time will tell whether the adjustments made produced desirable results.

The Real Story is Revealed

An OAS reveals the background and root cause of current conditions by sending an advisory to the operator prior to alarm activation. The OAS uses predictive algorithms to warn the operator about the rising level and advise him/her that without further attention the situation may enter a danger zone. Information similar to that shown in Figure 1 provides the operator the Condition and an Explanation of consequences of the current operating condition and a specific Response designed to avoid key risk factors and return the operation to a safe operational mode. The OAS might also inform the operator that the level control valve is not opening fast enough to remain in control, or that the valve may already be fully open indicating plugging, higher pressure downstream or some other obstruction.

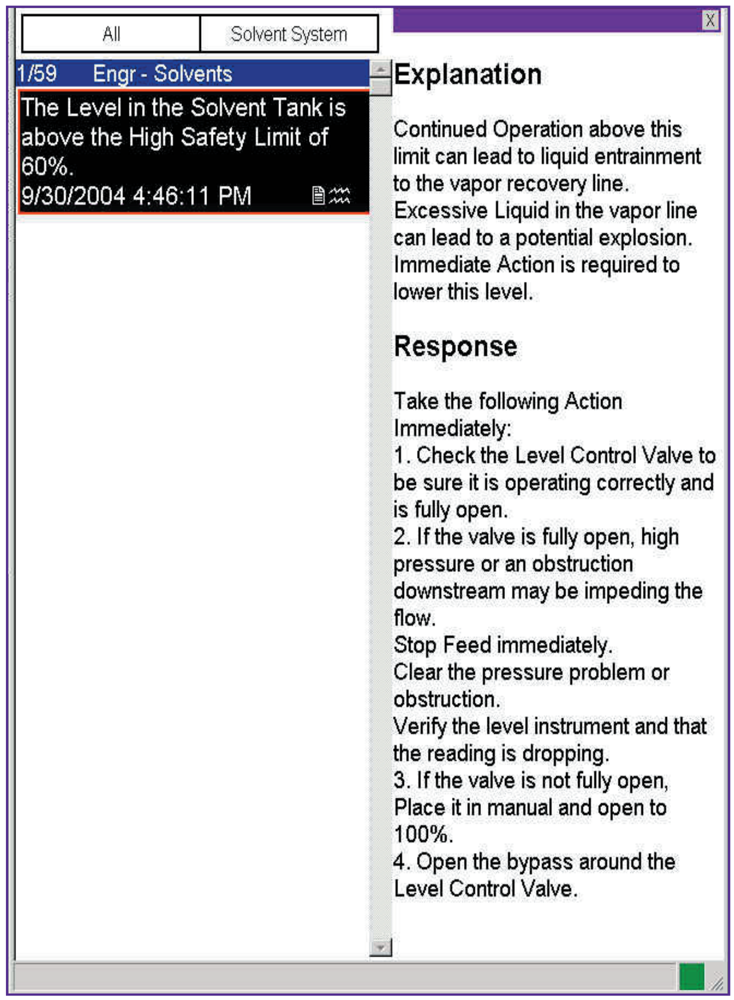

Figure 1 - Operations Advisory System Viewer

In this example, if the level exceeds 65%, liquid may overflow through a vent take off on the vessel to a line designed for

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vapor flow only. Assume, for the sake of this model, that the process automation engineer anticipated this issue and expected the operator to understand the process well enough to keep the system from moving into this critical operating region. In the DCS design, a safety interlock was put in place to avoid this critical condition by shutting motorized emergency block valves. Unfortunately, this results in a plant shutdown, production is lost, and there is the added risk of going through a shutdown and subsequent restart of a plant that uses flammable solvents in its process. If the operator takes the action described by the OAS, the DCS will not have to compensate for the situation, and the plant continues to run while operators take corrective actions to return to normal operations.

This OAS also acts as a sensor validator and shows where valve, flow meter and level transmitter irregularities are developing (such as instrument drift) that should be checked out by the I/E department.

One industry expert sums it up this way, "The DCS, if programmed correctly, is a very effective device, except it is probably only 40% used. What an OAS could be very good for is orienting an operator to a problem, providing coordinated information for an operator to evaluate the risk and making suggestions on what are the best actions the operator should take. I personally believe the strength of the OAS is during "Normal" not "Abnormal" operation and it must never be seen as an SIS" (Safety Interlock System).[ii]

The OAS Fills the Gap

While the above scenario may be simplistic, the OAS brings a positive driver toward achieving operational excellence and risk management to the plant site. The OAS fills the void between the control and shutdown systems, operations and other departments such as maintenance, and the operator and the plant. This goes a long way toward relieving the stress and pressure from the human operator who may not have enough time or experience to foresee the consequences and correct critical conditions.

The OAS should be designed to reflect pertinent real time process information around a critical condition that is progressing toward unacceptable consequences. Every plant possesses operating technicians with extensive knowledge in a variety of normal and abnormal situations. With a good OAS, delivering more accurate and concise advisory solutions, dependence on an overloaded alarm system can be avoided. An OAS system brings reliability and diagnostic information directly to existing operator stations in real time. As a result, the operator proactively manages developing critical conditions with both the root cause and the best practice corrective action at his/her fingertips.

Operations personnel do not need to be saddled with unnecessary advisories when a part of the process has been placed on standby, for example. The OAS should have the ability to provide suppressional algorithms that detect whether a system is in a particular operational mode before sending an advisory to the operator station. Additionally, if a process is in a different operational mode such as moving into start up or shut down or even changing grades of product at full operating rate, the OAS should be "smart" enough to know the difference and provide the correct advisories for current conditions.

Maintaining Operator Focus

Another aspect of implementing an OAS is to ensure that the system does not have an additive affect on the number of alarms or advisories that occur during normal operation. An instrumental question often asked by operators and pragmatic operations managers is, "Will this OAS give us even more things to watch during normal operations?"[iii] With the appropriate OAS, the answer is "No". The goals of such a system are to achieve reduced long-term average alarm rates during normal operations and improve the operator's ability to respond to abnormal conditions before a major plant upset can occur. If a major plant upset does occur, the operator should be dealing with the fewest alarms and advisories possible. The reduced number of alarms is made possible by proper prioritization of alarms and advisories within the OAS. In addition, tolerances should be set within the advisories to prevent nuisance advisories, i.e. large numbers of advisories that must be repeatedly acknowledged.

The EEMUA (Engineering Equipment and Materials Users Association) alarm system guide suggests that no more than 10 alarms/advisories be displayed in the first ten minutes of a major plant upset and no more than one every 10 minutes in normal operation. The idea is to reduce the number of alarms and advisories handled by the operator to a manageable number. While one alarm every 10 minutes may be ideal, consider the incident that occurred in 1994 at a refinery in England; operators were presented with some 275 alarms in the last 11 minutes before the explosion.[iv] An OAS system exists that is capable of prioritizing advisories and delivering them via a display structure such that, even if all 275 alarms occur, the top 5 most critical of those 275 are the ones presented to the operator as advisories. Additionally, the operator receives with the advisory the Condition, Explanation of the consequences of the current critical condition and a specific Response designed to avoid undesirable results. Again, proper prioritization will lead to a reduction of the 275 alarms in this example, while displaying only those critical advisories pertinent to avoiding the event and the 275 alarms. Once the top 5 advisories are addressed, operations can go to the OAS and review lower priority advisories. This capability exists to avoid such major accidents by dealing with the human interpretation, intervention and action sequence dilemma that occurs in facilities that are limited to a stand alone DCS for communication back to the operator.

An OAS at one large chemical plant actually reduced the number of alarms by 32%. Most significantly, this substantial result followed a formal alarm rationalization program the plant had already completed. At the same time, establishing proper advisory trigger settings for the OAS and moving some of the informational DCS alarms to the OAS yielded a net reduction

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in the combined number of alarms and advisories as compared to the number of DCS alarms previously managed by the operator. A downward trend in DCS alarms continues to this day (see Figure 2).

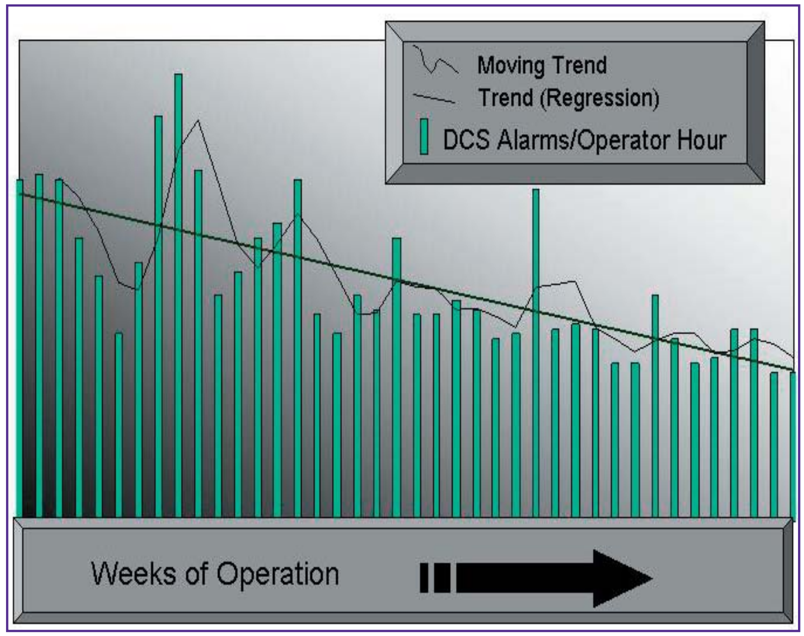

Figure 2 - DCS Alarm Reduction

Increasing Plant Safety

Supporting plant safety activities is another function of the OAS. One of the measurement aspects of Risk Management is tracking the avoidance of safety incidents. Our experience has shown that one benefit of an OAS is a reduction in EHS (Environmental, Health & Safety) incidents. Since the tracking of EHS incidents focuses only on those that have actually occurred, most organizations do not track those that have "not" occurred. "Near misses" might be tracked as those are actual incidents. A "near miss" magnifies that something went wrong with respect to safety and the consequences were much less than predicted given the circumstances of the incident. Due to this fact, little data exists that is directly associated with EHS incident avoidance. Nonetheless, an inference can be drawn between the use of an OAS and the number of EHS incidents that occur in an operating plant before and after the application is in place. For example, one application of an OAS at a client site with a nominal 1500 monitored instruments led to a 52% reduction in EHS minor incidents (see Figure 3).

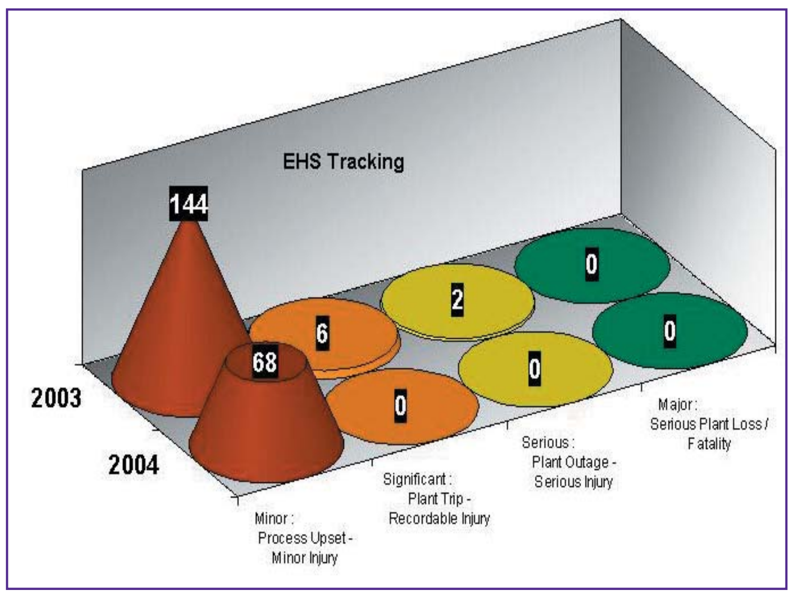

Figure 3 - EHS Tracking

Improving Plant Communications

Most of the time the OAS communicates information directly to operations and maintenance personnel through operating stations in the control room or the maintenance shop. For example, all alarms including those that have been moved from the DCS to the OAS as advisory messages and those advisory messages generated by the OAS are sorted and distributed as appropriate to personnel in the maintenance and instrument departments, while preserving the operator's prime concern for smooth plant operation.

Occasionally, a need arises to communicate specific types of information to other personnel within the organization. The OAS must have the capability to send advisories via email or pager in order to fulfill this requirement. For example, in the deployment of an OAS at one client, advisories were configured to inform the environmental engineer that developing conditions were leading to an environmental noncompliance. In another instance, the client wished to page engineers and management about an impending major upset that could require their immediate response. This allowed the operator to focus on corrective action while the OAS mobilized help.

OAS systems also provide an archive that allows for root cause analysis of events. Such an archive can be used to develop improved advisories with added conditional data, which promotes higher levels of expert response to developing critical conditions and sets tolerance parameters to inhibit nuisance advisories.

Improving the Bottom Line

While the OAS is improving plant safety performance, it also contributes to the bottom line. The above characterization of the safety benefits of an OAS should have you questioning why your plant has not implemented such a system yet. Occasionally, the question of how the system can contribute to profits and productivity arises. Over and over, industry professionals have stated that just a few days of production loss in one year can easily negate any benefits gained through a year of process plant optimization. Whether or not such an event occurs, justification remains that an OAS brings increased economic performance via algorithms designed to remind op-

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erations how to achieve and maintain the most profitable, optimum operating mode.

Morning production meetings are full of historical statements such as “the plant used too much steam yesterday” or “catalyst ratios were below par all of last week”. Driving an OAS to monitor real time steam usage, catalyst ratios or reactor charge ratios and provide operations with the appropriate advisory explaining why continuing operation in a less than optimized mode will detract from today’s profit is a much more proactive approach to dealing with such issues. Not only does the OAS give suggested responses to advisories, the feedback is given in real time. All of this allows those morning production meetings to become about how the OAS helped keep the plant’s profit up and production optimized all day yesterday!

The current proliferation of Six Sigma initiatives provides databases upon which business analysis of operational excellence opportunities can be built. The quandary facing companies today is how to apply logic from the results of business analysis back into the plant to yield value in real time. The OAS provides a mechanism to move the Six Sigma DMAIC (define, measure, analyze, improve and control) Model to a real time “digitization” of operations excellence at the front line of operations.[v]

One site of a large chemical company tracked productivity factors from a time prior to the OAS installation through several months of operation after the OAS was online in front of operations. The productivity factor takes into account how well the plant meets target production rates, stays online, produces at or above product specification and does all this without environmental incident. Results from the five months after implementation have shown a 7% increase in the productivity factor above the rate of the five months before implementation of the OAS (see Figure 4). The trend clearly points toward a continued increase in improvement as advisories provide operations with hints on how to tighten controls on upper and lower limits within the process. With the ability to segment advisory messages within the OAS MMI (Man-Machine Interface), the top priority of “Safety First” is maintained and increased profit and productivity contributes to the bottom line. “A reduced alarm problem means an improved control strategy and all the benefits that come from it.”[ii]

Conclusion

An OAS is an essential element necessary for plants to operate safely, profitably and efficiently today. DCS alarms alone are not sufficient. Plants should require the functionality of an OAS that brings the event, the background surrounding the event and a consistent, effective response to the operator’s attention in an instant. Having the appropriate response at the fingertips of the operator allows the plant to proactively attack critical conditions before they have a chance to become serious incidents. Activities requiring human intervention are handled in a more efficient manner; the system provides accurate, real time information to the operator, who can then take the appropriate, documented actions with confidence. A marked decrease in the number of alarms and advisories that require operator intervention also results. Plant operations and maintenance are driven to achieve and maintain operational excellence by the digitization of best practices and utilization of real time response to current plant conditions.

All of this results in increased safety, improved margins and fewer EHS incidents.

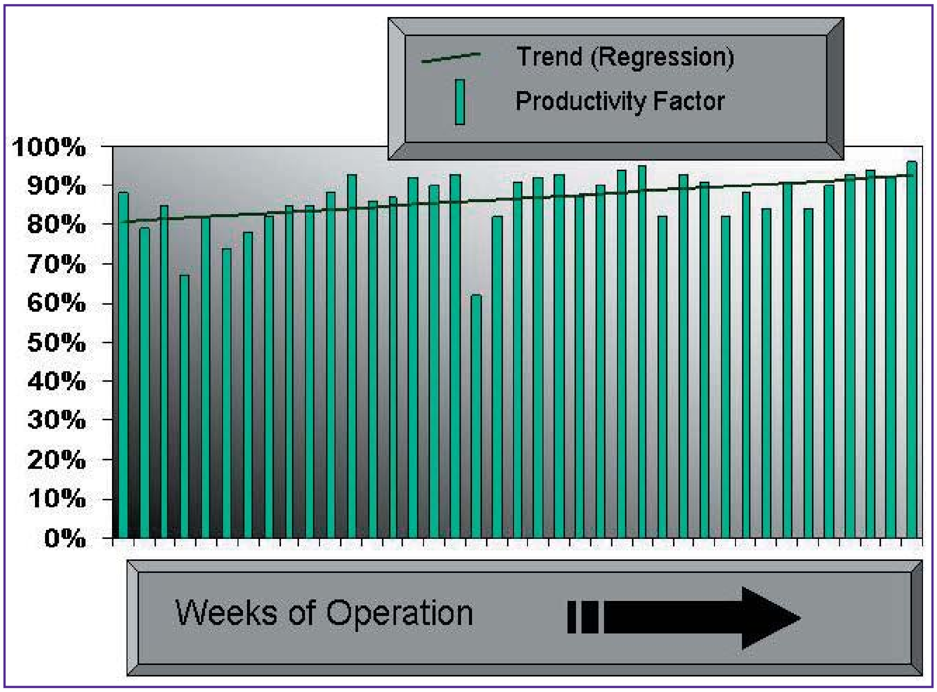

Figure 3 - EHS Tracking

[i] “Refining Reliability”, Hydrocarbon Engineering, Scott Stout, Vol. 7 Number 6, June 2002.

[ii] Personal communication with Ian Nimmo, Ian Nimmo is the former Director of the Abnormal Situation Management Consortium® and a managing partner of User Centered Design Services, LLC a consulting company focused on control room operations.

[iii] “Alarm Systems, a guide to design, management and procurement”, No. 191 Engineering Equipment and Materials Users Association, 1999

[iv] “Better Alarm Handling”, Health & Safety Executive, Chemicals Sheet No. 6.

[v] “Excellence in Operations”, Jack Stout, Hydrocarbons Engineering, Vol. 9, No. 4, April 2004.