Whitepaper

Alarm Management for SCADA control rooms

Definition of the term "alarm"

The concept of alarms (French for "a l'arme" which means "spring to arms") is very old and originates from the military concept where a guard warns his fellows in case of an attack. In process control, alarms have a very long tradition as well (e.g., a whistle indicating that water is boiling) and have evolved over time with older plants were using panels with bulbs and bells to alert the operators to large screen displays full of information.

However, in today's control room we often encounter the situation where the operators are flooded with too many alarms. Hence making it difficult to decide where to focus their actions.

Alarm configuration seems to be an easy task

Historically, the configuration of the Panel Boards has been expensive, because each alarm required extra hardware and wiring. Therefore the designers of a control room put considerable thought in the decision of whether an alarm was meaningful or not. This form of implicit alarm management often resulted in good quality operator interfaces. With the introduction of computerized control systems like the current generation of Supervisor Control and Data Acquisition (SCADA) systems, the cost associated with alarm configuration has been significantly reduced. Therefore, it is easy to configure several alarms on each and every point.

Engineers tend to hesitate before removing an alarm when unsure if the alarm is relevant. Modern field devices are able to generate a multitude of diagnostic messages, many of them issued as alarms. This typically results in huge amounts of configured alarms. As a consequence, during operation, operators receive huge amounts of alarms, even during normal operation. Today it is very common to receive more than 2,000 alarms a day per operator. Most of those alarms are nuisance alarms that provide no value for the operators.

Permanent high alarm rates indicate bad alarm quality

More and more companies understand that these high alarm rates are not acceptable and have an adverse effect on operator effectiveness. Alarm system quality improvement projects – often with the help of Alarm Management specialists – can rapidly result in impressive alarm rate reductions, e.g., by 50% or more and actually lead operators to perform their jobs more effectively. But due to the dynamic nature of the operations, the alarm system quality will degrade over time after it has been reached. If it becomes part of the daily work procedures to manage the alarm system quality, to ensure that the alarm system continues to be a useful resource for safe and efficient control room operation.

An alarm is an audible and/or visible means of indicating to the operator an equipment malfunction, process deviation, or abnormal condition requiring a response.

Definition of the term "alarm" according to ISA-18.2

The definition means that an alarm must indicate a problem, not a normal process condition. The target audience of an alarm should be operators, not engineers, maintenance technicians, or managers.

Today's reality in many control rooms is different: most of the occurring alarms have little or no value for the operators.

Human capacity is limited

Theoretically, every alarm shown to the operators should be meaningful and require operator action (see EEMUA 191). EEMUA 191 has emphasized the fact that the human capacity to absorb alarms is limited. If this limit is exceeded for longer periods of time, it is likely that important alarms will be overlooked, and in extreme cases the whole alarm system might be more or less ignored.

The guideline EEMUA 191 published first in 1999 and the standard ISA 18.2 published in 2009 have profoundly changed the way alarms are engineered in modern control systems.

EEMUA 191 focuses on the properties of the operator's information processing capabilities. It emphasizes the usability of an alarm system from the operator's perspective. If the operator is overloaded with alarms, the whole alarm system becomes useless. The document specifies several measurable performance indicators that can be used to benchmark a plant's alarm system performance, for example:

- Long term average alarm rate in steady operation: less than 1 alarm in 10 minutes
- Number of alarms during first 10 minutes after a major plant upset: under 10
- Alarm priority distribution: high (5%) - medium (15%) - low (80%) - Average fewer than 10 standing alarms.

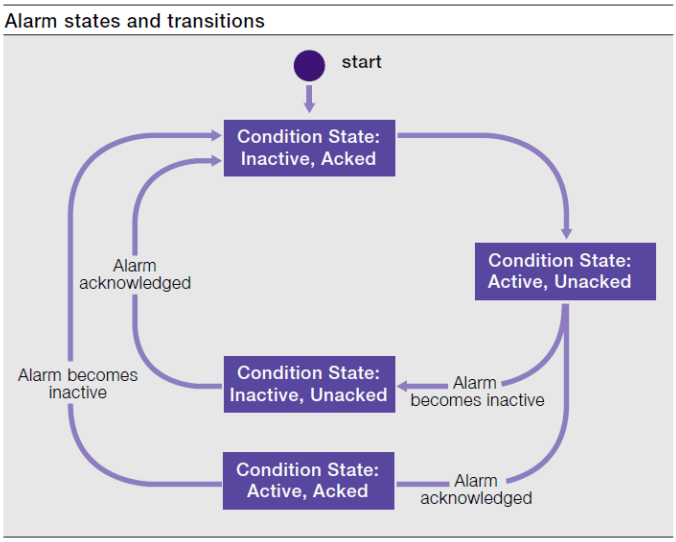
Of course these figures are only rough estimates and need to be adapted to the specific requirements of an individual control rooms

Guidelines and standards

The Engineering Equipment and Materials Users Association (EEMUA) published the first edition of their document 191 "Alarm Systems" in 1999, second edition in 2007 and third edition in 2013. ABB was actively involved in the writing of EEMUA 191.

Since 1999 several other guidelines, standards and books on alarm management have been written, all in the spirit of EEMUA 191. The standard ISA SP 18.2 “Management of Alarm Systems for the Process Industries” was published in 2009. The latest addition is the IEC 62682 “management of alarm systems for the process industries” published late 2014. This latest edition is further emphasizing the need for continuous alarm lifecycle management.

Guidelines like the above have rapidly gained worldwide acceptance as good engineering practice for alarm management. Today, the Standard ISA SP 18.2, which builds on the guideline EEMUA 191 can be seen as the most normative alarm management document.



EEMUA 191

In 1999, the Engineering Equipment and Materials Users Association (EEMUA) produced its Publication 191, “Alarm Systems, a guide to design, management and procurement” EEMUA is a non-profit distributing, industry association run for the benefit of companies that own or operate industrial facilities. EEMUA 191 has become the worldwide de-facto standard for Alarm Management. It explains how the quality of alarm systems should be managed.

A key idea of EEMUA 191 is that the cognitive resources of operators are limited and therefore should not be overloaded with alarms. The conclusion is obvious: ever y alarm should be useful and relevant to the operator. There should be no alarm without a predefined operator response.

EEMUA 191 introduces several easy to measure Key Performance Indicators (KPI) that allow to estimate the quality of an alarm system.

The common expectation is that operators should never overlook important alarms. However it’s important to understand that human operators have a limitation to the extent to which they can operate effectively to a period of high level uploading. EEMUA 191 recommends that the alarm rate in normal operation should be below 1 alarm in 10 minutes.

EEMUA 191 is a guideline for Alarm management and not mandatory. The document is recognized by a number of regulatory bodies as good practice. EEMUA 191 focuses on the properties of the operator’s information processing capabilities. It emphasizes the usability of an alarm system from the operator’s perspective. A second version of EEMUA 191 was published in 2007.

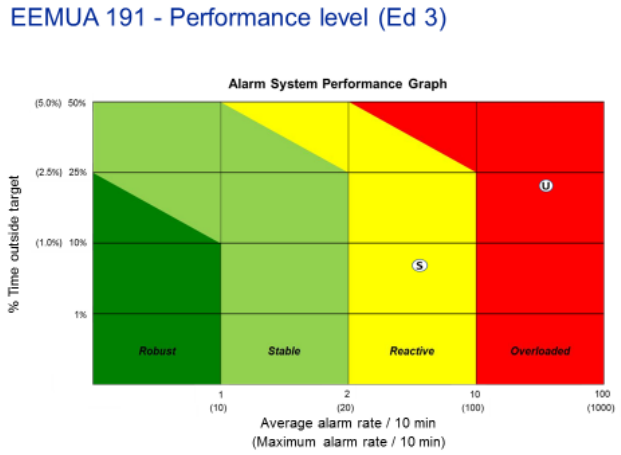


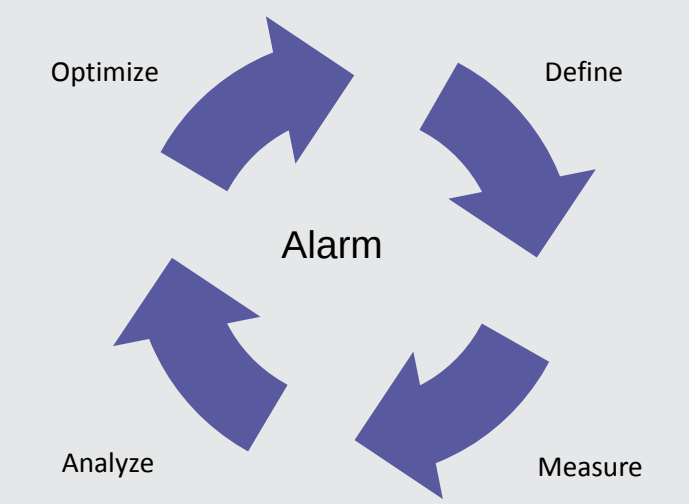
Figure 3 - Overall alarm system performance level

ISA SP 18.2

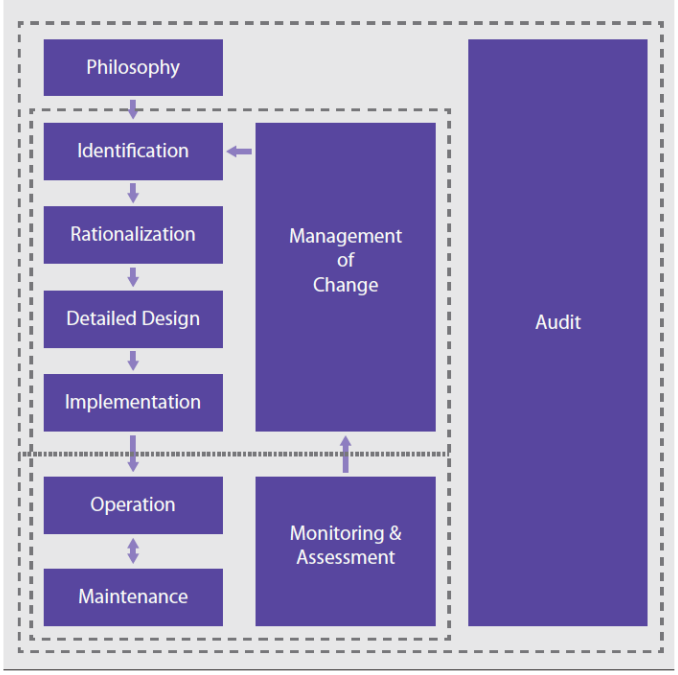
The ISA SP 18.2 standard “Management of Alarm Systems for the Process Industries” has been published in 2009. The committee has wide representation from users, vendors and consultants. As ISA SP 18.2 is based on work and ideas from EEMUA 191 and is a standard (not a guideline as EEMUA 191), it is likely that ISA SP 18.2 will take over the role of EEMUA 191 as the worldwide de-facto standard for alarm management.

The scope of ISA SP 18.2 is to establish terminology and practices for alarm systems, including the definition, design, installation, operation, maintenance, modification and work processes recommended to effectively maintain an alarm system

over time. Alarm system management includes multiple work processes throughout the alarm system life-cycle.



Alarm Management Lifecycle as defined in ISA 18.2



As was discussed with EEMUA 191, ISA SP 18.2 proposes Key Performance Indicators (KPI). These KPIs are easy to measure and can be used to estimate the quality of an alarm system. Measuring the alarm system quality is an important precondition for quality control and quality improvement – because only what is being measured can be controlled. Depending on industry and site-specific requirements adaptations of these KPIs will make sense. The important step is to define KPIs and continuously monitor them.

ABB's alarm management vision

ABB has a long-term involvement in and a strong commitment to standards like EEMUA 191, ISA SP 18.2 and IEC62682. Involvement with these standards coupled with ABB's long-term experience with all sorts of processes and control rooms, has led to the following vision for alarm management:

- Each alarm should alert, inform and guide
- Alarms should be presented at a rate that operators can deal with
- Detectable problems should be alarmed as early as possible - Cost/benefit of alarm engineering should be reasonable

SCADAvantage and AlarmInsight, implements ABB's newest technologies to bring this vision to reality. Regarding the alarm system, there are two parts that can be distinguished but not separated:

- Optimization of the alarm system - Optimization of the HMI

Alarm management lifecycle

Optimizing the alarm management system

In reality, the alarm management system also has a life cycle for the conception, application and maintenance of the corresponding systems that consists of several phases:

- Definition / engineering
- Measurement
- Analysis
- Optimization / rationalization

Alarm management system

Careful planning and conception is as important for the alarm system as it is for the whole plant. The same applies for documentation - it is equally important for the whole plant as for the alarm management system.

Alarm philosophy document

The first step in implementing an alarm management system should be a corporate alarm philosophy document that describes how alarms should work in a control room. It defines a consistent alarm philosophy for generating alarms in the control room.

The alarm philosophy document is the basis for the specification of the alarm attributes in SCADAvantage and Alarm Insights. This includes the basic alarm system (thresholds, priorities, grouping, etc.) as well as more advanced alarming techniques like state based alarming or the presentation of alarms in the Graphic User Interface (GUI).

Alarm engineering

Alarm engineering is the process of configuring and reviewing alarms against the principles of the alarm philosophy and determining and documenting the rationale and design requirements for the alarm. This includes the basis for the alarm setting, the consequence of deviation, and corrective action that should be taken by the operator. Further rationalization also includes the prioritization of alarms based on the mechanism defined in the alarm philosophy or its removal.

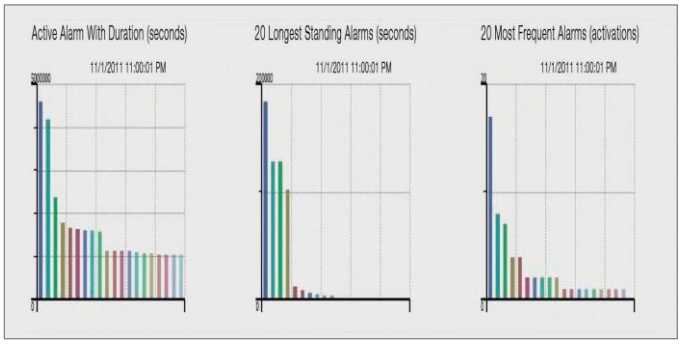
Alarm analysis

To sustain effective operation, it is important to have a well configured alarm system and to measure and analyze this system constantly.

The alarm philosophy document defines the KPIs describing the required alarm system quality. In the initial plant setup these KPIs may (or may not) reach the desired quality. But a plant usually changes all the time (modifications, extensions, wear and tear) and it cannot be assumed that a once reached quality level can be kept for long periods. Therefore a continuous monitoring mechanism needs to be implemented, that compares the current with the desired quality level.

Regular measurement of the alarm performance indicators is crucial for maintenance and optimization of the system. Alarm management is often implemented as part of the continuous Define – Measure – Analyze – Improve – Control (DMAIC) cycle in Six Sigma programs.

Systematic alarm management usually reveals weak spots in the process and can therefore help to directly improve operation performance.



Alarm frequency analysis

The operator guidance given by a high quality alarm system will further improve the plants performance.

If the alarm system quality has degraded, the reasons for this degradation need to be analyzed, and actions to fix these problems need to be per formed. For example if new operating procedures are driving the process more to its borders, the old alarm thresholds might be too tight and might need to be adapted to the new operating procedures. If a broken measurement instrument permanently generates alarms, this instrument needs to be repaired or exchanged.

Standard alarm reports (EEMUA 191 and ISA SP 18.2 compliant) are already integrated and preconfigured e.g.,

- Most-frequent alarms
- Longest-standing alarms
- Average time to acknowledge alarms over time (trend)
- Alarm priority distribution
- Number of disabled alarms, inhibited alarms, shelved alarms and hidden alarms over time (trend)

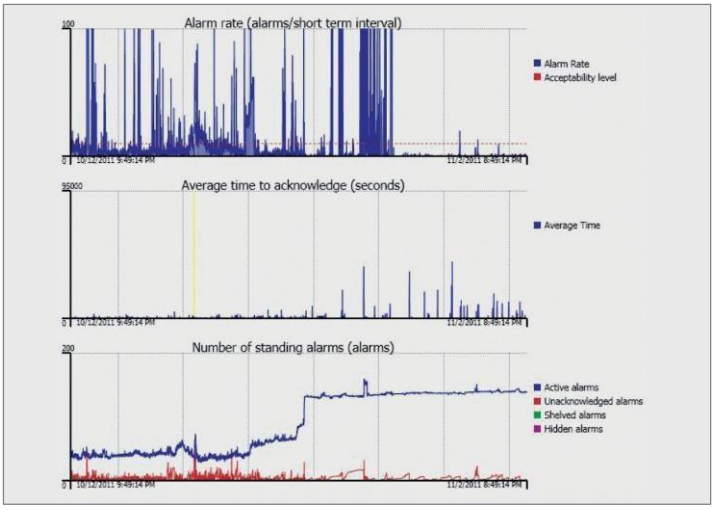
Individual reports for ever y desired time frame and every desired range of alarms can easily be generated by an easy to use drag-and-drop inter face. With these reports, it is easy to determine which alarms cause the most disturbance and which are nuisance alarms.

Alarm optimization

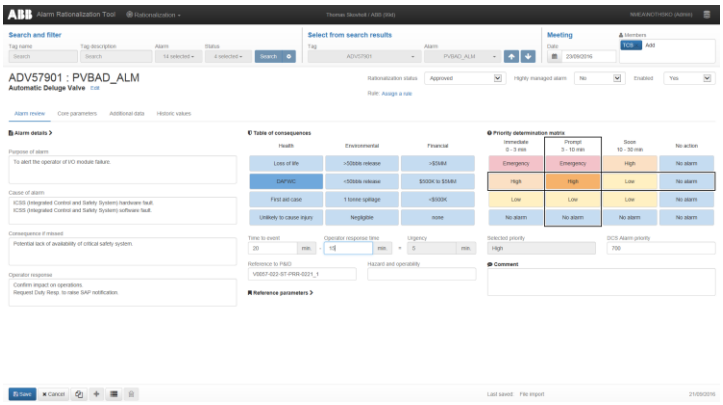
During alarm optimization the results of alarm measurement, analysis are transferred to the process.

Alarm management lifecycle

Since the processes constantly change, the alarm management system has to be checked regularly and modified if necessary



Alarms over time analysis



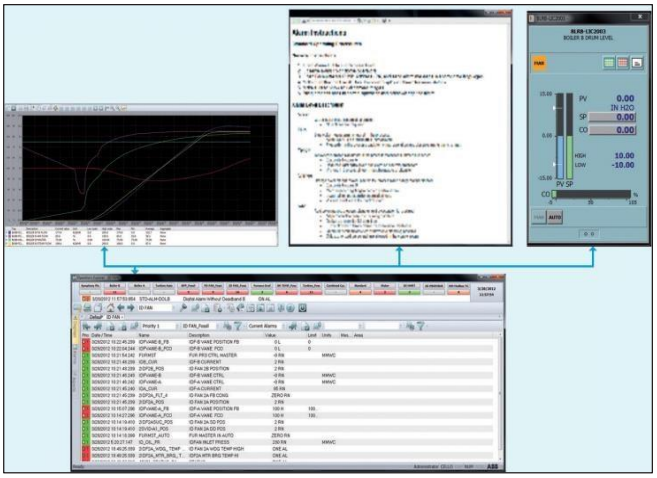
Improving Operator effectiveness

Alarm summary data values

When an alarm is triggered, an operator's response is based on the information and sequence of events data available via the alarm list. The better this list is, the more appropriate the operators' reaction and the quicker the problem gets resolved in the manner intended.

The way an alarm is presented thus dictates how effectively it is handled. In SCADAvantage alarm management for example, operators can acknowledge all visible alarms, and enter comments for individual alarms that are recorded in the events list. Navigation to the corresponding event list is simple and direct.

Direct navigation from alarm list to actual values and related information

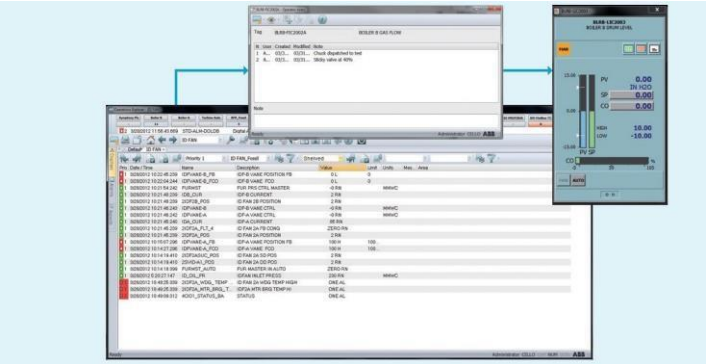


The visible part of SCADAvantage alarm lists always gives direct access to the actual values of the parameters that have triggered the alarm.

Additionally statistical evaluations are integrated directly with the message client to improve the search for each cause of disturbance.

State-based alarm hiding removes unnecessary alarms

Optimizing operator workload improves effectiveness, especially during critical situations, this is a key function of alarm hiding and alarm shelving.

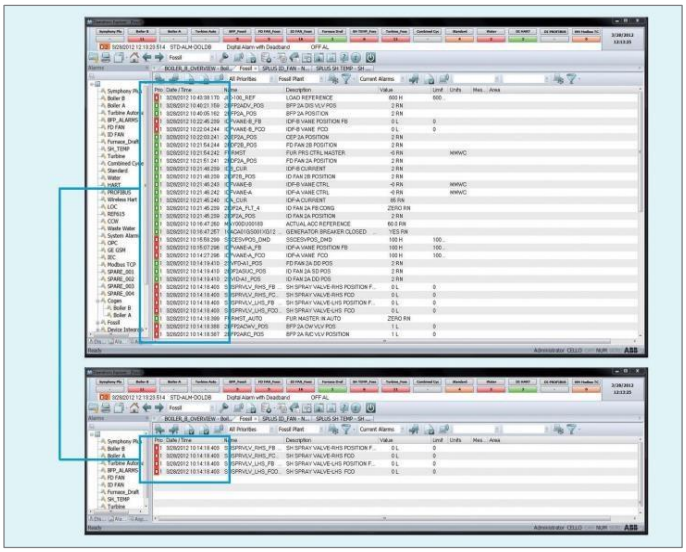


Alarm shelving

Alarm hiding is set up during the engineering phase. Its main purpose is to suppress alarms that are either expected or not relevant in a particular situation, or that are based on a known process state eg, low temperatures or flow during a controlled shutdown. As the name suggests, 'hidden' alarms are never visible to operators. They only see alarms that require action on their part.

Alarm shelving

Shelving lets operators decide whether or not to put an alarm 'on the shelf' for a defined period of time or a certain occurrence. This temporarily removes it from the main alarm list to a special list, but the alarm itself is not affected. It will later require attention from the operator. In the meantime, the operator can concentrate on tasks judged to require their immediate focus. Simple navigation makes alarm shelving a valuable and much-appreciated tool that helps operators work with maximum efficiency.



Alarm grouping

SCADAvantage alarm list

Alarm grouping replaces long lists

The aim of alarm grouping is not unlike that of alarm hiding and alarm shelving; to reduce the number of events listed, thereby helping operators handle key tasks with their full, undistracted attention.

A group alarm is a single alarm that is presented instead of several individual alarms. The individual alarms are generally related to a common process unit or a similar operator response. By minimizing the number of alarm list entries that have to be read and assessed, alarm grouping helps operators work more effectively.

Alarm Callout

With the callout module, SCADAvantage is capable of contacting a person by a variety of methods when an alarm is generated. System may be configured to generate a callout based on an escalation list that defines a number of users who are to be contacted by specified methods. The callout module includes mechanisms that allow for escalation of a callout if the associated alarm that initiated the callout is not acknowledged within a configurable period of time, other Users may be defined that the callout module will subsequently contact. The callout module supports several callout methods including:

- Numeric Page
- Voice
- E-mail/Alpha-Numeric Page
- Voice via Sound Card
- Text via Serial Port
- SMS Text to smart phone device

Consistent alarm-response navigation gives fast access to essential information

Should a situation become urgent, the operator needs support to shorten the time from the alarm occurring to finding the root cause and taking corrective action. SCADAvantage alarm management provides this support with direct access from the alarm message to all available, alarm-related information.

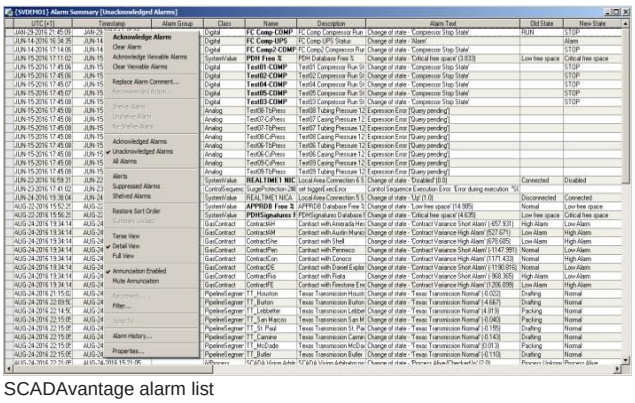
When an alarm is triggered and operators need specific information on what that particular part is and does, as well as how they should react, they are just one click away from the faceplate, graphic display, operating manual or live video image

Implementation of the alarm system

Since operators are an essential part of the alarm system, operator training is an essential activity during system implementation and/or during bigger rationalization audits. The alarm philosophy document should describe how testing and training have to be documented and which modifications will require retesting and/or retraining.

Modern alarm management - bringing together safety and effectivity

Working with a user friendly alarm management system like SCADAvantage improves an operator's ability to navigate, analyze and act in a timely and correct manner. Knowing at once what an alarm means and how best to deal with it, increases plant availability and thereby productivity. As well as helping secure the investment made in the facility, this also protects the individuals working there and the surrounding environment.



SCADAvantage alarm list

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