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TECHNICAL REPORT

ISA-TR18.2.7-2017

Alarm Management When Utilizing Packaged Systems

Approved 17 February 2017

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ISA-TR18.2.7-2017, Alarm Management When Utilizing Packaged Systems

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ISA
67 Alexander Drive
P.O. Box 12277
Research Triangle Park, North Carolina 27709

E-mail: standards@isa.org

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This preface, as well as all footnotes and annexes, is included for information purposes only and is not part of ISA-TR18.2.7-2017.

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G. Nasby (Co-Chair)	City of Guelph Water Services
J. Bogdan	J. Bogdan Consulting LLC
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S. Kandasamy	Chevron Energy Technology Company
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D. Logerot	ProSys
L. Myers	Consultant
A. Perez Verde-Ramo	Sparq Systems
D. Reed	Rockwell Automation
N. Sands	DuPont
D. Visnich	Burns and McDonnell
R. Weibel	TIPS

The following people served as voting members of ISA18 and contributed to this technical report:

NAME	COMPANY
D. Dunn, ISA18 Co-Chair	Phillips 66
N. Sands, ISA18 Co-Chair	DuPont
B. Fitzpatrick, ISA18 Managing Director	Wood Group Mustang
J. Alford	Consultant
S. Apple	Schneider Electric

J. Bogdan
K. Brown
M. Brown
A. Bryant
M. Carter
L. Dubois
B. Hollifield
S. Kandasamy
D. Logerot
C. Luntz
M. Marvan
D. Metzger
L. Myers
G. Nasby
G. Plowman
D. Rothenberg
T. Stauffer
D. Strobhar
B. Vail
D. Visnich
R. Weibel

J Bogdan Consulting LLC
Enbridge Inc.
Matrikon Inc.
Oxy Inc.
Hargrove Controls + Automation
Manage4U
PAS
Chevron Energy Technology Company
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Siemens AG DF FA
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Applied Control Solutions LLC
Chevron Energy

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Abstract

In 2016, the ANSI/ISA-18.2-2016 (ISA-18.2) alarm management standard was released. This technical report, Alarm Management When Utilizing Packaged Systems, provides guidance on the application of the ISA-18.2 standard to facilities that use packaged systems. This includes guidance for designing, configuring, interfacing and implementing alarms with respect to packaged systems and integrating them into a facility's BPCS (basic process control system). Other topics addressed include how to apply the various ISA-18.2 life cycle stages to packaged systems, common interfacing issues, and the many benefits of using a standardized alarm management approach for integrating packaged systems with a BPCS. This report also contains some content on stand-alone packaged systems.

Foreword

In June of 2009, ISA-18.2-2009, Management of Alarm Systems for the Process Industries, commonly referred to as ISA-18.2, was issued. Subsequently, the standard was adopted by ANSI and became ANSI/ISA-18.2-2009. In 2009 the ISA18 committee also established six working groups to develop a series of technical reports with guidance on how to implement the principles contained in ISA-18.2. The six technical reports are listed below with a brief overview. In 2016 the standard underwent revisions and became ANSI/ISA-18.2-2016.

- TR1 – Alarm Philosophy – provides guidance on the alarm philosophy. TR1 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.
- TR2 – Alarm Identification and Rationalization – provides guidance on alarm identification and rationalization. TR2 is limited to the scope of ISA-18.2 Clauses 8 and 9. Identification and rationalization covers the processes 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.
- TR3 – Basic Alarm Design – provides guidance on basic alarm design. TR3 focuses on the scope of ISA-18.2 Clause 10 and may include other clauses as needed (e.g., operations and 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.
- TR4 – Enhanced and Advanced Alarm Methods – provides guidance on advanced and enhanced alarm methods. TR4 focuses on the scope of ISA-18.2 Clause 12. 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, predictive alarming, as well as most of the designed suppression methods.
- TR5 – Alarm Monitoring, Assessment, and Audit – provides guidance on monitoring, assessment and audit of alarms. TR5 focuses on the scope of ISA-18.2 Clauses 16 and 18. Monitoring, assessment, and audit cover the continuous monitoring, periodic performance assessment, and recurring audit of the alarm system.
- TR6 – Alarm Systems for Batch and Discrete Processes – provides guidance on the application of ISA-18.2 alarm life cycle activities to batch and discrete processes, expanding on multiple clauses of ISA-18.2.

In 2013, the ISA18 committee established a seventh committee to develop this technical report on alarm management for facilities utilizing packaged systems which can be summarized as follows:

- TR7 – Alarm Management when Utilizing Packaged Systems – provides guidance on the application of ISA-18.2 to facilities that use packaged systems. This includes guidance for designing, configuring, interfacing and implementing alarms with respect to packaged systems and integrating them into a facility's BPCS (basic process control system).

Each technical report is written to be a standalone document. In an effort to minimize repetition, the technical reports have cross references.

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.

Preamble

ANSI/ISA-18.2-2016 describes requirements that address alarm systems for facilities in the process industries to improve safety, quality, and productivity. The general principles and processes in ANSI/ISA-18.2-2016 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.

The ISA-18.2 standard, however, does not provide specific guidance on how to effectively apply alarm management to scenarios where packaged systems are used in process facilities. This technical report provides guidance for this type of application of alarm management.

Note that, as a technical report, the contents of this document are informative. ANSI/ISA-18.2-2016 contains the mandatory (normative) requirements.

1. Scope

1.1 General considerations

This technical report provides guidance on how to integrate packaged systems (PSs) into a BPCS-based centralized alarm system. The scope includes discussing various issues that can arise when ISA-18.2 work processes are applied to facilities where PSs are used, and providing guidance on how to successfully apply ISA-18.2 in these situations.

Within the context of this report, a packaged system (PS) can be visualized as existing outside of the BPCS. It is a separate entity, usually containing an embedded microprocessor, controller or hardwired logic, which performs specific tasks for a piece of equipment or a process operating within a facility. Most PSs can be configured to send alarm or status information to a BPCS, directly to an alarm annunciation system, or both.

While not the primary emphasis of this report, some discussion is included of PSs that are stand-alone and also those that are only partially integrated with a BPCS.

PSs can take many forms but have several common characteristics. Typically, PSs combine multiple elements such as process equipment, embedded control systems (typically PLC), and instruments.

1.2 Alarm system interfaces

This report includes a focus on alarming-specific issues that can arise when PS interfaces are specified, designed, and implemented. Pros and cons of several design techniques are discussed from an alarm system point of view; the system designer should select the best PS interface option to use for the particular application.

1.3 Packaged system design

Within the context of this report, PSs are only considered as sources of possible alarms or of process data for the BPCS to create the alarm. This report does not contain guidance on how to design PSs or how PSs should operate.

1.4 Safety instrumented systems

Safety Instrumented Systems (SIS) are considered to be a special case of PSs. While governance of SIS is described by ISA-84, some SISs have the same common attributes as a PS and, in such cases, the guidance in this technical report may apply. SIS design is out of the scope of this document.

2. Normative references

NOTE In some cases, reference to ISA standards may have historically used "S" instead of "ISA," e.g., S88.

ISA-18.2: ANSI/ISA-18.2-2016, *Management of Alarm Systems for the Process Industries*, also known as ISA-18.2

ISA-84:ISA-84.00.01-2004 (Parts 1-3), *Safety Instrumented Systems for the Process Industry Sector*

ISA-88: ANSI/ISA-88.00.01-2010, *Batch Control Part 1: Models and Terminology*

ISA-101: ANSI/ISA-101.01-2015, *Human Machine Interfaces for Process Automation Systems*

3. Definition of terms and acronyms

Definitions which are copied from ISA-18.2 are shown in Section 3.1. Those that come from other sources (i.e., other ISA standards or TRs) or newly created with this technical report are shown in Section 3.2. Definitions from other sources are shown with the source in square brackets. Synonymous terms, which are not used in this technical report, but which might be used by readers, are listed in parentheses. Likewise, acronyms and abbreviations which are copied from ISA-18.2 are shown in Section 3.3. Acronyms and abbreviations from other sources are shown in Section 3.4 with references in square brackets. New acronyms and abbreviations are shown in Section 3.4.

NOTE 1 Some alarm terms that are frequently used in industry are not defined or used in ISA-18.2 or this document because they have multiple meanings and interpretations by different BPCS vendors. Examples include alarm enable, alarm disable, and alarm inhibit.

3.1 Definitions from ISA-18.2

3.1.1. active

an alarm in a state in which the alarm condition is true

NOTE 1 Functions such as deadband, on or off delays and latching can allow the alarm to be active when the alarm condition is false or the alarm is not to be active when the alarm condition is true.

NOTE 2: This is the definition from the 2016 version of ISA-18.2. In the 2009 version of ISA-18.2, the term “activate” used to mean “process of enabling an alarm function within the alarm system”. In this report, the 2016 definition is used.

3.1.2 advanced alarming

collection of techniques that can help manage annunciations during specific situations.

EXAMPLE: state-based alarming

3.1.3 alarm

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

3.1.4 alarm attribute

Setting for an alarm within the process control system

EXAMPLE: alarm priority

3.1.5 alarm class

group of alarms with common alarm management requirements (e.g., testing, training, monitoring, and audit requirements)-

EXAMPLE: safety related alarm class

3.1.6 alarm flood

condition during which the alarm rate is greater than the operator can effectively manage (e.g., more than 10 alarms per 10 minutes)

3.1.7. alarm historian

long term repository for alarm records

3.1.8 alarm log

short term repository for alarm records

3.1.9 alarm management (alarm system management)

collection of processes and practices for determining, documenting, designing, operating, monitoring, and maintaining alarm systems

3.1.10 alarm message

text string displayed with the alarm indication that provides additional information to the operator (e.g., operator action)

3.1.11 alarm philosophy

document that establishes the basic definitions, principles, and processes to design, implement, and maintain an alarm system

3.1.12 alarm priority

relative importance assigned to an alarm within the alarm system to indicate the urgency of response (e.g., seriousness of consequences and allowable response time)

3.1.13 alarm setpoint (alarm limit, alarm trip point)

threshold value of a process variable or discrete state that is used to determine if the alarm is active

3.1.14 alarm system requirements specification

document which describes the functionality of the alarm system

3.1.15 alarm type

alarm attribute which gives a distinction of the alarm condition

EXAMPLE: low process variable alarm, high process variable alarm or discrepancy alarm

3.1.16 alert

audible and/or visible means of indicating to the operator an equipment or process condition that requires awareness, and which does not meet the criteria for an alarm

3.1.17 chattering alarm

alarm that repeatedly transitions between active state and not active state in a short period of time

3.1.18 classification

process of separating alarms into classes based on common requirements (e.g., testing, training, monitoring, and auditing requirements)

3.1.19 dynamic alarming

automatic modification of alarms based on process state or conditions

3.1.20 highly managed alarm

alarm belonging to a class with additional requirements (e.g., regulatory requirements) above general alarms

3.1.21 implementation

transition stage between design and operation during which the alarm is put into service.

NOTE1 to entry Implementation includes activities such as commissioning and training.

3.1.22 master alarm database

authorized list of rationalized alarms and associated attributes

NOTE1 The list can be in many forms and not only in the form of a database.

3.1.23 nuisance alarm

alarm that annunciates excessively, unnecessarily, or does not return to normal after the correct response is taken

EXAMPLE: chattering, fleeting, or stale alarm

3.1.24 operator (controller)

person who monitors and makes changes to the process

3.1.25 out-of-service

state of an alarm during which the alarm indication is suppressed, typically manually, for reasons such as maintenance

3.1.26 prioritization

process of assigning a level of operational importance to an alarm

3.1.27 rationalization

process to review potential alarms using the principles of the alarm philosophy, to select alarms for design, and to document the rationale for each alarm

3.1.28 remote alarm

alarm from a remotely operated facility or directed to a remote interface

3.1.29 re-alarmed alarm (re-triggering alarm)

alarm that is automatically re-annunciated to the operator under certain conditions

3.1.30 safety instrumented system (SIS)

instrumented system used to implement one or more safety instrumented functions. A SIS is composed of any combination of sensor(s), logic solver(s) and final element(s)

3.1.31 shelve

temporarily suppress an alarm, initiated by the operator, with engineering controls (e.g., time-limited) that unsuppress the alarm

3.1.32 silence

operator action that terminates the audible alarm indication

3.1.33 state-based alarm (mode-based alarms)

alarm that has attributes modified or is suppressed based on operating states or process conditions

3.1.34 suppress

prevent the indication of the alarm to the operator when the alarm is active

EXAMPLE: shelve, suppress by design, remove from service

3.1.35 tag (point)

unique identifier assigned to a process measurement, calculation, or device within the control system

3.2 Definitions from sources other than ISA-18.2

3.2.1 batch process

a process that leads to the production of finite quantities of material by subjecting quantities of input materials to an ordered set of processing activities over a finite period of time using one or more pieces of equipment [ISA-88]

3.2.2 common alarm

single alarm with several related input sensors where one operator action is required to address any and all of the common alarm components [ISA18-TR3]

3.2.3 open productivity and collaboration (OPC, OLE for process control)

set of specifications for the exchange of information in a process control environment

3.2.4 packaged system (package unit)

A self-contained combination of hardware and software that typically provides alarm, HMI, and/or control functionality for a specific process function that is part of a facility

3.3 Acronyms from ISA-18.2

3.3.1 ASRS: Alarm system requirements specification

3.3.2 BPCS: Basic process control system

3.3.3 cGMP: current good manufacturing practice

3.3.4 HMA: Highly managed alarm

3.3.5 HMI: Human-machine interface

3.3.6 MOC: Management of change

3.3.7 SIS: Safety instrumented system

3.4 Acronyms from sources other than ISA-18.2

3.4.1 DCS: Distributed control system

3.4.2 DNP3: Distributed network protocol (3-layer, see www.dnp.org)

3.4.3 FDA: Food and Drug Administration (US government)

3.4.4 I/O: Input/output

3.4.5 IEEE: Institute of Electrical and Electronics Engineers

3.4.6 KPI: Key performance indicator

3.4.7 LP: Local panel

3.4.8 OPC: Open Productivity and Collaboration (see OPC Overview in Bibliography)

3.4.9 OSHA: Occupational Safety and Health Administration (US government)

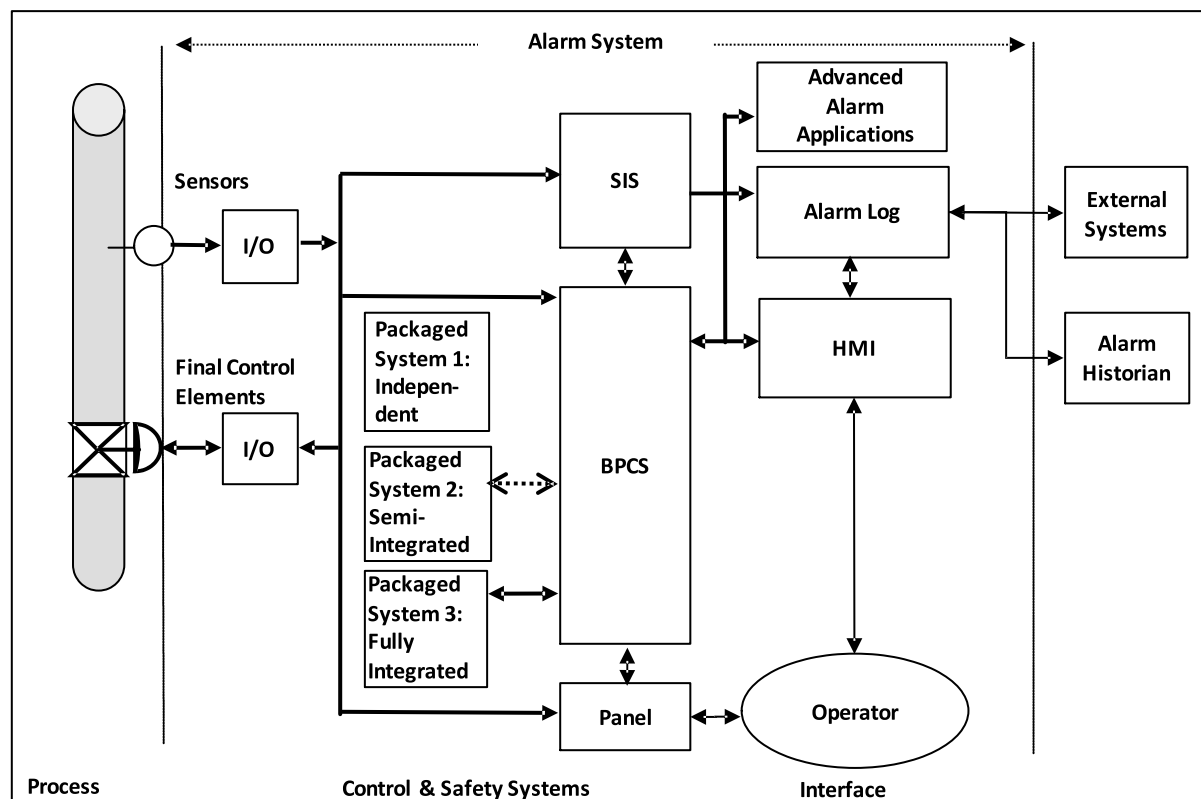
3.4.10 PLC: Programmable logic controller**3.4.11 PS: Packaged system****3.4.12 PSCP: Packaged system control panel****3.4.13 RAGAGEP: Recognized and generally accepted good engineering practices****3.4.14 SCADA: Supervisory control and data acquisition****3.4.15 TR: Technical report****4. Introduction****4.1 Purpose**

This clause provides an introduction to working with alarms from packaged systems. This document provides guidance for plant design engineers, system integrators, and owner/operators who undertake the design, implementation and operation of alarm management in the context of ISA-18.2 with respect to facilities utilizing packaged systems.

4.2 Overview

Process control systems may include packaged systems (PSs). These islands of automation, more fully described in Clause 5, may have alarms which fall within the scope of a process operator using a BPCS. A key recommendation of this report is to pursue integration of PSs with a BPCS due, in part, to the consistency it can potentially provide to operators regarding alarms. A major concern for non-integrated PSs is the challenge in making PS alarms behave like BPCS alarms.

How the PS fits within the alarm data flow specified in ISA-18.2 is shown in Figure 1.



NOTE 1 Packaged System 1 is an example of a PS with no connectivity to the BPCS of process information, alarm data, or control capability.

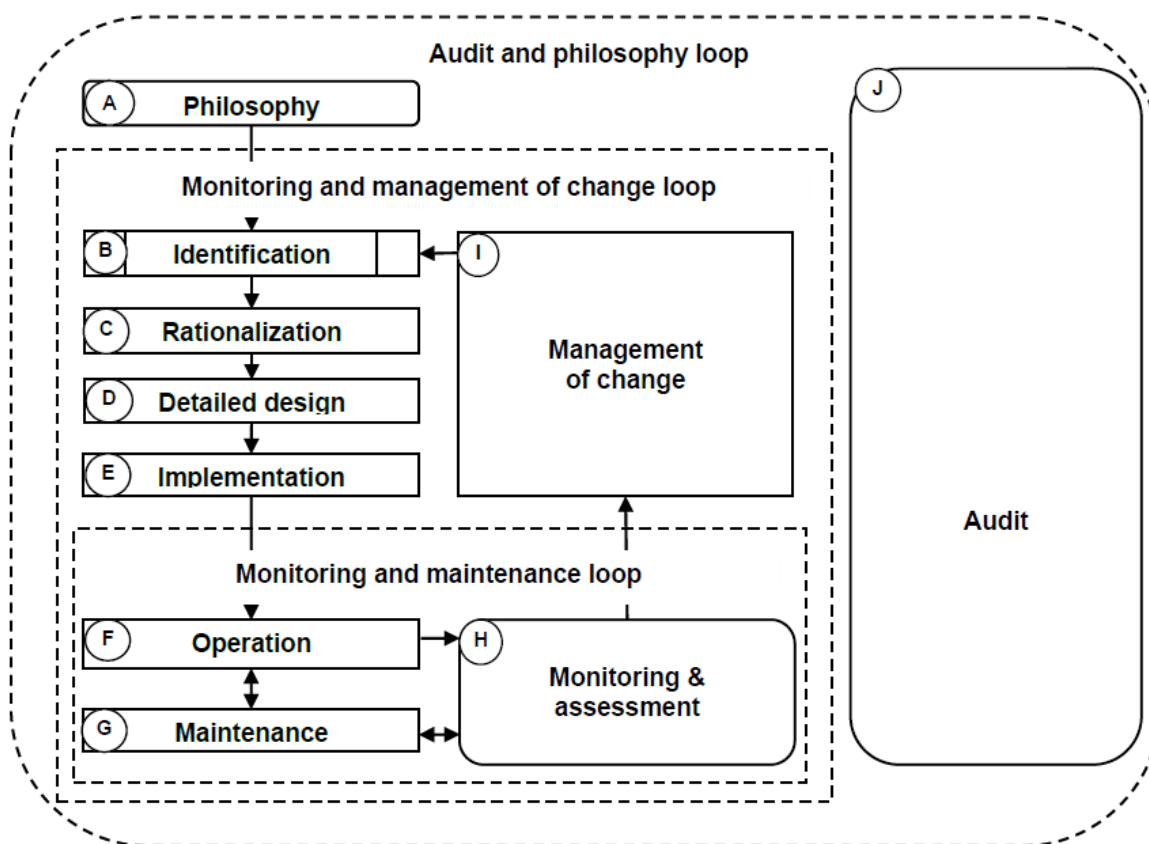
NOTE 2 Packaged System 2 represents a PS with limited connectivity to the BPCS of some process information, alarm data, or control capability.

NOTE 3 Packaged System 3 represents a PS with full connectivity to the BPCS of process information, alarm data, or control capability.

Figure 1 – Alarm system dataflow with multiple packaged systems included

4.3 The alarm management lifecycle

This subclause is intended to summarize important concepts in ISA 18.2. Each configured alarm has a lifecycle from creation to deletion. The components of management of these alarms are shown in Figure 2, which is copied from ANSI/ISA-18.2-2016, Figure 2.



NOTE 1 The box used for stage B represents a process defined outside of this standard per 5.2.2.3.

NOTE 2 The independent stage J represents a process that connects to all other stages per 5.2.2.11

NOTE 3 The rounded shapes of stages A, H, and J represent entry points to the lifecycle per 5.2.3.

NOTE 4 The dotted lines represent the loops in the lifecycle per 5.2.5.

Figure 2 – Alarm management lifecycle

The alarm management lifecycle consists of multiple stages. Figure 2 illustrates the relationship between the stages of the alarm management lifecycle described in ISA-18.2. The alarm management lifecycle covers alarm system specification, design, implementation, operation, monitoring, maintenance, and change activities from initial conception through decommissioning.

The lifecycle model is useful in identifying the requirements and responsibilities for implementing an alarm management system. The lifecycle is applicable for the installation of new alarm systems, and for updating and managing existing alarm systems.

A description of each stage of the lifecycle is included in ISA-18.2.

4.4 Document structure

This document is organized into different subjects by numbered clauses. Each clause starts with a statement of its purpose.

Clause 5 provides a description of packaged systems and their common characteristics.

Clause 6 describes the benefits of PSs incorporating the principles of ISA-18.2 and this TR.

Common characteristics of packaged systems are further discussed in Clause 7: (Packaged System Control Panels) and Clause 8: (Packaged System Interfacing Details).

The components of the alarm management lifecycle are discussed in Clauses 9 through 21.

Clause 9 addresses Alarm Philosophy and Clause 10 describes an ASRS (Alarm System Requirements Specification) for a PS (or facilities utilizing PSs). The Alarm Philosophy document is essential for overall facility alarm management, and the ASRS is essential in defining the requirements of individual systems.

Clauses 11 and 12 address alarm identification and rationalization, which are necessary to identify and characterize the packaged system alarms to be designed and implemented, as described in Clauses 13 through 16.

Clause 17 covers the use of PS alarms during process operations, including response procedures. Clause 18 is about maintenance of packaged system alarms, which helps assure, by testing and repair, that alarms continue to work as intended.

Clause 19 discusses monitoring packaged system alarms to assure optimum performance. This activity may result in suggested changes to alarms, so Clause 20 addresses management of change. Periodically, perhaps annually, a thorough examination and evaluation of the alarm system and its management is performed as an audit, which is described in Clause 21.

Clause 22 lists references and Clause 23 is a bibliography for further reading.

5. What is a packaged system

5.1 Purpose

The purpose of this clause is to define in detail what is considered a packaged system in the context of this report.

Packaged systems can take many forms but share many common characteristics. They are self-contained combinations of hardware and software that typically provide alarm, HMI, and/or control functionality for a specific process function that is part of a facility and that have been provided by a single specialized vendor. Often packaged systems combine multiple elements such as process equipment, embedded control systems (e.g., PLC), HMI, instruments and control elements (e.g., valves, pumps). The packaged system's control system is usually designed so that it can operate on its own without depending upon other control systems, but it may receive permissives, interlocks, or operating setpoints from other control systems. Packaged systems usually have some sort of functionality for providing alarms and status information up to the BPCS, but not always. Lastly, packaged systems are typically supplied by a specialized vendor that is different than the supplier of other control systems used by the facility.

5.2 Terminology

This section provides an explanation of several key terms that are used in this technical report with respect to discussing packaged systems and how alarm management can be applied to them.

All uses of the term “alarm” in both ISA-18.2 and this technical report refer to notifications that meet the definition of an alarm - an audible and/or visible means of indicating to the operator an equipment malfunction, process deviation, or abnormal condition requiring a timely response. It is a fundamental principle of alarm management that the alarm system is reserved for items meeting this definition, and excludes items that do not. However, it is common, particularly with packaged systems, that vendors will implement what they may refer to as “alarms” that do not meet the ISA-18.2 definition of an alarm, e.g. status or mode signaling of normal conditions. The appropriate determination and routing of alarms is a subject of this report; non-alarm notifications are outside the scope of this report.

Typically, a Packaged System (PS) is supplied with a Packaged System Control Panel (PSCP). The PSCP has functionality (in varying degrees) to control, monitor, and alarm conditions on the PS. In most cases, a PSCP will contain some sort of operator interface, e.g., pushbuttons, switches, or screen-based indicators and controls. Alarms related to conditions on the PS are usually annunciated in some fashion on the PSCP, as initially supplied by the vendor.

A PSCP is often located on or immediately adjacent to its PS. In this document, such a case is referred to as a Local Panel (LP). PSCPs can also be relocated to other, more remote, locations, often by simply extending wiring with or without signal amplification. Some facilities may also locate a PSCP in a central control room, which may be the packaged system’s main control panel or be a secondary remote panel for the PSCP.

A PS is often part of a larger process, controlled by a Basic Process Control System (BPCS), such as a DCS or SCADA system. For purposes of this document, a PSCP is not considered to be part of the BPCS even though it may interact with the BPCS.

When a process has both a BPCS and a PS, it is a common practice to integrate the two together in varying degrees. Issues with PS integration and with both alarm functionality and operator response related to such integration are discussed in this document. This includes discussion of PSCP vs. BPCS alarm annunciation practices, methods, and concerns.

One component of the BPCS is its Human-Machine Interface (HMI). This is the collection of screens, keyboards, and other input/output devices through which the operator monitors and interacts with the process controlled by the BPCS. It is sometimes referred to as an operator console. BPCS alarms are indicated through the BPCS’s HMI. A BPCS may have multiple consoles and multiple operators operating different parts of the overall process. These consoles may be located in a centralized location (such as a control room or control center), located some distance from the process itself, or spread across a facility or factory floor.

In the same way, the PS’s control system could have its own HMI. The location of the PS’s HMI can vary.

The integration of the PS could be done by integrating the PS’s controller to the BPCS’s controller, to the BPCS’s HMI, or to both. In some special cases the integration could be done by integrating the PS’s HMI into the BPCS’s HMI. In this report, Clause 7 on packaged system control panels and Clause 8 on packaged system interfacing contain various integration examples.

There are many permutations regarding the capabilities of specific PSs, PSCPs, BPCSs, HMIs, and the various ways in which they are partially or fully integrated. This technical report cannot discuss them all, but provides principles and insight as to some of the most common issues and their solutions.

5.3 Supplier and commercial considerations

A packaged system is typically a complete system designed to work as a unit. It is commonly designed as a turn-key package by a single vendor. The vendor also typically carries the responsibility of providing the warranty and support for the packaged system. For this reason, it is often difficult for end users and/or system integrators to modify packaged systems without impacting, or even invalidating, the equipment's warranty. During the process of applying alarm management work processes to packaged systems, careful involvement of the vendor should be considered at each life cycle stage.

Packaged systems designs are typically focused on the process-related role that they perform. From the vendor's perspective, ease of interfacing the packaged system into a facility-wide control system is often a secondary consideration. For this reason, if PS interfacing is required, (e.g., status information and/or alarms needs to be communicated to the BPCS), coordination with the vendor should take place early in the design process. To be most effective, the alarm management work processes should commence during development of the PS specification and continue through the life of the project. Incorporating alarm management concepts into package system specifications is discussed in more detail in Clauses 6 and 10.

5.4 Legacy PSs

Some facilities may contain existing PSs that were developed and are supported in-house. Some of these may be legacy systems that have operated for a long time, but lack up-to-date operating systems, complete documentation, or support personnel familiar in detail with the software code. The objectives of alarm management, and the challenges to achieving them, are similar for in-house developed systems versus systems obtained from commercial vendors. However, there are a few differences. For example, warranty issues and a vendor's intellectual property rights are typically not barriers to making changes to in-house developed PSs. Changes may still be challenging to pursue due to any number of reasons, e.g., unavailability of the personnel who originally developed the system, use of hardware components for which replacements are no longer available, or use of hard coded functionality vs. configurable changeable software. Owners of legacy PSs may also need to be mindful if a system is being supported via service contracts with an outside vendor; if this is the case, proposed changes to a PS and its alarms may need to be discussed with the vendor to ensure that they are still able to support it in the manner desired by the end-user.

5.5 System architectures

In general, packaged systems tend to be configured in one of three ways, related to their degree of integration with a BPCS. An overview of these three ways is given below. Detailed discussion of these situations, and their ramifications for alarm annunciation and response, are contained in Clause 7.

5.5.1 Stand-alone independent operation

When used in stand-alone configuration, the PS is not connected to any BPCS, or the facility does not have a BPCS. PS control and alarm functionality is handled via the Packaged System Control Panel (PSCP), typically by a roaming operator. There will likely be significant inconsistencies with alarm functionality on PSs from different vendors.

In this approach, individual packaged systems may communicate with each other (e.g., interlocks or permissives), but there is no centralized supervisory control or HMI. In this type of architecture, the primary way an operator receives alarms is by walking around on the process floor and noticing visual or audible alarms on individual pieces of equipment. For this type of system, implementing alarm management is more difficult, but there are still benefits to the operator and best practices that can be implemented.