

TECHNICAL REPORT
ISA-TR18.2.6-2012
Alarm Systems for Batch
and Discrete Processes
Approved 31 May 2012

ISA-TR18.2.6-2012, Alarm Systems for Batch and Discrete Processes

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

E-mail: standards@isa.org

Preface

This preface is included for information purposes only and is not part of ISA-TR18.2.6-2012.

This technical report has been prepared as part of the service of ISA, the International Society of Automation, toward a goal of helping in the understanding and use of ANSI/ISA-18.2-2009 as applied to batch and discrete processes. To be of real value, this document should not be static but should be subject to periodic review. Toward this end, the Society welcomes all comments and criticisms and asks that they be addressed to the Secretary, Standards and Practices Board; ISA, 67 Alexander Drive; P.O. Box 12277; Research Triangle Park, NC 27709, USA; Telephone (919) 549-8411; Fax (919) 549-8288; E-mail: standards@isa.org.

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The following served as members of ISA18 Work Group 6 (WG6) to develop this technical report:

NAME	COMPANY
Joseph Alford	Consultant
John Bogdan	J. Bogdan Consulting LLC
Bridget Fitzpatrick	Mustang Engineering
Tejas Ghiya	Genentech
Bill Hollifield	PAS
Douglas Metzger	DPM Consulting
Graham Nasby	Eramosa Engineering Inc.
Alan Phipps	Eli Lilly
Gregory Ruklic	Consultant
Henry Salomons	Dow Chemical
Nicholas Sands	DuPont
Ruth Schiedermayer	Object Technologies CEM, Inc.
Marcus Tennant	Yokogawa
Bob Weibel	TiPS, Inc.

The following people acted as voting members of ISA18 in approving publication of this technical report:

NAME	COMPANY
Donald Dunn, Co-Chair	Aramco Services Co.
Nicholas Sands, Co-Chair	DuPont
Erwin Icayan	ACES Inc.
Joseph Alford	Joseph S. Alford LLC
Stephen Apple	IntelaTrac-Wonderware Mobile Solutions
Joe Bingham	AES Global Inc.
Alex Boquiren	Bechtel Corp.
Alan Bryant	Oxy Inc.
John Campbell	Consultant
Bridget Fitzpatrick	Mustang Engineering
Max Hanson	MCC Control Systems
Bill Hollifield	PAS
Alan Hugo	Capstone Technology
Lokesh Kalra	Chevron
Edward Marszal	Kenexis
Michael Marvan	Shell Canada
Douglas Metzger	DPM Consulting
Ian Nimmo	User Centered Design Services LLC
Patrick O'Donnell	BP
Douglas Rothenberg	D. Roth Inc.
Todd Stauffer	Exida Co.
David Strobhar	Beville Engineering Inc.
Angela Summers	SIS-TECH Solutions LP
Beth Vail	URS SMS
Bob Weibel	TiPs Inc.

This technical report was approved for publication by the ISA Standards and Practices Board on 31 May 2012.

NAME	COMPANY
D. Dunn, Vice President	Aramco Services Co.
E. Cosman, Vice President-Elect	The Dow Chemical Co.
D. Bartusiak	ExxonMobil Chemical Company
P. Brett	Honeywell Inc.
J. Campbell	Consultant
M. Coppler	Det Norske Veritas Certification Inc..
B. Dumortier	Schneider Electric
J. Federlein	Federlein & Assoc. Inc.
J. Gilsinn	U.S. NIST
E. Icayan	ACES Inc.
J. Jamison	EnCana Corporation Ltd.
K. Lindner	Endress+Hauser Process Solutions AG
V. Maggioli	Feltronics Corp.
T. McAviney	Instrumentation & Control Engineering LLC
R. Reimer	Rockwell Automation
S. Russell	Valero Energy Corp.
N. Sands	DuPont
H. Sasajima	Azbil Corp.
T. Schnaare	Rosemount Inc.
J. Tatera	Tatera & Associates Inc.

I. Verhappen
W. Weidman
J. Weiss
M. Wilkins
D. Zetterberg

Yokogawa Canada Inc.
WCW Consulting
Applied Control Solutions LLC
Yokogawa IA Global Marketing USMK
Chevron Energy Technology Company

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Foreword

In 2003, the ISA Standards and Practices Board reactivated its ISA18 Committee (which had produced a standard in 1979 on Annunciator Sequences and Specifications – ISA-18.1-1979) to create standards for computer-based alarm systems for the process industries. In June of 2009, the ANSI/ISA approval process was completed for the standard, the result being ANSI/ISA-18.2-2009, *Management of Alarm Systems for the Process Industries*, commonly referred to as ISA-18.2. Starting in mid-2009, the ISA18 committee established working groups to produce technical reports, designed to augment the standard with additional rationale, usage guidelines, and examples in different areas of alarm management. Six technical reports are being created by these working groups:

- a) WG1 – Alarm Philosophy
- b) WG2 – Alarm Identification and Rationalization
- c) WG3 – Basic Alarm Design
- d) WG4 – Enhanced and Advanced Alarm Methods
- e) WG5 – Alarm System Monitoring, Assessment, and Auditing
- f) WG6 – Alarm Systems for Batch and Discrete Processes

This technical report, produced by Working Group 6, is designed to provide guidance, rationale, and examples for those with a need for understanding and application of ISA-18.2 to batch and discrete processes.

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. The guidance includes suggestions on appropriate techniques that are generally applicable; however, selection of activities and practices for a given system is the responsibility of the system's designers, users, and/or support staff.

It is intended that this guidance will be updated over time as experience is gained. As such, while the general format of this guidance is expected to remain relatively stable, the specifics of its application and specific solutions are expected to evolve.

Introduction

This technical report (TR) is one of several TRs developed to provide examples and discuss how to implement the requirements and best practices contained in ISA-18.2, *Management of Alarm Systems for the Process Industries*. This TR provides guidance to manufacturers, vendors, consultants, and practitioners at end-user companies in describing how the standard applies to batch and discrete processes. Relevant techniques and examples are included.

The technical report is organized into two parts. The first part is introductory in nature (Clauses 1-5). The second part, which is the main body of the technical report (Clauses 6-18), presents information and examples on how each of the alarm management lifecycle activities described in the standard, ISA-18.2, applies to batch and discrete processes. In order to facilitate use of this technical report as an extension of the standard, Clauses 6-18 refer to the same lifecycle activities in both documents. Clause 6 in the TR, for example, corresponds to Clause 6 in ISA-18.2.

Following the recommended guidance in this technical report will not necessarily ensure that alarm management problems will be avoided. It will, however, help to identify and address alarm specification, design, implementation, and management opportunities that are important to batch and discrete processes. It can also help minimize the generation of nuisance alarms that could complicate and frustrate operators' awareness, understanding, and response to abnormal situations.

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. The guidance includes suggestions on appropriate applications that are generally applicable; however, selection of activities and practices for a given system is the responsibility of the system's designers, users, and/or support staff.

It is intended that this guidance will be updated over time with future revisions to this TR as experience is gained in dealing with the nuances of batch and discrete process alarms. As such, while the general format of this guidance is expected to remain relatively stable, the specifics of its application and specific solutions are expected to evolve.

Purpose

This technical report addresses the specification, design, implementation, and management of alarms and alarm systems for batch and discrete processes. It explains how ISA-18.2 applies to batch and discrete processes and contains several examples.

This technical report was written to provide guidance for the use of ISA-18.2 for batch and discrete processes with due consideration of other guidance documents that have been developed throughout industry.

Alarms for batch and discrete processes are often associated with additional design, implementation, and management considerations compared to those for continuous processes. This technical report is intended to include these additional considerations.

1 Scope

1.1 General applicability

This technical report covers the application of alarm management principles in ISA-18.2 to batch and discrete processes. The general principles and techniques described in this technical report 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. Use of this technical report should consider batch and discrete process alarms from all systems presented to the operator, which may include basic process control systems, annunciator panels, safety instrumented systems, fire and gas systems, and emergency response systems.

1.2 The alarm system

A diagram of the scope of an alarm system, reproduced from Figure 1 of ISA-18.2, is shown here as Figure 1.

The alarm system serves to alert, inform, and guide operators regarding abnormal process conditions or equipment malfunctions. The alarm system may include both the basic process control system (BPCS) and the safety instrumented system (SIS), each of which uses measurements of process conditions and logic to generate alarms (see Figure 1). Abnormal situation information and response guidance for operators may be provided within the BPCS or SIS or by linkages to software outside the BPCS or SIS. The alarm system also includes an alarm log and a mechanism for communicating the alarm information to the operator via an HMI, usually a computer screen or an annunciator panel. There are other functions outside the alarm system that may be important to the effectiveness of the alarm system, such as an alarm historian.

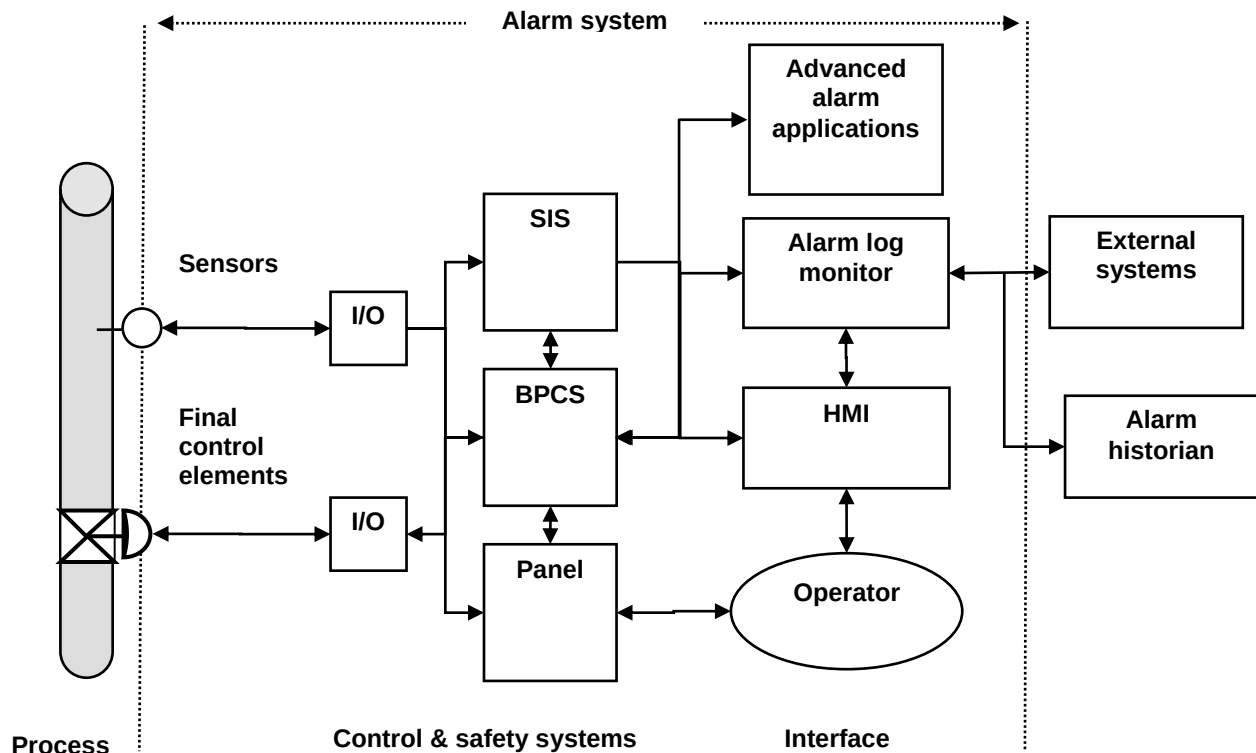


Figure 1 – Alarm system dataflow (from ISA-18.2)

Components and work processes associated with control systems that are considered exclusions to the alarm system as shown in Figure 1 (e.g., sensors and final control elements, annunciator panels, fire detection and suppression systems, security systems, etc.) are described in ISA-18.2.

2 Normative references

ANSI/ISA-18.2-2009, *Management of Alarm Systems for the Process Industries* (referred to in this document as ISA-18.2).

ANSI/ISA-84.00.01-2004 Parts 1-3 (IEC 61511-1, -2, and -3 Mod) *Functional Safety: Safety Instrumented Systems for the Process Industry Sector* (referred to in this document as ISA-84)

ANSI/ISA-88.00.01-2010 *Batch Control Part 1: Models and Terminology* (referred to in this document as ISA-88)

ANSI/ISA-95.00.01-2010 (IEC 62264-1 Mod) *Enterprise-Control System Integration - Part 1: Models and Terminology* (referred to in this document as ISA-95)

3 Definitions of terms and acronyms

3.1 Definitions

Defined terms used in this technical report are listed below. Synonymous terms, which are not used in this technical report, are listed in parentheses.

Note 1 Most definitions listed here are copied from ISA-18.2. Those that are not from ISA-18.2 are shown in italics.

Note 2 Some alarm terms that are frequently used in industry are not defined or used in ISA-18.2 or this technical report because they have multiple meanings and interpretations by different BPCS vendors. Examples include alarm enable, alarm disable, and alarm inhibit.

3.1.1 activate

the process of enabling an alarm function within the alarm system

3.1.2 advanced alarming

a collection of techniques (e.g., state-based alarming and dynamic prioritization) that can help manage alarm rates in specific situations

3.1.3 alarm

an 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 attributes (alarm parameters)

the settings for an alarm within the process control system (e.g., alarm setpoint, alarm priority)

3.1.5 alarm class

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

3.1.6 alarm deadband

the range through which an input is varied from the alarm setpoint necessary to clear the alarm

3.1.7 alarm flood (alarm shower)

a condition during which the alarm rate is greater than the operator can effectively manage (e.g., more than 1 alarm per minute)

3.1.8 alarm historian

the long-term repository for alarm records

3.1.9 alarm log

the short-term repository for alarm records

3.1.10 alarm management (alarm system management)

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

3.1.11 alarm message

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

3.1.12 alarm philosophy

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

3.1.13 alarm priority

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

3.1.14 alarm setpoint (alarm limit, alarm trip point)

the threshold value of a process variable or discrete state that triggers the alarm indication

3.1.15 alarm system requirements specification

the document that specifies the details of the alarm system design that are used in selecting components of an alarm system

3.1.16 alarm type (alarm condition)

the alarm on a process measurement (e.g., low process variable alarm, high process variable alarm, or discrepancy alarm)

3.1.17 alert

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

3.1.18 batch process (from ISA-88)

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

3.1.19 chattering alarm

an alarm that repeatedly transitions between the alarm state and the normal state in a short period of time

3.1.20 classification

the process of separating alarms into classes based on common requirements (e.g., testing, training, monitoring, and auditing requirements). See also *alarm class*.

3.1.21 continuous process

a method used to manufacture a weight or volume of product without interruption

3.1.22 critical process parameter

an operational variable that must be controlled within predetermined criteria to ensure that the product meets its specification

3.1.23 discrete process

the assembly and/or packaging of individual product units, each of which is identifiable

3.1.24 dynamic alarming

The automatic modification of alarms based on process state or conditions

3.1.25 highly managed alarm

an alarm belonging to a class with more requirements than general alarms (e.g., a safety alarm)

3.1.26 implementation

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

3.1.27 lean methodology

a production practice that strives to prevent waste by eliminating any activities or materials that do not provide value

3.1.28 master alarm database

the authorized list of rationalized alarms and associated attributes

3.1.29 measurement uncertainty

the possible difference between the actual value of a process parameter and the displayed/recorded value due to the cumulative tolerances of all components involved in generating the displayed/recorded value

3.1.30 nuisance alarm

an alarm that annunciates excessively, unnecessarily, or does not return to normal after the correct response is taken (e.g., chattering, fleeting, or stale alarms)

3.1.31 OPC

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

3.1.32 operator

the person who initiates and monitors the operation of a process

3.1.33 out-of-service

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

3.1.34 plant state (plant mode)

a defined state of operation of a process plant (e.g., shutdown, startup, operating)

3.1.35 prioritization

the process of assigning to an alarm a level of importance that can be implemented within the alarm system

3.1.36 process manufacturing

the combination of continuous, batch, and/or discrete operations utilized in order to manufacture and package a product

3.1.37 process type

the characterization of a process as predominately continuous, batch, or discrete

3.1.38 proven acceptable range

the boundaries of process parameters within which the manufacture of product of acceptable quality has been demonstrated

3.1.39 rationalization

the process to review a potential alarm against the principles of the alarm philosophy to establish and document the rationale and design requirements for the alarm

3.1.40 remote alarm

an alarm from a remotely operated facility or a remote interface

3.1.41 re-alarmed alarm (re-triggering alarm)

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

3.1.42 shelve

a mechanism, typically initiated by the operator, to temporarily suppress an alarm

3.1.43 state-based alarm (mode-based alarm)

an alarm that is automatically modified or suppressed based on process state or conditions

3.1.44 statistical alarm

an alarm generated based on statistical processing of a process variable or variables

3.1.45 suppress

any mechanism to prevent the indication of the alarm to the operator when the base alarm condition is present (i.e., shelving, designed suppression, out-of-service)

3.1.46 tag (point)

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

3.2 Acronyms

Note Most acronyms listed here are copied from ISA-18.2. Those that are not from ISA-18.2 are shown in italics.

3.2.1 Ack: Acknowledge or Acknowledged

3.2.2 ASRS: Alarm System Requirements Specification

3.2.3 BPCS: Basic Process Control System

3.2.4 CPP: *Critical Process Parameter*

3.2.5 cGMP: current Good Manufacturing Practice (e.g., from US Government FDA)

3.2.6 CM: *Control Module*

3.2.7 EEMUA: Engineering Equipment and Materials Users' Association

3.2.8 EM: *Equipment Module*

3.2.9 EMI: *Electromagnetic Interference*

3.2.10 EPA: Environmental Protection Agency (US Government)

3.2.11 ERP: Enterprise Resource Planning

3.2.12 ESD: Emergency Shutdown System

3.2.13 FDA: Food and Drug Administration (US government)

3.2.14 FMEA: Failure Modes and Effects Analysis

3.2.15 HMA: Highly Managed Alarm

3.2.16 HMI: Human Machine Interface

3.2.17 HAZOP: Hazard and Operability Study

3.2.18 KPI: *Key Performance Indicator*

3.2.19 MES: Manufacturing Execution System (see ISA-95)

3.2.20 MOC: Management of Change

3.2.21 MTBF: *Mean Time Between Failures*

3.2.22 OEE: *Operational Equipment Effectiveness*

3.2.23 OPC: *OLE for Process Control Systems, where OLE is Object Linking and Embedding (see OPC Overview in Bibliography)*

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

3.2.25 P&ID: Piping (or Process) and Instrumentation Diagram

3.2.26 PAR: *Proven Acceptable Range*

3.2.27 PHA: Process Hazards Analysis

3.2.28 RFI: *Radio Frequency Interference*

3.2.29 RFID: *Radio Frequency Identification*

3.2.30 RPN: *Risk Priority Number*

3.2.31 RTN: Return to Normal

3.2.32 SIF: Safety Instrumented Function

3.2.33 SIL: Safety Integrity Level

3.2.34 SIS: Safety Instrumented System

3.2.35 SRS: Safety Requirements Specification

3.2.36 SOP: Standard Operating Procedure

3.2.37 Unack: Unacknowledged

4 Continuous, batch, and discrete processes

4.1 General discussion

Production manufacturing is generally comprised of processes that create output either by transforming raw materials into a new material or by generating discrete physical items. Chemical, biological, physical, or other methods can be used to convert, separate, or blend materials to produce an intermediate or final product, typically measured by weight or volume. Discrete manufacturing creates components, subassemblies, or final product measured by part count.

Manufacturing processes can utilize batch or continuous methodology to achieve results. Batch signifies that materials or subassemblies are held or batched at one or more stages during manufacturing for hold or transfer, while continuous signifies that there are no interruptions until the final product is output.

The impact of applying analysis-based process improvement may result in a reduction in batching and an increase in application of continuous methods to reduce or remove non-value-added production time. However, specific product requirements, including use of high-value, unstable, or other sensitive materials and process steps, may dictate the use of batch methodologies to achieve consistent control and desired product quality. Batching commonly creates intermediate inventory, which can require more complex inventory tracking systems. It is important to note that batch processes can have parts (sub-processes) that are continuous in nature, and continuous processes can have sub-processes that are batch in nature. These are often referred to as semi-continuous or semi-batch, depending on the dominant method of operations. The material flow path may be fixed, or in continuous process cases, such as petroleum or chemical separation, it may provide separate pathways for each grade or composition output by the process.

This clause introduces some of the differences and commonalities of the different manufacturing methodologies affecting alarm systems. While the scope of ISA-18.2 covers all process types, this technical report provides specific guidance for batch and discrete processes. However, since continuous production is a common manufacturing paradigm, and portions of some batch and discrete processes operate in a continuous fashion, some aspects of continuous processes are included in this report to provide appropriate context.

4.1.1 Production tracking identifiers

Identifiers, such as batch number or lot number, are typically defined in requirements for processes to provide tracking of raw materials, intermediate, and final products. Each of the production methodologies described in this report has varying requirements for managing alarms and the respective impact on products. For instance, the output of continuous processes may be divided into batches based on time, and alarms typically will be traced to records for specific batches.

While most final products routinely have batch identification assigned for customer tracking, justification for use of batch identifiers for materials and intermediate products within a process is dependent on the need to track, report, and analyze process data and abnormal event records. Either batch or continuous methods may track individual material containers, lots, or units when more oversight is required, such as in the production or use of controlled substances.

4.1.2 Production state and step transitions

In addition to production activities, batch and continuous methods typically employ various setup or preparatory operations, as well as process-end or shutdown activities, in addition to production activities. It is more common that discrete production operations may be stopped for planned or unplanned intervals, leaving product or components in the system or production line without adverse effect. This may not be the case for many continuous manufacturing operations. However, for continuous operations designed to accommodate planned interruptions or shutdowns, alarms and instruments should be designed to function without nuisances during these events.

In some batch operations, a steady-state production phase similar to continuous processes may exist for a period of time. However, batch operations typically have many more steps, as well as state or control-point transitions, and the preparatory and shutdown operations are a higher percentage of total process activities. Batch steady-state operations, if any, typically operate for a shorter time than is common in continuous processes. Where processes contain non-automated operations or steps, the HMI or other control interfaces physically closer to the process systems and equipment are utilized to facilitate efficient workflow responses to alarms and notifications.

The examination of a target process is recommended to determine where steady-state operations exist, if any, within phases and operations. Alarm management within the steady-state region for either continuous or batch processes may be handled in a similar fashion as described in this report. Non-steady-state operations, such as preparatory or shutdown activities, or transitions between steady-state operations, typically have conditions requiring activation, suppression, alarm setpoint setting/changing, timing, and other attributes of specific alerts and alarms within each operation or step. These attributes are defined to meet manufacturing requirements while eliminating nuisance alarms or otherwise unnecessary notifications. Advanced alarming techniques, though not significantly different from those used in continuous processes, generally have a higher frequency of use in batch processes.

Alarm suppression in configurable systems may include methods to temporarily prevent or limit alarms by time or number of occurrences or may allow other special controls or logic to inactivate one or more alarms for all or part of a production run.

4.1.3 Time calculation and recording

Recording of time and date/time stamps for data and event records in computer systems are ideally based on two paradigms: calendar time/date and relative time. Relative time is typically the elapsed time for a given batch or for a given unit of product. Many systems employ a hybrid approach, with parallel functions or systems, using relative time for data and calendar time for events. Some standard, vendor-supplied control systems may not provide relative time functionality, possibly necessitating the need for additional software development. The alarm management program should employ a simple and reliable methodology of ensuring that the recording of time in manufacturing records is accurate and supportive of integrated systems reporting functionality.

4.1.4 Alarm management

One principle is that an alarm is sent directly to the individual or group responsible for responding to it. Continuous operations are more likely to utilize centralized control-room-based oversight and fewer personnel in the immediate areas of manufacturing. If the targeted recipient of an alarm is not the control-room operator, it may still be appropriate to send information to the control room, depending on the situation.

Good alarm design for systems takes into account the role of alerts, process pauses, and human-machine interactive alarm responses, impacting product quality, yield, or throughput. A common paradigm in batch processes is that recipients of alarms include groups or individuals, in addition to control-room operators, designated to respond directly to alarms as experts ready to correct problems. Also, the nature of some processes, especially batch, can place highly variable loadings on plant utilities, so it is not unusual for utilities to be the root cause of an abnormal situation. Therefore, especially for continuous operations, it is possible that alarms may need to be directly sent to groups managing plant steam, compressed air, nitrogen, sterile water, cooling water, or other utilities.

4.2 The forms of production

The practice of how alarm generation, response, and resolution are configured and executed for the continuous, batch, and discrete types of production is affected by many variables.

The effects of each process type and alarm-handling methodology need to be evaluated for each scenario. Decisions must be made at the local level to determine how various circumstances should be factored into the overall approach when configuring alarms.

Alarm management design and implementation must address any regulatory requirements, such as in pharmaceutical or medical-device production. Examples of these requirements include operator identification and audit trail, and creation/management of official production records.

4.2.1 Continuous production

Continuous production is characterized by a steady outflow of final product. Raw materials may be fed to the process in steady stream(s), or, alternatively, added from batches that are supplied as needed to support operations. The materials flow path typically remains unchanged during production operations. Control and oversight of operations are often managed from a centralized control location with dedicated inside and outside operators. Manufacturing typically takes place 24 hours a day until production targets are met.

Production interruptions vary from slight reduction in processing throughout to an extended shutdown. Interruptions tend to be more disruptive to downstream process steps and may require line clearing/cleaning and/or restart operations. Both the activities of shutting down and restarting continuous production are typically major operational activities and may take many hours or even days to execute.

4.2.1.1 Continuous process product identification

While not a necessity, an identifier, such as batch number, may be given to a complete production run from start-up to shutdown. There are cases in which it is necessary to capture continuous process output into pre-determined volumes or weights, each given a batch ID to facilitate practical tracking, shipping, and consumption of products. It may be necessary to track raw materials through production to final product shipments.

4.2.1.2 Continuous process time calculation and recording

For continuous processes, calendar time may be more useful than relative time, as any batch identification assigned to portions of production for tracking can be based on time and date to provide the context of production. However, there may be time-based control progression that is more appropriately based on relative time, such as when control algorithms increase or decrease process step time based on actual conditions.

Alarm configuration for continuous processes in some cases may be a function of time or process step sequence. Alarm attributes, such as alarm setpoints, alarm suppressed-by-design periods, or allowable operator shelving time may need to change during process execution as per the process design. It is more common that a lengthy continuous processing steady-state period exists that utilizes a fixed set of alarm attributes. Preparatory and shutdown-state transitions may be utilized as in batch processes, and the

function transition between steps can be modeled, as in the ISA-88 batch standard. Alarm attributes are typically automatically changed when a process transitions to another state or is paused/aborted if that is an option for the process. States may be manually initiated and thus may be less automated or optimized.

4.2.1.3 Continuous process alarm management

In continuous operations, alarms are designed to be as predictive as possible, providing timely notification to operators before conditions degrade to where manufacturing upsets occur, safety is compromised, product is affected, or the process must be shut down. Continuous manufacturing, especially for transformative processes, can require a lengthy cleaning/preparation and restart process. There may be fewer changes to alarm setpoints or other parameters during a continuous production phase of operations than in batch or discrete processes. Model-based alarming can be used to provide modification of acceptable process or control ranges by time or other dynamic parameters to more closely monitor critical process parameters.

4.2.2 Batch production

Batch production is characterized by utilization of planned quantities of raw materials and intermediates to create a pre-determined quantity of final product. The flow path can vary, depending upon product, and systems can be designed to be rapidly reconfigurable to desired specifications of product families without major software/hardware changes.

Controlling operations may be managed from one or more control centers, which may be decentralized to support startup, shutdown, and restart activities occurring more frequently than in continuous processes.

Batch production can be more agile than continuous production in the ability to go to a safe state or hold, and therefore, an alarm may have a corresponding action that puts the process into a hold state while the alarm condition is being attended. Any interruptions usually only affect the current batch and may be more isolated to specific process steps than in continuous manufacturing, although processes creating intermediates or sub-assemblies can be time-dependent and interlocked to subsequent process steps.

4.2.2.1 Batch process product identification

Batch identifiers are used to plan and track predetermined weights or volumes of production. Batch identifiers are often reference codes but may be a date or date code of manufacture. In some identification practices, lots comprise multiple batches.

4.2.2.2 Batch process time recording

For batch processes, relative time (i.e., the time since the beginning of the batch or process step) can be more relevant than calendar time in helping provide the context and importance of process information.

4.2.2.3 Batch process alarm management

Since batch processes typically are characterized by a larger number of states in which alarms play a role, the capability to programmatically change the configuration of an alarm so that it is active for certain batch steps but not others is important. Additionally, it can be important to programmatically change the priority of alarms as a function of process step/phase. For example, the pH of the contents in a chemical reactor might be low priority during media make-up yet high priority once the reactor has heated up, and the chemical reaction is occurring.

Configuration as a function of batch state selection, including the transition between states, is defined by the ISA-88 batch standard. For example, alarm attributes, such as alarm setpoints, alarm suppressed-by-design period, or allowable operator shelving time, may need to be automatically changed when a process state transitions to another state or is paused or aborted.

Various process parameters may be time-varying for a batch process, i.e., not only from state to state (step to step), but within a state (step). For example, fed-batch reactors are often characterized by an

incoming material for which the feed rate (and, therefore, alarm setpoints) may change frequently during the batch step in which a chemical reaction is taking place. Therefore, numerous automated and/or manual alarm setpoint adjustments may be needed as a batch progresses. Additionally, automated changes could be based on process-relative time, or other state or conditional logic necessary to execute the process.

Batch plant processes are often associated with many manual operations in preparing equipment needed for upcoming process steps and in transferring process material. There may also be manual operations performed in association with a production phase. Therefore, significant operator time may be spent away from the control room.

Facility departments responsible for maintaining utilities directly supporting production are essential to the management of the often changing conditions of batch processes. Such groups are not normally located in a plant's central control room or on the plant floor but are located remotely. Therefore, batch processes especially tend to require automation systems to have the capability to send alarms, pages, emails, text messages, and/or other information to remote areas and to accommodate alarm acknowledgements from remote areas.

As in continuous production, alarm management methods within systems are typically designed to notify operators of conditions prior to the onset of consequences for conditions, such as those that may affect product quality, personnel safety, the environment within or outside of facilities, or business-critical operations.

4.2.3 Discrete production

Discrete production is characterized by utilization of individual parts, components, or assemblies to create individual or unit products. The flow path is generally fixed, however, some pre-defined steps in fixed equipment and systems may be skipped or activated as necessary for a current production configuration. Discrete packaging operations may be part of the overall manufacturing paradigm for continuous production processes as well. Discrete processes typically may be stopped for periods of time to address problems or facilitate packaging or other configuration changes, except in cases where a product may be sensitive to conditions, such as temperature or moisture. These short stoppages generally have little or no impact on subsequent process steps, other than a delay in production.

Controlling operations are often managed from one or more decentralized control centers, small consoles, custom controls, or portable/handheld devices.

Operations can typically be readily started and stopped. Manufacturing operations are typically specialized in nature and, therefore, unique, except within product families.

4.2.3.1 Discrete process product identification

Discrete manufacturing may utilize serial numbers or other assigned identifiers to track or trace individual units.

Optionally, numbers or identifiers may be assigned and used to track a group of output units from discrete processes into batches or lots. Identification of products is typically by serial number, although low-cost items may only be traceable via production-run number/ID, date/time, or date code. It may be necessary to track production-run numbers associated with certain builds of components that make up a larger item. The production-run numbers or codes should be associated with the various alarms experienced during the stage of manufacturing where the alarm occurred.

4.2.3.2 Discrete process time calculation and recording:

For discrete processes, calendar time can be more useful than relative time, as any batch or lot identification assigned to portions of production are often based on time and date to provide the context and importance of process information.