TECHNICAL REPORT

ISA-TR18.2.4-2012

Enhanced and Advanced Alarm Methods

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ISA-TR18.2.4-2012, *Enhanced and Advanced Alarm Methods*

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Preface

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Foreword

In 2009, ANSI/ISA-18.2-2009, *Management of Alarm Systems for the Process Industries*, commonly referred to as ISA-18.2, was issued. In that same year the ISA18 committee established working groups to develop a series of technical reports with guidance on how to implement the practices outlined in ISA-18.2. The six independent technical reports are described below:

- ISA-dTR18.2.1, *Alarm Philosophy* [dTR1], provides guidance on the alarm philosophy and is limited to the scope of Clause 6 in ISA-18.2. The alarm philosophy provides guidance for successful management of the alarm system. It covers the definitions, principles, and activities by providing overall guidance on methods for alarm identification, rationalization, classification, prioritization, monitoring, management of change, and audit. (As of the publication of this technical report, the draft, dTR1, had not been published.)

- ISA-dTR18.2.2, *Alarm Identification and Rationalization* [dTR2], provides guidance on alarm identification and rationalization and is limited to the scope of Clauses 8 and 9 in ISA-18.2. Identification and rationalization cover the activities to determine the possible need for an alarm or a change to an alarm; systematically compare alarms to the alarm philosophy; and determine the alarm setpoint, consequence, operator action, priority, and class. Activities include, but are not limited to, identification, justification, prioritization, classification, and documentation. (As of the publication of this technical report, the draft, dTR2, had not been published.)

- ISA-dTR18.2.3, *Basic Alarm Design* [dTR3], provides guidance on basic alarm design, focuses on the scope of Clause 10 of ISA-18.2, and may include other clauses as needed (e.g., Clause 14 on operations and Clause 15 on maintenance). Basic alarm design covers the selection of alarm attributes (e.g., types, deadbands, and delay times) and may be specific to each control system. (As of the publication of this technical report, the draft, dTR3, had not been published.)

- ISA-TR18.2.4-2012, *Enhanced and Advanced Alarm Methods* [TR4], provides guidance on enhanced and advanced alarm methods and focuses on the scope of Clause 12 of ISA-18.2. Enhanced alarm design covers guidance on additional logic, programming, or modeling used to modify alarm behavior. These methods may include: dynamic alarming, state-based alarming, adaptive alarms, logic-based alarming, and predictive alarming, as well as most of the designed suppression methods.

- ISA-TR18.2.5-2012, *Alarm System Monitoring, Assessment, and Auditing* [TR5], provides guidance on monitoring, assessment and audit of alarms and focuses on the scope of Clauses 16 and 18 in ISA-18.2. Monitoring, assessment, and audit cover the continuous monitoring, periodic performance assessment, and recurring audit of the alarm system.

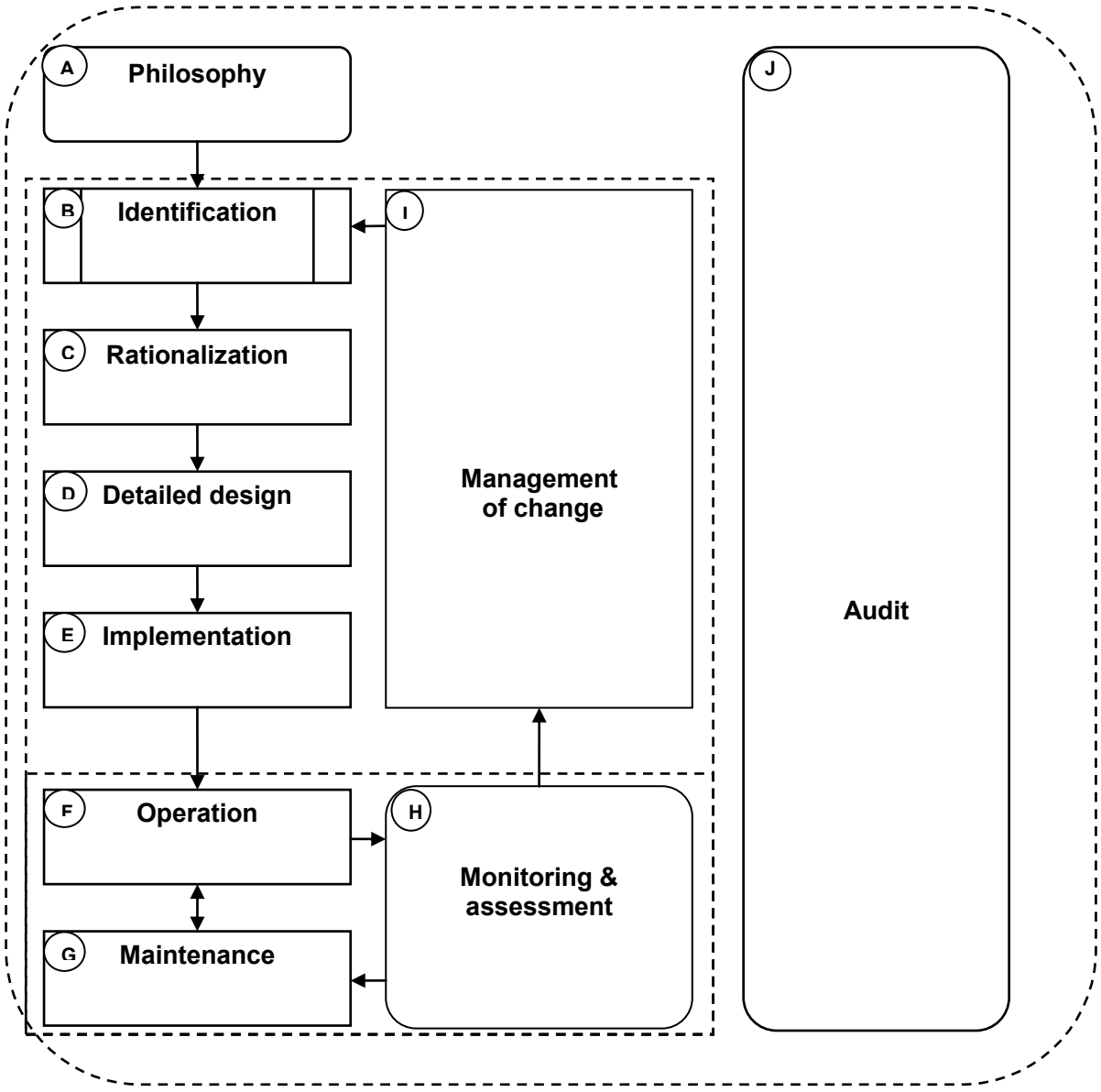
- ISA-TR18.2.6-2012, *Alarm Systems for Batch and Discrete Processes* [TR6], provides guidance on the application of ISA-18.2 alarm lifecycle activities to batch and discrete processes, expanding on multiple clauses of ISA-18.2.

The guidance as presented in this document is general in nature and should be applied to each system as appropriate by personnel knowledgeable in the manufacturing process and control systems to which it is being applied. This guidance will evolve with experience and technology advancements.

Introduction

Alarm management lifecycle

ISA-18.2 gives requirements that address alarm systems for facilities in the process industries to improve safety, quality, and productivity. The general principles and processes in ISA-18.2 are intended for use in the lifecycle management of an alarm system based on programmable electronic controller- and computer-based human machine interface (HMI) technology. These requirements are presented in the standard, using the alarm management lifecycle shown in ISA-18.2.



Note 1: The box used for stage B represents a process defined outside of ISA-18.2.
Note 2: The independent stage J represents a process that connects to all other lifecycle stages.
Note 3: The rounded shapes of stages A, H, and J represent entry points to the lifecycle.
Note 4: The dotted lines represent the loops in the lifecycle.

Figure 1 – Alarm management lifecycle (ISA-18.2)

Enhanced and advanced alarming
Clause 12 of ISA-18.2 discusses enhanced and advanced alarm methods. These methods typically go beyond the basic methods and techniques that are usually, or at least initially, applied. It is an informative clause and contains no mandatory requirements. Enhanced and advanced alarming is not a separate stage in the alarm management lifecycle, a separate work process, or a specific application. It is a collection of methods and techniques that can be applied within the ISA-18.2 lifecycle stages. For example, advanced alarming techniques on specific alarms are designed in the ISA-18.2 design stage and implemented in the implementation stage. Significant improvement in alarm system function and performance can usually be made by following the basic alarming methods and principles. However, in many cases they may not be sufficient to achieve the goals for performance and operator guidance stated in the alarm philosophy. For example, due to changing process or equipment state, the alarms may not always trigger at the appropriate times for operator action, or they may trigger at times when no action is needed.

Enhanced and advanced alarming methods are additional layers of logic, programming, modeling, or a combination thereof, used to modify alarm behavior or to improve operator guidance to better meet the objectives of an alarm system.

Purpose of this technical report
The purpose of this technical report is to help people evaluate when to use enhanced and advanced alarming methods, what benefits they can achieve, and what challenges and costs to expect. The objectives of this technical report are:

a) to educate plant personnel as to what solutions are possible when the basic alarming methods alone do not achieve a site's alarm management objectives

b) to help plant personnel to identify potential benefits, costs, risks, and necessary follow-up for solutions at their sites; to help decide whether or not they should consider enhanced and advanced alarming techniques; and if so, which specific techniques should be incorporated into their alarm philosophy and work processes

c) to help those involved in the design, procurement, implementation, maintenance, and operation of enhanced and advanced alarming methods, for both existing systems and new systems

d) to provide guidance and examples to help ensure successful deployment of the solutions

Report organization
Clause 12 of ISA-18.2 divides enhanced and advanced alarming into four categories based on type of solution: information linking, logic-based alarming, model-based alarming, and additional alarming considerations.

This technical report is organized by type of alarming problem, rather than by solution technique. The intent is to cover all the techniques but to cover them in the context of the site problems that they address. Some techniques can be used to address multiple problems, and in the more complex problems and solutions, multiple techniques may be used, as shown in some of the examples of this report.

The technical report is organized as follows:

Clause 1 discusses the scope of this technical report, including important exclusions.

Clause 2 gives normative references.

Clause 3 provides definitions of terms and acronyms used in this technical report, most of which are defined in ISA-18.2 and used here.

Clause 4 discusses the primary differences between enhanced/advanced alarming methods and basic alarming methods, including discussion of situations that may lead to the need for enhanced and advanced methods.

Clauses 5 through 10 provide guidance and examples for using enhanced or advanced alarming methods to solve alarm system problems that remain after application of the basic alarming techniques. The problems, with their solutions, are presented roughly in their order of complexity.

Clause 5 discusses situations in which the information embedded in the alarm itself may not be enough to guide the operator to appropriate action. Often the appropriate guidance has already been identified during the rationalization stage. This clause discusses information linking techniques, such as those for presenting this and other guidance to operators at the appropriate times.

Clause 6 discusses situations in which changing plant operating conditions may lead to the need for advanced methods, such as designed suppression or changing alarm attributes, in order for the alarm system to properly track the changing states of the process. This can occur for planned operating states, such as start-up, shutdown, and different feedstocks; or it can occur due to unplanned events, such as a compressor trip.

Clause 7 builds upon this discussion. In some cases, the dynamic alarming methods of Clause 6 still do not provide adequate operator guidance, and enhancements may be needed to provide appropriate guidance for all anticipated process situations. Clause 7 discusses utilization of dynamic cause analysis to provide more tailored operator guidance in such situations.

Clause 8 discusses situations in which the basic alarm system alone does not deliver the alarm to the person (i.e., role) on the operating team who (based on the operating philosophy) should react to the alarm. In some situations, the responder is not in the control room or is in the control room but at a different console due to process dynamics, scheduling, or other competing plant floor activities. This clause discusses these issues and related solutions.

Clause 9 discusses appropriate use of alerts. As identified in ISA-18.2, alerts share some of the same characteristics but do not meet all of the criteria of alarms. Though they are not alarms, the use of alerts relative to alarms is important and is discussed in this clause.

Clause 10 briefly discusses the use of enhanced/advanced alarming methods for batch and discrete processes. These methods are more broadly covered in TR6.

Clause 11 discusses how the alarm system integrity is maintained through appropriate application of site work processes, including those discussed in ISA-18.2. If appropriate care is not taken in the application of the enhanced and advanced methods presented here, loss of alarm integrity and other problems can result.

Clauses 12 and 13 provide a list of references and a bibliography.

1 Scope

1.1 Exclusions

The following is a list of items not discussed in this technical report. In general they are left out of this report, not because they are unimportant, but because they are already covered by another ISA-18 technical report or otherwise assumed to be part of basic alarm management.

1.1.1 Alarm rationalization and basic alarm design

This technical report assumes that alarm rationalization and basic alarm design, as discussed in ISA-18.2, are being performed. Rationalization, also discussed in dTR2, is performed at an appropriate level, basic to advanced, as determined by the alarm philosophy (see dTR1) of the site. Basic alarm design is discussed in dTR3. Together these activities include such techniques as properly chosen alarm setpoints, deadband selection, use of on and off delays, and proper range specification.

1.1.2 Process variable calculations

Most process variable calculations (analog and logical) are performed in the control system and considered as part of the basic alarm design process. PV calculations can be complex yet have basic alarming functionality. This includes such techniques as:

a) common alarms, e.g., a common high-temperature alarm coming from multiple temperature transmitters on a tank, or a common toxic-gas alarm coming from multiple gas detectors
b) numeric calculations within the control system used with basic alarming, such as rate calculations (producing rate-of-change alarms), statistical calculations (producing statistical alarms, such as alarming on standard deviations, etc.) and other complex calculations
c) simple to complex models used to estimate process values online, often referred to as virtual sensors
d) high-speed counters and accumulators, often needed in discrete manufacturing applications, which accumulate and aggregate within the control system before applying basic alarming
e) logic calculations within the control system to create an alarm only when it is a valid alarm, e.g., a calculation including a logical AND of low pressure and the associated pump running, to create a logical PV that is alarmed

NOTE If the alarm is created by the control system, and logic is added to conditionally suppress it, this falls under the definition of advanced alarming and is discussed in Clause 6.

1.1.3 Operating displays for basic alarming strategies

Often it is important for operating display design and alarm design to go hand in hand. This may be for basic or enhanced/advanced alarm strategies. This technical report deals with some human interface design issues but only as related to the enhanced/advanced alarming strategies presented.

1.1.4 Audible indication strategies

The use of different audible alarm indications (sounds) to distinguish operating consoles for multiple console control rooms is considered to be a human interface strategy, rather than an enhanced alarm strategy. For the purposes of this technical report, the use of specialized audible sounds is not covered here.

1.1.5 Alarm shelving

As discussed in 11.7 of ISA-18.2, alarm shelving is an important recommended function and can be used in a number of ways. It is also discussed in dTR1. Its use is not considered advanced or enhanced alarming.