



IEC 62682

Edition 2.0 2022-12
COMMENTED VERSION

INTERNATIONAL STANDARD



Management of alarm systems for the process industries





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FOR THE PROCESS INDUSTRIES****FOREWORD**

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This commented version (CMV) of the official standard IEC 62682:2022 edition 2.0 allows the user to identify the changes made to the previous IEC 62682:2014 edition 1.0. Furthermore, comments from IEC SC 65A experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

IEC 62682 has been prepared by subcommittee 65A: System aspects, of IEC technical committee 65: Industrial-process measurement, control and automation. It is an International Standard.

This second edition cancels and replaces the first edition published in 2014. This edition constitutes a technical revision.

This edition includes minor technical changes with respect to the previous edition, based on changes to ANSI/ISA-18.2:2016. These include the inclusion of packaged systems in the scope (Clause 1), definitions (Clause 3) and alarm system requirements specification (Clause 7). There are changes to improve clarity in wording throughout the document.

The text of this International Standard is based on the following documents:

Draft	Report on voting
65A/1046/FDIS	65A/1064/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

Purpose

This International Standard addresses the development, design, installation, and management of alarm systems in the process industries. Alarm management includes multiple work processes throughout the alarm–~~system~~ management life cycle. This document defines the terminology and models to develop an alarm system, and it defines the work processes recommended to effectively maintain the alarm–~~system~~ throughout the life cycle. Ineffective alarm systems have often been cited as contributing factors in the investigation reports following major process incidents. This document is intended to provide a methodology that will result in the improved safety, quality, and operation in the process industries.

The first edition of this document was adapted from ANSI/ISA-18.2-2009, *Management of Alarm Systems for the Process Industries*, an International Society of Automation (ISA) standard, and with due consideration of other guidance documents that have been developed throughout industry. This second edition has incorporated some changes made in ANSI/ISA-18.2-2016.

This document is not the first effort to define terminology and practices for effective alarm systems. In 1999 the Engineering Equipment and Materials Users' Association (EEMUA) issued Publication 191, *Alarm Systems: A Guide to Design, Management and Procurement*, with the 2nd edition published in 2007 and the 3rd edition published in 2013. In 2003 the User Association of Process Control Technology in Chemical and Pharmaceutical Industries (NAMUR) issued worksheet NA 102, *Alarm Management*, which was updated in 2008. During the development and maintenance of this document, every effort was made to keep terminology and practices consistent with the previous work of these respected organizations and committees.

This document provides requirements for alarm management and alarm systems. It is intended for those individuals and organizations that

- a) manufacture or implement embedded alarm systems,
- b) manufacture or ~~implement~~ install third-party alarm system software,
- c) design or install alarm systems,
- d) operate and ~~for~~ maintain alarm systems, and
- e) audit or assess alarm system performance.

Organization

This document is organized in ~~two~~ parts. ~~The first part is introductory in nature, (Clauses 1 to 5). The main body of the standard follows (Clauses 6 to 18).~~

The first part (Clause 1 to Clause 3) are normative without any mandatory requirements. Clause 4 contains mandatory requirements. Clause 5 is normative without any mandatory requirements. The main body of the standard (Clause 6 to Clause 18), describes mandatory requirements and non-mandatory recommendations.

Within this document, mandatory requirements are stated with "shall", non-mandatory recommendations are stated with "should", and permissible requirements are stated with "may". The phrase "is required" indicates the requirement has been stated previously in the document.

MANAGEMENT OF ALARM SYSTEMS FOR THE PROCESS INDUSTRIES

1 Scope

1.1 General applicability

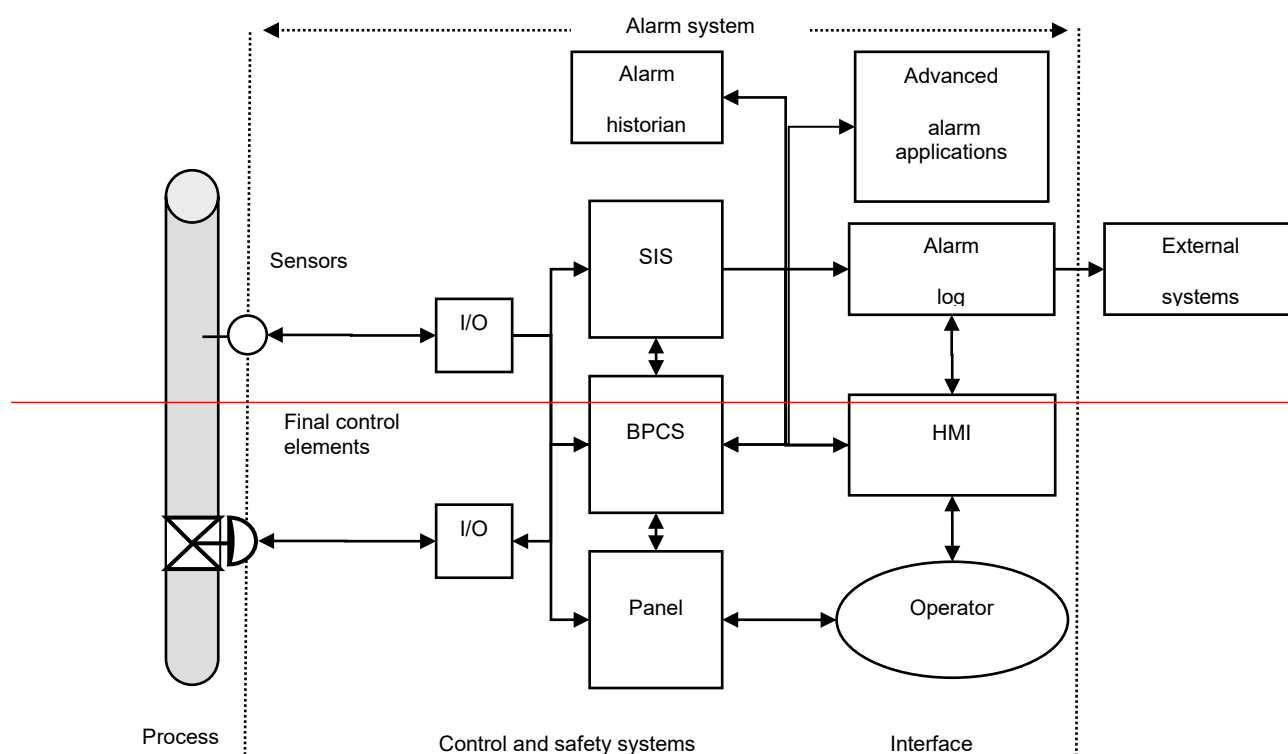
This document specifies general principles and processes for the ~~lifecycle~~ management of alarm systems based on ~~programmable electronic controller and computer-based human-machine interface (HMI) technology~~ controls system and human-machine interfaces (HMI) **1** for facilities in the process industries. It covers all alarms to be presented to the operator through the control system, which includes alarms from basic process control systems, annunciators ~~panels~~, packaged systems, and safety instrumented systems, ~~fire and gas systems, and emergency response systems~~ **2**.

The practices in this document are applicable to continuous, batch, and discrete processes. There can be differences in implementation to meet the specific needs based on process type.

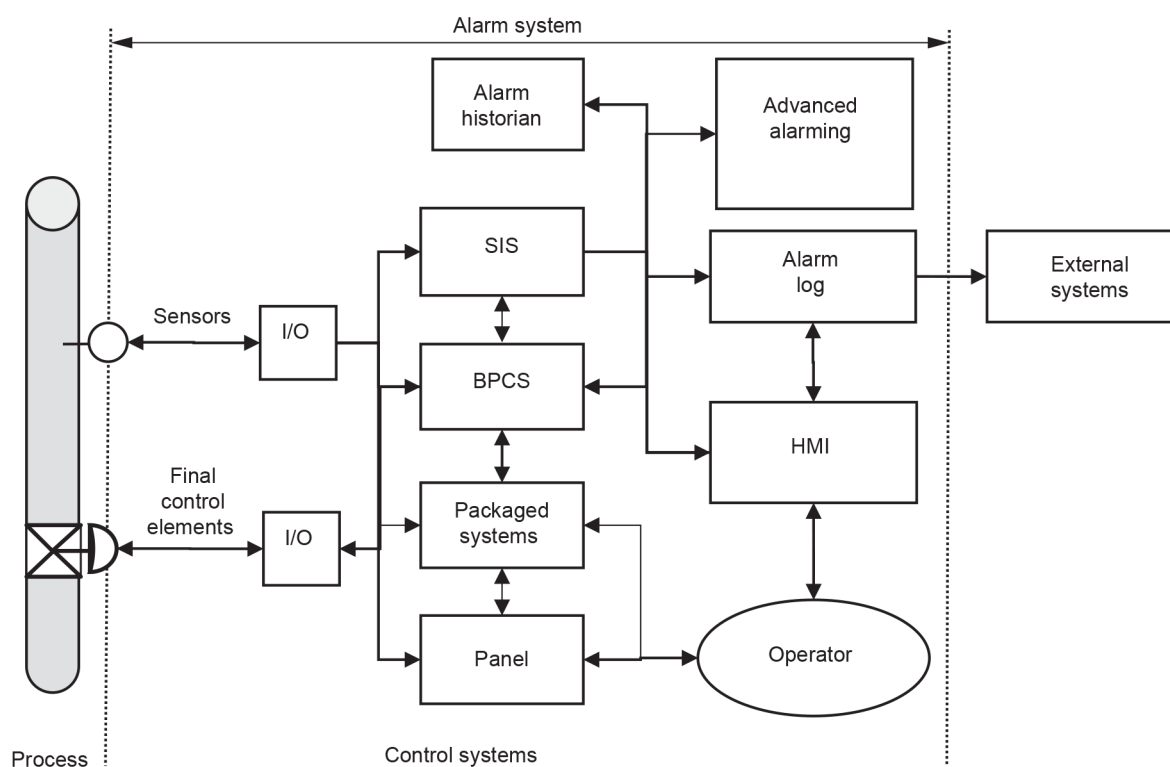
~~In jurisdictions where the governing authorities (e.g., national, federal, state, province, county, city) have established process safety design, process safety management, or other requirements, in addition to the requirements of this standard, these should be taken into consideration.~~ **3**

The primary function within the alarm system is to notify operators of abnormal process conditions or equipment malfunctions and support the response. The alarm systems can 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. Figure 1 illustrates the concepts of alarm and response dataflow through the alarm system. The alarm system also includes a mechanism for communicating the alarm information to the operator via an HMI, usually a computer screen or an annunciator ~~panel~~. Additional functions of the alarm system are an alarm and event log, an alarm historian, and the generation of performance metrics for the alarm system. There are external systems that can use the data from the alarm system.

Figure 1 is not intended to represent physical wiring. **4**



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NOTE 1 Packaged systems (e.g., refrigeration machines) can be included in the control system.

NOTE 2 Panel can refer to annunciator panel or other panel types.

NOTE 3 The lines are intended to represent data flow and not physical wiring. **5**

Figure 1 – Alarm system dataflow

1.2 Exclusions and inclusions

1.2.1 Operators

The functions of the operator receiving and responding to alarms are included in the scope of this document. Management of operators is excluded from the scope of this document.

1.2.2 Process sensors and final control elements

The alarms ~~from implemented~~ in sensors and final control elements are included in the scope of this document. ~~Process sensors and final control elements are shown in Figure 1 to indicate alarms can be implemented in these devices.~~ **6** The design and management of process sensors and final control elements are excluded from the scope of this document.

1.2.3 Annunciators

The integration of annunciators into an alarm system is included in the scope of this document. The specification and design of annunciators is excluded from the scope of this document.

1.2.4 Human machine interface

The appearance of alarms in the HMI and functions of alarm related displays are included in the scope of this document. The design and maintenance of the HMI are excluded from this document.

NOTE ANSI/ISA-101.01-2015 provides information on HMI design and maintenance.

1.2.5 Safety instrumented systems

The alarms ~~from implemented~~ in a safety instrumented system are included in the scope of this document. ~~The safety instrumented system (SIS) is shown in Figure 1 to indicate alarms can be implemented in these devices.~~ **7** The design and management of safety instrumented systems are excluded from this document.

NOTE IEC 61511-1 provides information on safety instrumented systems.

~~The alarms and diagnostics from fire detection and protective systems or security systems that are presented to the operator through the control system are included in the scope of this standard. Fire detection and protective systems and security systems are excluded from the scope of this standard.~~

1.2.6 Fire and gas detection and protective systems

The alarms from fire and gas detection and protective systems presented to the operator through the control system are included in the scope of this document. The design and management of fire and gas detection and protective systems is excluded from the scope of this document.

1.2.7 Security systems

The alarms from security systems presented to the operator through the control system are included in the scope of this document. The design and management of security systems is excluded from the scope of this document.

1.2.8 Packaged systems

The alarms from packaged systems presented to the operator through the control system are included in the scope of this document. The design and management of packaged systems is excluded from the scope of this document.

1.2.9 Event data

The indication and processing of analog, discrete, and event data other than alarm indications are excluded from the scope of this document. The analysis techniques using both alarm and event data are excluded from the scope of this document.

1.2.10 Alarm identification methods

Required methods of alarm identification are not specified in this document. Examples of alarm identification methods are listed.

1.2.11 Management of change

A specific management of change (MOC) procedure is not included in this document. Some requirements and recommendations for an MOC procedure are included.

1.2.12 Purchase specification

This document is not intended to be used as an alarm system purchase specification.

2 Normative references

~~The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.~~

~~None.~~

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms, definitions, and acronyms apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 Terms and definitions

3.1.1

absolute alarm

alarm generated when the alarm setpoint is exceeded

EXAMPLE: High-high, high, low, low-low.

3.1.2

acknowledge

operator action that confirms recognition of an alarm

3.1.3

active

alarm state in which the alarm condition is true

Note 1 to entry: 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 to not be active when the alarm condition is true.

3.1.4

adaptive alarm

alarm for which the setpoint is changed by an algorithm ~~(e.g., rate-based)~~

EXAMPLE: Setpoint calculated based on production rate.

3.1.5

adjustable alarm

operator-set alarm

alarm for which the setpoint can be changed manually by the operator

3.1.6

advanced alarming

collection of techniques that can help manage annunciations during specific situations

EXAMPLE: State-based alarming.

3.1.7

alarm

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

3.1.8

annunciation

alarm annunciation

function of the alarm system to call the attention of the operator to an alarm

3.1.9

alarm attribute

setting for an alarm within the ~~process~~ control system

EXAMPLE: Alarm ~~setpoint~~ priority.

3.1.10

alarm banner 8

graphic element that lists annunciated alarms with selected information

Note 1 to entry: Return to normal indications can also appear on the alarm summary.

Note 2 to entry: Information can include the date, time, priority, and alarm type.

3.1.11

alarm class

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

EXAMPLE: Safety related alarm class.

3.1.12

alarm deadband

change in signal from the alarm setpoint necessary for the alarm to return to normal

~~3.1.12~~

~~(alarm) filtering~~

~~function which selects alarm records to be displayed according to a given element of the alarm record~~

3.1.13**alarm flood**

condition during which the alarm rate is greater than the operator can effectively manage

EXAMPLE: More than 10 alarms per 10 minutes.

3.1.14**alarm group**

set of alarms with common association

EXAMPLE: Grouping alarms by process unit, process area, equipment set, or service.

3.1.15**alarm historian**

long term repository for alarm records

3.1.16**alarm log**

short term repository for alarm records

3.1.17**alarm management**

alarm system management

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

3.1.18**alarm message**

text string displayed with the alarm indication that provides additional information to the operator

EXAMPLE: Message with operator action or probable cause. **9**

3.1.19**alarm off-delay**

debounce

time ~~a process measurement remains in the normal state before the alarm becomes inactive~~ an alarm remains active after the process measurement has returned within the alarm setpoint

3.1.20**alarm on-delay**

time ~~a process measurement remains in the alarm state before the alarm is annunciated~~ before an alarm becomes active after the process measurement has exceeded the alarm setpoint

3.1.21**alarm philosophy**

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

3.1.22**alarm priority**

relative importance assigned to an alarm within the alarm system to indicate the urgency of response

EXAMPLE: Priority can use seriousness of consequences and allowable response time to determine urgency.

3.1.23**alarm rate**

number of annunciated alarms, per operator, in a specific time interval



3.1.24

~~(alarm)~~ record

record

set of information which documents an alarm state change

3.1.25

alarm response procedure

guidance for response to an alarm

Note 1 to entry: The guidance can be in many forms and not only in the form of a procedure document.

Note 2 to entry: The guidance can include operator action, probable cause, and other information.

3.1.26

alarm setpoint

alarm limit

alarm trip point

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

~~3.1.26~~

~~(alarm) sorting~~

~~function which orders alarm records to be displayed according to a given element of alarm record~~

3.1.27

alarm summary

alarm list

display that lists annunciated alarms with selected information ~~(e.g., date, time, priority, and alarm type)~~

Note 1 to entry: Return to normal indications can also appear on the alarm summary.

Note 2 to entry: Information can include the date, time, priority, and alarm type.

3.1.28

alarm system

~~operator support~~ system for generating and handling alarms ~~for managing~~ to help the operator manage abnormal situations **10**

Note 1 to entry: The operator is included in the alarm system. See Figure 1.

3.1.29

alarm system requirements specification

document which ~~specifies~~ describes the ~~details~~ functional requirements of the alarm system ~~design~~

3.1.30

alarm type

alarm attribute which gives a distinction of the alarm condition

EXAMPLE: Low process variable alarm, high process variable alarm, ~~or~~ and discrepancy alarm.

~~3.1.31~~

~~alert~~

~~audible and/or visible means of indicating to the operator an equipment or process condition that can require evaluation when time allows~~ **11**

3.1.31**allowable response time**

maximum time between the annunciation of the alarm and when the operator ~~takes~~ must take corrective action to avoid the consequence

3.1.32**annunciator**

device or group of devices that call attention to changes in process conditions

3.1.33**assessment**

comparison of information from monitoring and additional qualitative (subjective) measurements against stated goals and defined performance metrics

3.1.34**audit <of alarm management>**

comprehensive assessment that includes the evaluation of alarm system performance and ~~the effectiveness~~ 12 of the work practices used to administer the alarm system

3.1.35**bad-measurement alarm**

alarm generated when the signal for a process measurement is outside the expected range

EXAMPLE: Bad-measurement alarm generated at 3,8 mA for a 4 mA to 20 mA signal.

3.1.36**basic process control system 13****BPCS**

system which responds to input signals from the process, its associated equipment, other programmable systems and/or operators and generates output signals causing the process and its associated equipment to operate in the desired manner but which does not perform any safety instrumented function

Note 1 to entry: A BPCS includes all of the devices necessary to ensure that the process operates in the desired manner.

Note 2 to entry: A BPCS typically may implement various functions such as process control functions, monitoring, and alarms.

[SOURCE: IEC 61511-1:2016, 3.2.3, modified – “SIF” has been changed to “safety instrumented function”]

3.1.37**benchmark**

initial audit of an alarm system designed to specifically identify problem areas for the purpose of formulating improvement plans

3.1.38**bit-pattern alarm**

alarm that is generated when a pattern of digital signals matches a predetermined pattern

3.1.39**calculated alarm**

alarm generated from a calculated value instead of a direct process measurement

3.1.40**call-out alarm**

alarm that notifies and informs an operator by means other than, or in addition to, the operator console ~~display~~

EXAMPLE: Alarm annunciated via pager or telephone.

3.1.41

chattering alarm

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

3.1.42

classification

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

Note 1 to entry: Requirements can include testing, training, and auditing.

3.1.43

console

~~{operator} console~~

~~interface for an operator to monitor and/or control the process, which may include multiple displays or annunciators, and defines the boundaries of the operator's span of control~~

hardware, software, and furniture or enclosure at which users monitor and/or control the process, which can include multiple stations, communication devices, and other devices

Note 1 to entry: The span of control of the operator is usually determined by the information available at the operator console.

3.1.44

control system

system that responds to input signals from the equipment under control and/or from an operator and generates output signals that cause the equipment under control to operate in the desired manner

Note 1 to entry: The control system can include ~~both~~ one or more basic process control systems (BPCS), safety instrumented systems (SIS).

Note 2 to entry: The control system can include one or more packaged systems.

[SOURCE: IEC 61508-4:2010, 3.3.3, "EUC" has been deleted from the term defined, "from the process" has been changed to "from the equipment under control", "causing" has been changed to "that cause", notes have been modified] 14

3.1.45

controller-output alarm

alarm generated from the output signal of a control algorithm instead of a direct process measurement

EXAMPLE: Alarm on output on PID controller.

3.1.46

decommission

process to remove an alarm from the alarm system

3.1.47

deviation alarm

alarm generated when the difference between two values exceeds ~~a limit~~ an alarm setpoint

EXAMPLE: Alarm on deviation between primary and redundant instruments or a deviation between process variable and controller setpoint.

3.1.48**discrepancy alarm**

mismatch alarm

alarm generated by the difference between the expected plant or device state to its actual state

EXAMPLE: Alarm when a motor fails to start after it is commanded to the on state.

3.1.49**display**

visual representation of information used by the operator for monitoring and control

3.1.50**dynamic alarming**

automatic modification of alarm attributes based on process state or conditions

3.1.51**enforcement**

enhanced alarming technique that can verify and restore alarm attributes in the control system to the values in the master alarm database

3.1.52**event**

representation of a solicited or unsolicited fact indicating a state change

~~Note 1 to entry:~~ EXAMPLE: Mode changes and device state changes.[SOURCE: IEC 62264-2:2004/2013, 3.1.2, modified – ~~a note has been added~~ "in the enterprise" has been deleted and an example has been added.] 15**3.1.53****first-out alarm**

first-up alarm

alarm determined ~~(i.e., by first-out logic)~~ to be the first in a multiple-alarm scenario

Note 1 to entry: The first alarm is determined by logic.

3.1.54**fleeting alarm**

alarm that transitions between an active alarm state and a not active alarm state in a short period of time without rapidly repeating

3.1.55**highly managed alarm****HMA**

alarm belonging to a class with additional requirements above general alarms

Note 1 to entry: Regulatory requirements can be additional requirements.

EXAMPLE: Safety related alarm.

3.1.56**human machine interface****HMI**

collection of hardware and software used by the operator and others to monitor and interact with the control system and with the process via the control system

3.1.57

implementation

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

Note 1 to entry: Implementation includes activities such as commissioning and training.

3.1.58

instrument diagnostic alarm

alarm ~~generated by a field device~~ to indicate a field device or signal fault ~~(e.g., sensor failure)~~

EXAMPLE: Out-of-range alarm.

3.1.59

interim alarm

alarm used on a temporary basis to replace an out-of-service alarm

3.1.60

latching alarm

alarm that remains in alarm state after the process condition has returned to normal and requires an operator reset before the alarm returns to normal

3.1.61

master alarm database

authorized list of rationalized alarms and associated attributes

Note 1 to entry: The list can be in many forms and not only in the form of a database.

3.1.62

monitoring

measurement and reporting of quantitative (objective) aspects of alarm system performance

3.1.63

nuisance alarm

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

EXAMPLE: Chattering alarm, fleeting alarm, ~~or~~ and stale alarm.

3.1.64

operator

controller

person who monitors and makes changes to the process

~~3.1.65~~

~~operator station~~

~~human-machine interface within the operator console~~

~~Note 1 to entry: Operator station can include multiple screens.~~

3.1.65

operator alert 16

audible and/or visible means of indicating to the operator an equipment or process condition for evaluation when time allows which could result in a response

3.1.66

out-of-service

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

3.1.67**packaged system**

self-contained combination of hardware and software that can provide alarm, HMI, and control functionality for a specific process function that is part of a facility

3.1.68**plant state**

plant mode

defined set of operational conditions for a process plant

EXAMPLE: Shutdown, normal operation.

3.1.69**prioritization**

process of assigning a level of operational importance to an alarm

3.1.70**process area**

physical, geographical or logical grouping of resources determined by the site

~~[SOURCE: IEC 62264-1:2003, 3.1]~~

3.1.71**rate-of-change alarm**

alarm generated when the change in process variable per unit time (dPV/dt) exceeds a defined setpoint

3.1.72**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

3.1.73**re-alarms alarm**

re-triggering alarm

alarm that is automatically re-annunciated ~~to the operator~~ **17** under certain conditions

3.1.74**recipe-driven alarm**

alarm with setpoints that depend on the recipe that is currently being executed

3.1.75**remote alarm**

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

3.1.76**reset**

operator action that unlatches a ~~latched~~ latching alarm

3.1.77**return to normal**

clear

alarm transition from an active ~~annunciated~~ alarm state to a not active ~~annunciated~~ alarm state

3.1.78

safety instrumented system

SIS

instrumented system used to implement one or more safety instrumented functions

~~Note 1 to entry: This can include either safety instrumented control functions or safety instrumented protection functions or both.~~

Note 1 to entry: A SIS is composed of any combination of sensor (s), logic solver (s), and final elements(s). It also includes communication and ancillary equipment (e.g., cables, tubing, power supply, impulse lines, heat tracing).

Note 2 to entry: A SIS may include software.

Note 3 to entry: A SIS may include human action as part of a SIF (see ISA TR 84.00.04:2015, part 1).

[SOURCE: IEC 61511-1:2003/2016, 3.2.72 3.2.67, modified – Removed figure from notes and reference to figure from note 1] **18**

3.1.79

safety related alarm

safety alarm

alarm that is classified as critical ~~to process safety~~ for the protection of human life or the environment

EXAMPLE: An alarm ~~with a risk reduction factor greater than 10~~ indicating a potential asphyxiation hazard. **19**

3.1.80

shelve

temporarily suppress an alarm, initiated by the operator, with engineering controls to unsuppress the alarm

Note 1 to entry: Engineering controls can include time limits.

3.1.81

silence

operator action that terminates the audible alarm indication

3.1.82

stale alarm

alarm that remains annunciated for an extended period of time

EXAMPLE: Alarm that remains annunciated for 24 hours.

3.1.83

state-based alarm

mode-based alarms

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

3.1.84

statistical alarm

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

3.1.85

suppress

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

EXAMPLE: Shelve, suppress by design, remove from service.

3.1.86

suppressed by design

alarm annunciation to the operator prevented based on plant state or other conditions

3.1.87**system diagnostic alarm**

alarm generated by the control system to indicate a fault within the system hardware, software or components

EXAMPLE: Communication error.

3.1.88**tag**

control system point

point

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

3.1.89**unacknowledged**

alarm state in which the operator has not yet confirmed recognition of an alarm indication

3.1.90**unshelve 20**

transition from the shelved alarm state to the normal or unacknowledged state

3.1.91**unsuppress 20**

transition from a suppressed alarm state to the normal or unacknowledged state

3.2 Abbreviated terms

ACKED	Acknowledged
ASRS	Alarm system requirements specification
BPCS	Basic process control system
CGMP	Current good manufacturing practice
DSUPR	~~Designed suppression~~ Suppressed-by-design
EEMUA	~~Engineering equipment and materials users' association~~
ERP	Enterprise resource planning
FMEA	Failure mode and effects analysis
HAZOP	Hazard and operability study
HMA	Highly managed alarms
HMI	Human machine interface
I/O	Input/output
LOPA	Layer of protection analysis
MES	Manufacturing execution system
MOC	Management of change
NORM	Normal
OOSRV	Out-of-service
P&ID	Piping (or process) and instrumentation diagram
PHA	Process hazards analysis
RTNUN	Return to normal unacknowledged
SHLVD	Shelved
SIS	Safety instrumented system
~~SOP~~	~~Standard operating procedure~~
UNACK	Unacknowledged

4 Conformance to this document

4.1 Conformance guidance

To conform to this document, it shall be shown that each of the mandatory requirements ~~in the normative clauses~~ has been satisfied. ~~This is the responsibility of the owner/operator.~~

4.2 Existing systems

For existing alarm systems designed and constructed in accordance with codes, standards, ~~and/or~~ practices prior to the issue of this document, the owner/operator shall determine that the equipment is designed, maintained, inspected, tested, and operated in a safe manner. The practices and procedures of this document shall be applied to existing systems in a reasonable time as determined by the owner/operator.

4.3 Use of required functionalities

This document requires certain control system functionalities (e.g., shelving) to support the alarm system. Where an alarm system does not have all required functionality, conformance may be achieved if the functionality described in the alarm philosophy is provided.

4.4 Responsibility

Conformance to this document is the responsibility of the owner/operator.

4.5 Local Jurisdictions

Some jurisdictions where the governing authorities (for example national, federal, state, province, county, city) have established process safety design, process safety management, or other requirements, in addition to the requirements of this document. **21**

5 Alarm system models

5.1 Alarm systems

Alarm systems are used to communicate indications of abnormal process conditions or equipment malfunctions to the operators, the personnel monitoring and operating the process, and to support the response. Effective alarm systems are well designed, implemented, operated, and maintained. Alarm management is the set of practices and processes that ensures an effective alarm system.

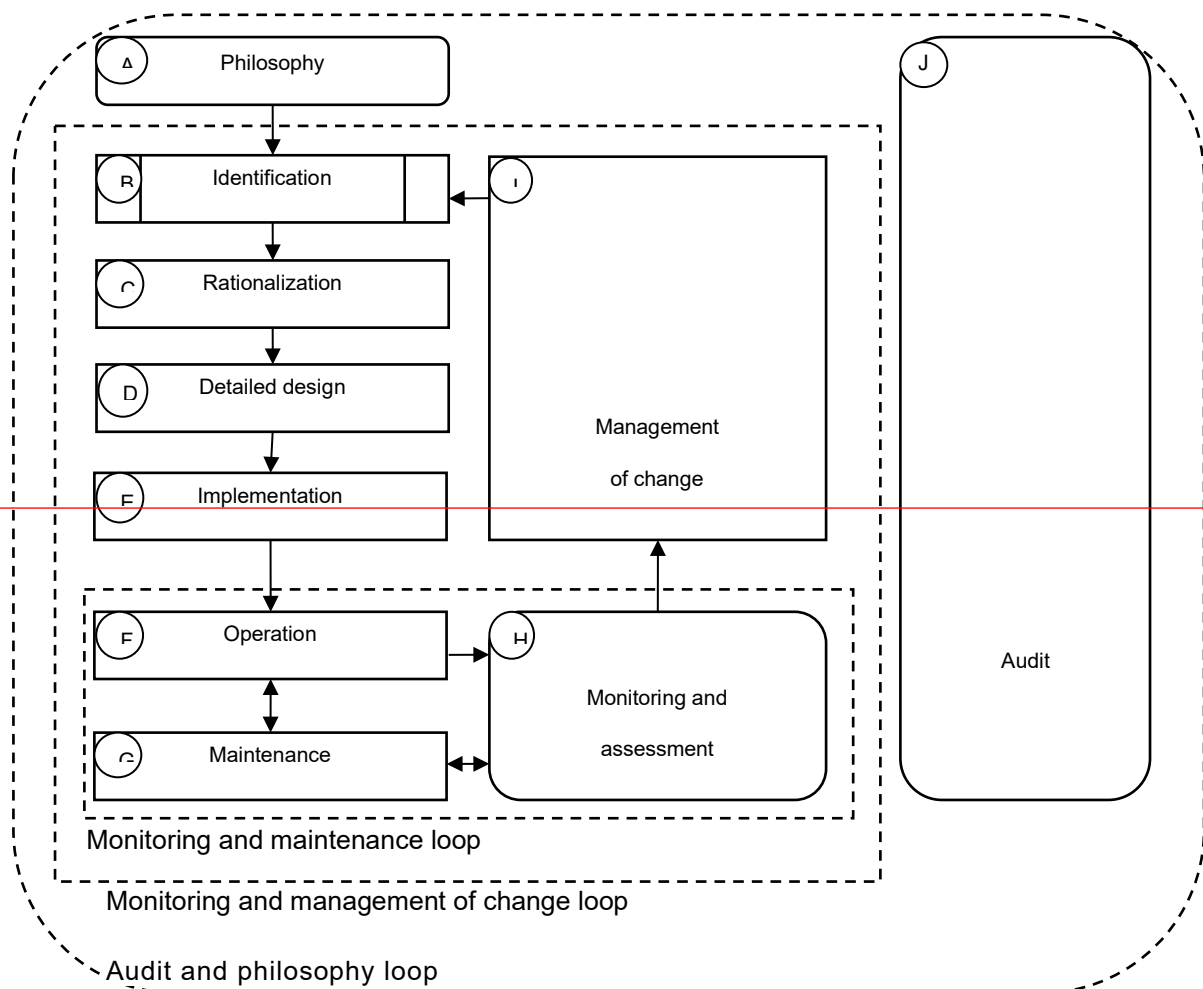
A foundational part of alarm management is the definition of an alarm: an audible and/or visible means of indicating to the operator an equipment malfunction, process deviation, or abnormal condition requiring a timely response. An essential element of this definition is the response to the alarm. This definition is reinforced in the alarm management processes described in this document.

5.2 Alarm management life cycle

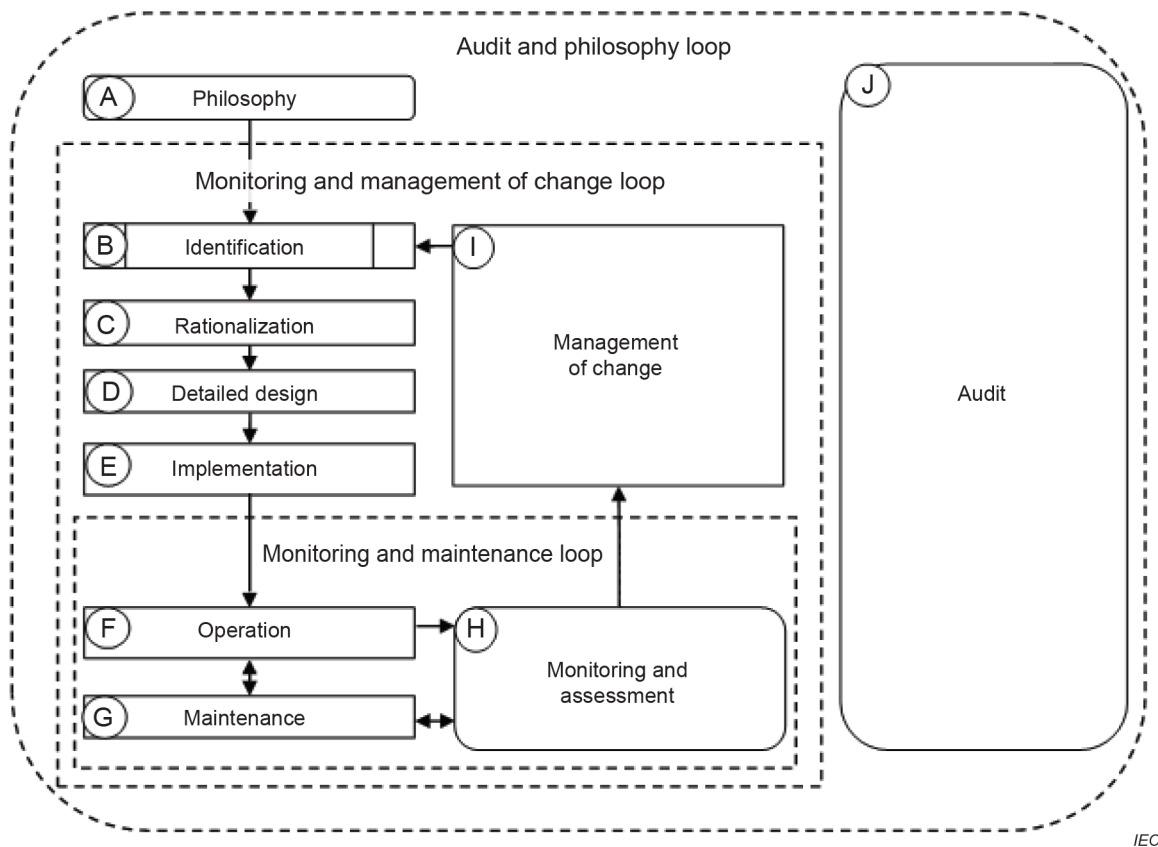
5.2.1 Alarm management life cycle model

Figure 2 illustrates the relationship between the stages of the alarm management life cycle described in this document. The alarm management life cycle covers alarm system specification, design, implementation, operation, monitoring, maintenance, and ~~change~~ MOC activities from initial conception through decommissioning.

The life cycle model is useful in ~~identifying~~ organizing the requirements and responsibilities for implementing ~~an~~ alarm management ~~system~~. The life cycle is applicable for the installation of new alarm systems or managing an existing system.



IEC



NOTE 1 The box used for stage B represents a process defined outside of this document (see 5.2.2.3).

NOTE 2 The independent stage J represents a process that connects to all other stages (see 5.2.2.11).

NOTE 3 The rounded shapes of stages A, H, and J represent entry points to the life cycle (see 5.2.3).

NOTE 4 The dotted lines represent the loops in the life cycle (see 5.2.5).

Figure 2 – Alarm management life cycle

5.2.2 Alarm management life cycle stages

5.2.2.1 General

The alarm management life cycle stages shown in Figure 2 are briefly described in the following subclauses. The letter label is an identifier used in the text. The requirements and recommendations for each stage are described in Clause 6 to Clause 18 of this document.

5.2.2.2 ~~Alarm philosophy~~ Philosophy (A) 22

Basic planning is necessary prior to designing a new alarm system or modifying an existing system. Generally, the first step is the development of an alarm philosophy that documents the objectives of the alarm system and the processes to meet those objectives. The alarm philosophy reflects the operations and maintenance work processes and can reference those processes in other documents. For new systems the alarm philosophy serves as the basis for the alarm system requirements specification (ASRS) document.

The philosophy starts with the basic definitions and extends them to operational definitions. The criteria for alarm prioritization and the definition of alarm classes, performance metrics, performance limits, and reporting requirements are based on the objectives and principles for alarm systems. The schemes for presentation of alarm indications in the HMI, including use of priorities, are also set in the alarm philosophy, ~~which should be consistent with the overall HMI design~~. The philosophy specifies the processes used for each of the alarm management life cycle stages, such as the threshold for the MOC process and the specific requirements for change. The philosophy is maintained to ensure consistent alarm management throughout the life cycle of the alarm system.

The development of the ASRS is included in the philosophy stage of the life cycle. The specification can be plant specific, providing details on restrictions or options, and can be the basis for selecting new or modifying existing control systems. The specification typically goes into more detail than the alarm philosophy and ~~may~~ can provide specific guidance for system design.

5.2.2.3 Identification (B)

The identification stage is a collection point for potential alarms proposed by ~~any~~ one of ~~several~~ the methods for determining if an alarm ~~might be~~ is necessary. These methods are defined outside of this document so the identification stage is represented as a predefined process in the life cycle. The methods can be formal such as process hazards analysis, safety requirements specifications, recommendations from an incident investigation, good manufacturing practice, environmental permits, P&ID development, or operating procedure reviews. ~~Information from identification (e.g., alarm setpoint, consequence) should be captured for rationalization.~~ Process modifications and operating tests can also generate the need for alarms or modifications. Some alarm changes will be identified from the routine monitoring of alarm system performance. At this stage the need for a new alarm or modifications to an existing alarm has been identified and the alarm is ready to be rationalized.

5.2.2.4 Rationalization (C)

The rationalization stage reconciles the identified need for an alarm or alarm system change with the principles ~~and definitions~~ in the alarm philosophy. The steps can be completed in one process or sequentially. The output of rationalization is documentation of the alarm, including any advanced alarm techniques, which can be used to complete the design.

Rationalization is the process of applying the requirements for an alarm and generating the supporting documentation such as the ~~basis for the~~ alarm setpoint, the consequence, and corrective action that can be taken by the operator.

Rationalization includes the prioritization of an alarm based on the method defined in the alarm philosophy. Often priority is based on the consequences of the alarm and the allowable response time.

Rationalization also includes the activity of classification during which an alarm is assigned to one or more classes to designate requirements (e.g., ~~design~~, testing, training, ~~or reporting monitoring, and audit~~ **23** requirements). The type of consequences of a rationalized alarm, or other criteria, can be used to separate the alarms into classes as defined in the alarm philosophy.

The rationalization results are documented, typically in the master alarm database (i.e., an approved document or file), which is maintained for the life of the alarm system.

5.2.2.5 Detailed design (D)

In the design stage, the ~~additional~~ alarm attributes are specified and designed based on the requirements determined by rationalization. There are three areas of design: basic alarm design, HMI design, and design of advanced alarming techniques.

The basic design for each alarm follows guidance based on the type of alarm and the specific control system.

The HMI design includes display and annunciation for the alarms, including the indications of alarm state and alarm priority.

Advanced alarming techniques(e.g., state-based alarming)~~—are additional functions that improve the effectiveness of the alarm system beyond the basic alarm and HMI design. These methods include state-based alarming.~~

5.2.2.6 Implementation (E)

In the implementation stage, the activities necessary to install an alarm or alarm system and bring it to operational status are completed. Implementation of a new alarm or a new alarm system includes the physical and logical installation and functional verification of the system.

Since operators are an essential part of the alarm system, operator training is an important activity during implementation. Testing of new alarms is often an implementation requirement. The documentation for training, testing, and commissioning~~may~~ can vary with classification as defined in the alarm philosophy.

5.2.2.7 Operation (F)

In the operation stage, the alarm or alarm system is in service and it performs its intended function. Refresher training on both the alarm philosophy and the purpose of each alarm is included in this stage.

5.2.2.8 Maintenance (G)

In the maintenance stage, the alarm or alarm system is not operational but is being tested or repaired. Periodic maintenance (e.g., testing of instruments) is necessary to ensure the alarm system functions as designed.

5.2.2.9 Monitoring and assessment (H)

In the monitoring and assessment stage, the overall performance of the alarm system and individual alarms are continuously monitored against the performance goals stated in the alarm philosophy. Monitoring and assessment of the data from the operation stage~~may~~ can trigger maintenance work or identify the need for changes to the alarm system or operating procedures. ~~Monitoring and assessment of the data from the maintenance stage provides an indication of the maintenance efficiency. The overall performance of the alarm system is also monitored and assessed against the goals in the alarm philosophy.~~ Without monitoring an alarm system is likely to degrade over time.

5.2.2.10 Management of change (I)

In the management of change stage, modifications to the alarm system are proposed and approved. The change process should follow each of the alarm management life cycle stages from identification to implementation.

5.2.2.11 Audit (J)

In the audit stage, periodic reviews are conducted to evaluate the effectiveness of the alarm management process and maintain the integrity of the alarm system~~and alarm management processes~~. Audits of system performance can reveal gaps not apparent from routine monitoring. Execution against the alarm philosophy is audited to identify system improvements, such as modifications to the alarm philosophy. Audits can also identify the need to increase the discipline of the organization to follow the alarm philosophy.

5.2.3 Alarm management life cycle entry points

5.2.3.1 General

Depending on the selected approach, there are three points of entry to the alarm management life cycle:

- a) alarm philosophy,
- b) monitoring and assessment, and
- c) audit.

These entry points are represented by rounded boxes in Figure 2. As entry points these life cycle stages are only the initial step in managing an alarm system. All stages of the life cycle are necessary for ~~a~~ complete alarm management ~~system~~.

5.2.3.2 Start with alarm philosophy (A)

The first possible starting point is the development of an alarm philosophy which establishes the objectives of the alarm system and ~~may~~ can be used as the basis for the ASRS. This is the life cycle entry point for new ~~installations~~ systems.

5.2.3.3 Start with monitoring and assessment (H)

The second possible starting point is to begin monitoring an existing alarm system and ~~assess~~ benchmark the performance. Problem alarms can be identified and addressed through maintenance or management of change. The monitoring data can be used in a benchmark assessment prior to the development of the alarm philosophy.

5.2.3.4 Start with audit (J)

The third possible starting point is an initial audit, or benchmark, of all aspects of alarm management against a set of documented practices, such as those listed in this document. The results of the initial audit can be used in the development of a philosophy.

5.2.4 Simultaneous and encompassing stages

The life cycle diagram (Figure 2) is drawn to represent sequential stages. There are several simultaneous stages which are represented in the life cycle. Some stages encompass the activities of other stages.

The monitoring and assessment stage (H) is simultaneous to the operation and maintenance stages.

The management of change stage (I) represents the initiation of the change process through which all appropriate stages of the life cycle are authorized and completed.

The audit stage (J) is an overarching activity that can occur at any point in the life cycle and includes a review of the activities of the other stages.

5.2.5 Alarm management life cycle loops

5.2.5.1 General

In addition to the alarm management life cycle stages, there are three loops in the life cycle. Each loop performs a function during the life cycle.

5.2.5.2 Monitoring and maintenance loop

The ~~operation~~-monitoring and ~~assessment~~-maintenance loop is the routine monitoring that identifies problem alarms for maintenance. Repaired alarms are returned to operation.

5.2.5.3 Monitoring and management of change loop

The ~~operation~~-monitoring and ~~assessment~~-management of change loop is triggered when routine monitoring indicates the design of an alarm is not ~~compatible~~ in compliance with the alarm philosophy. The design might need to be modified or an advanced alarming technique might need to be applied. The alarm could remain in operation while the MOC process is initiated and the stages of the life cycle are repeated.

5.2.5.4 Audit and philosophy loop

The audit and philosophy loop is the life cycle itself and the process of continuous improvement of the alarm system. Audit identifies processes in the life cycle to strengthen.

5.2.6 Alarm management life cycle stage inputs and outputs

The alarm management life cycle stages are connected as the outputs of one stage are often the inputs to another stage. The connections are not fully represented in the life cycle diagram (Figure 2). Table 1 provides more information on the relationships between the inputs and outputs of the life cycle stages.

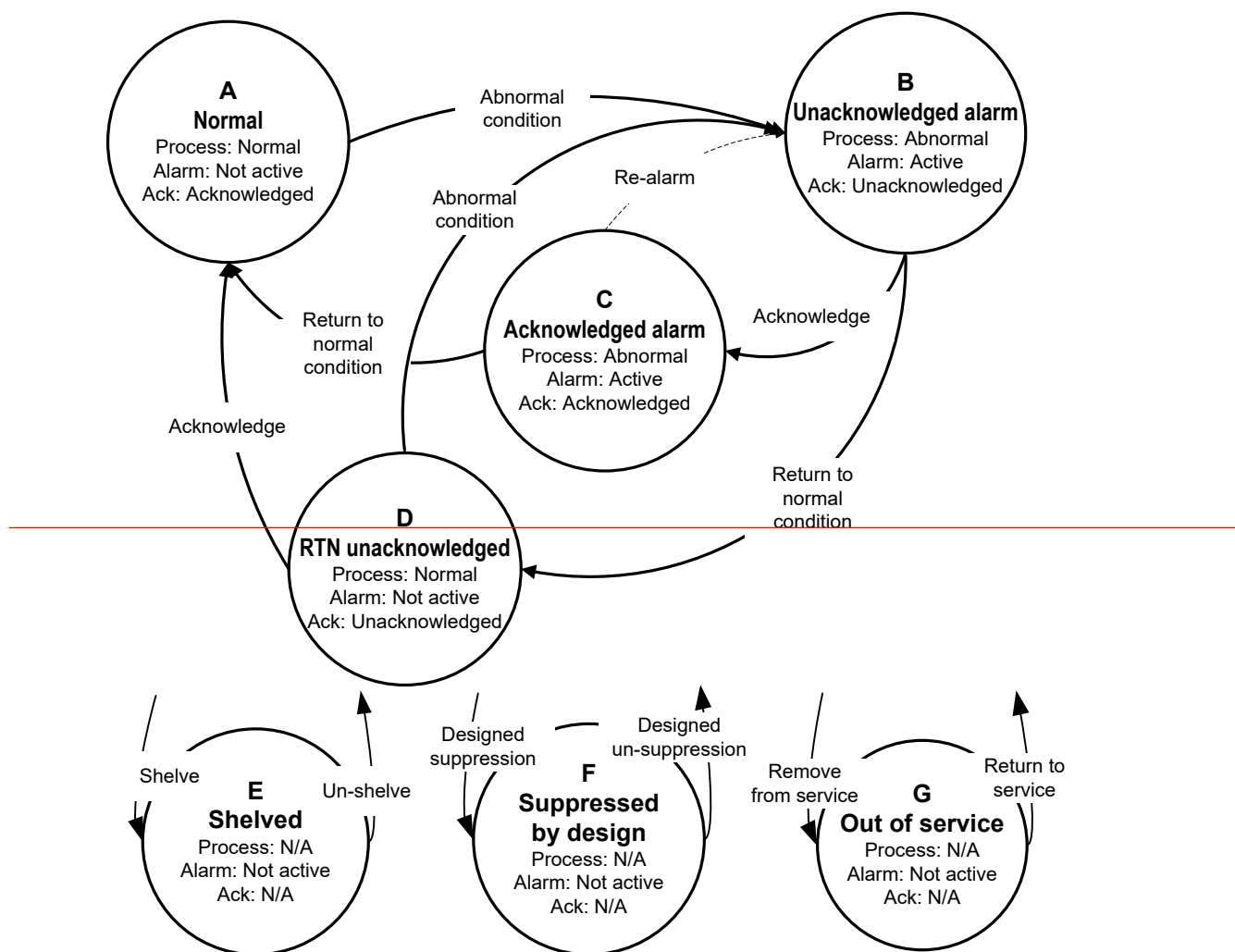
Table 1 – Alarm management life cycle stage inputs and outputs

Alarm management life cycle stage		Activities	Clause number	Inputs	Outputs
Stage	Title				
A	Philosophy	Documenting the objectives, guidelines and work processes for alarm management, and ASRS	6, 7	Objectives and standards, ~~audit recommendations~~	Alarm philosophy and ASRS
B	Identification	Determining potential alarms	8	PHA report, ~~SRS~~ , P&IDs, operating procedures, ~~etc.~~	List of potential alarms
C	Rationalization	Rationalization, classification, prioritization, and documentation	9	Alarm philosophy, and list of potential alarms	Master alarm database and alarm design requirements
D	Detailed design	Basic alarm design, HMI design, and advanced alarming design	10, 11, 12	Master alarm database and alarm design requirements	Completed alarm design
E	Implementation	Installing alarms, implementation testing, and implementation training	13	Completed alarm design, master alarm database, and ASRS	Operational alarms and alarm response procedures
F	Operation	Operator responds to alarms and refresher training	14	Operational alarms and alarm response procedures	Alarm data
G	Maintenance	Maintenance repair and replacement, and periodic testing	15	Alarm monitoring reports and alarm philosophy	Alarm data
H	Monitoring & assessment	Monitoring alarm data and report performance	16	Alarm data and alarm philosophy	Alarm monitoring reports and proposed changes
I	Management of change	Process to authorize additions, modifications, and deletions of alarms	17	Alarm philosophy and proposed changes	Authorized alarm changes
J	Audit	Periodic audit of alarm management processes	18	Standards, alarm philosophy, and audit protocol	Recommendations for improvement

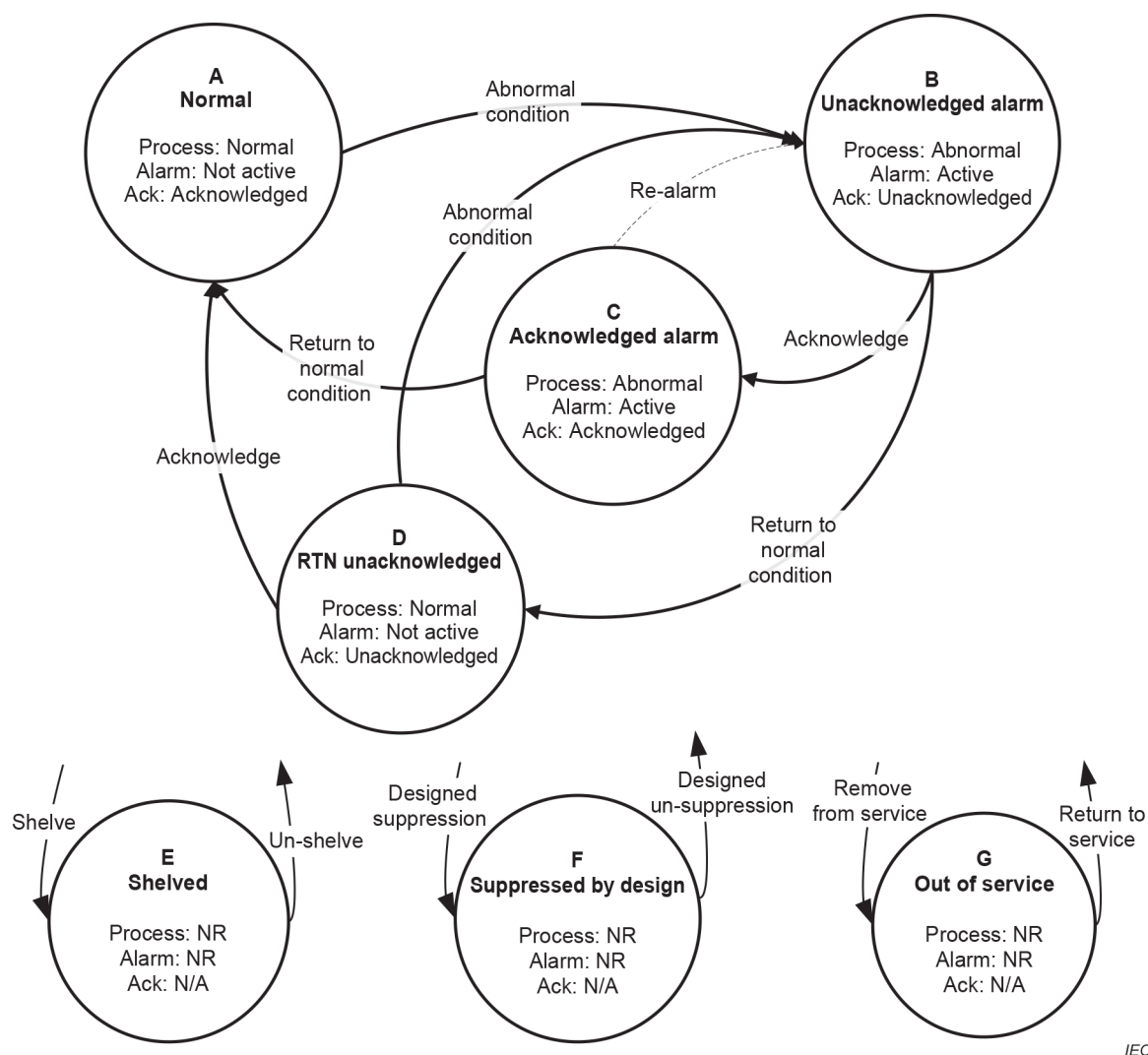
5.3 Alarm states

5.3.1 Alarm state transition diagram

The alarm state transition diagram shown in Figure 3 represents the states and transitions for typical alarms. While there are exceptions, this diagram describes the majority of alarms and serves as a useful reference for the development of alarm system principles and HMI functions.



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NOTE 1 States E, F, and G can connect to any alarm state in the diagram.

NOTE 2 The dotted line indicates an infrequently implemented option.

NOTE 3 N/A indicates not applicable.

NOTE 4 NR indicates that the state is not relevant (either normal or abnormal, not active or active).

Figure 3 – Alarm state transition diagram

5.3.2 Alarm states

5.3.2.1 General

The circles in Figure 3 represent the states of an alarm. The letter label is an identifier. The second line is a state name, often abbreviated. The third line describes process conditions, the fourth and fifth lines list the alarm status and its acknowledgement status, respectively. The possible states of alarm suppression are shown on the lower part of the diagram.

5.3.2.2 Normal state (A)

The normal (NORM) alarm state is defined as the state in which the process is operating within normal specifications, the alarm is not active and previous alarm occurrences have been acknowledged.

5.3.2.3 Unacknowledged state (B)

The unacknowledged alarm (UNACK) state is the initial state of an alarm becoming active due to abnormal conditions. In this state the alarm is unacknowledged. Previously acknowledged alarms can be designed to re-arm, causing a return to this state.

5.3.2.4 Acknowledged state (C)

The acknowledged (ACKED) alarm state is the state in which the alarm is active, and the operator has acknowledged the alarm.

5.3.2.5 Return to normal unacknowledged state (D)

In the returned to normal unacknowledged (RTNUN) alarm state, the process is within normal limits and the alarm becomes not active before an operator has acknowledged the alarm ~~condition~~.

5.3.2.6 Shelved state (E)

In the shelved (SHLVD) alarm state, an alarm is temporarily suppressed using a controlled methodology, and not annunciated. An alarm in the shelved state is under the control of the operator. The shelving function can automatically unshelve alarms.

5.3.2.7 Suppressed-by-design state (F)

In the suppressed-by-design (DSUPR) alarm state, an alarm is suppressed based on operating conditions or plant states, and not annunciated. An alarm in the suppressed-by-design state is under the control of logic that determines the relevance of the alarm.

5.3.2.8 Out-of-service state (G)

In the out-of-service (OOSRV) alarm state, an alarm is manually suppressed (e.g., control system functionality to remove alarm from service) when it is removed from service and not annunciated, typically for maintenance. An alarm in the out-of-service state is ~~under~~ in the ~~control of~~ maintenance stage of the life cycle.

NOTE An alarm in the out-of-service state is not the same as out of service of a unit or equipment. Equipment can be out of service while the associated alarms are not out of service.

5.3.2.9 ~~Alarm status by state~~ Summary of alarm states

The alarm status, annunciation status, and acknowledge status of different alarm states are summarized in Table 2.

Table 2 – Summary of alarm states

ID	Mnemonic	State name	Process condition	Alarm status	Annunciation status	Acknowledge status
A	NORM	Normal alarm state	Normal	Not active	Not annunciated	Acknowledged
B	UNACK	Unacknowledged alarm state	Abnormal	Active	Annunciated	Unacknowledged
C	ACKED	Acknowledged alarm state	Abnormal	Active	Annunciated	Acknowledged
D	RTNUN	Returned to normal unacknowledged alarm state	Normal	Not active	Annunciated	Unacknowledged
E	SHLVD	Shelved state	Normal or abnormal	Not active or active	Suppressed	Not Applicable
F	DSUPR	Suppressed-by-design state	Normal or abnormal	Not active or active	Suppressed	Not Applicable
G	OOS RV	Out-of-service alarm state	Normal or abnormal	Not active or active	Suppressed	Not Applicable

5.3.3 Alarm state transition paths

5.3.3.1 General

The arrows in Figure 3 represent transitions between states. The diagram does not directly illustrate the effects of alarm deadband, on-delay, or off-delay, which can impact the evaluation of alarm status (i.e., active or not active).

5.3.3.2 Transition from normal to unacknowledged (A → B)

The transition from normal to unacknowledged occurs when the process has gone out of the normal range beyond the alarm setpoint and has remained in this state long enough to ~~trigger~~ make the alarm active.

5.3.3.3 Transition from unacknowledged to acknowledged (B → C)

The transition from unacknowledged to acknowledged occurs when an operator acknowledges an alarm that is active before the process returns to normal.

5.3.3.4 Transition from acknowledged to unacknowledged (C → B)

The transition from acknowledged to unacknowledged is the infrequently used option that periodically generates repetitive alarm indications for a single alarm while the alarm remains ~~in the alarm state~~ active.

5.3.3.5 Transition from acknowledged to normal (C → A)

The transition from acknowledged to normal is part of a normal sequence for an alarm. The alarm moves from the acknowledged state to normal and becomes not active.

5.3.3.6 Transition from unacknowledged to return-to-normal unacknowledged (B → D)

The transition from unacknowledged to return-to-normal unacknowledged occurs when the process returns to normal and the alarm becomes not active before an operator has acknowledged the alarm.

5.3.3.7 Transition from return-to-normal unacknowledged to normal (D → A)

The transition from return-to-normal unacknowledged to normal occurs when an alarm has returned to normal and becomes not active. This transition can require operator acknowledgment or can be acknowledged automatically.

5.3.3.8 Transition to shelved (any state → E)

The transition to shelved occurs when an operator shelves an alarm to avoid clutter in the active alarm displays. Shelving is a manual operation.

5.3.3.9 Transition from shelved to normal or unacknowledged (E → A or B)

The transition from shelved to normal or unacknowledged occurs when an alarm is unshelved, manually or automatically. ~~If the alarm is not active, the transition should be to the normal state. If the alarm is active, the transition should be to the unacknowledged state.~~ If the alarm is automatically unshelved, the transition should be to the unacknowledged state. If the alarm is manually unshelved, the transition should be to the acknowledged state.

5.3.3.10 Transition to suppressed-by-design (any state → F)

The transition to suppressed-by-design occurs when process conditions ~~or states~~ are used to suppress alarms by design. Designed suppression is typically an automatic operation.

5.3.3.11 Transitions from suppressed-by-design ~~red~~ to normal or unacknowledged (F → A or B)

The transition from suppressed-by-design to normal or unacknowledged occurs when process conditions ~~or states~~ are used to unsuppress alarms when appropriate. Designed unsuppression is typically an automatic operation. If the alarm is active, the transition should be to the unacknowledged state. If the alarm is not active, the transition should be to the normal state.

5.3.3.12 Transition to out-of-service state (any state → G)

The transition to out-of-service state occurs when an alarm ~~can be~~ is removed from service for maintenance or other reasons. Remove from service is typically a manual operation.

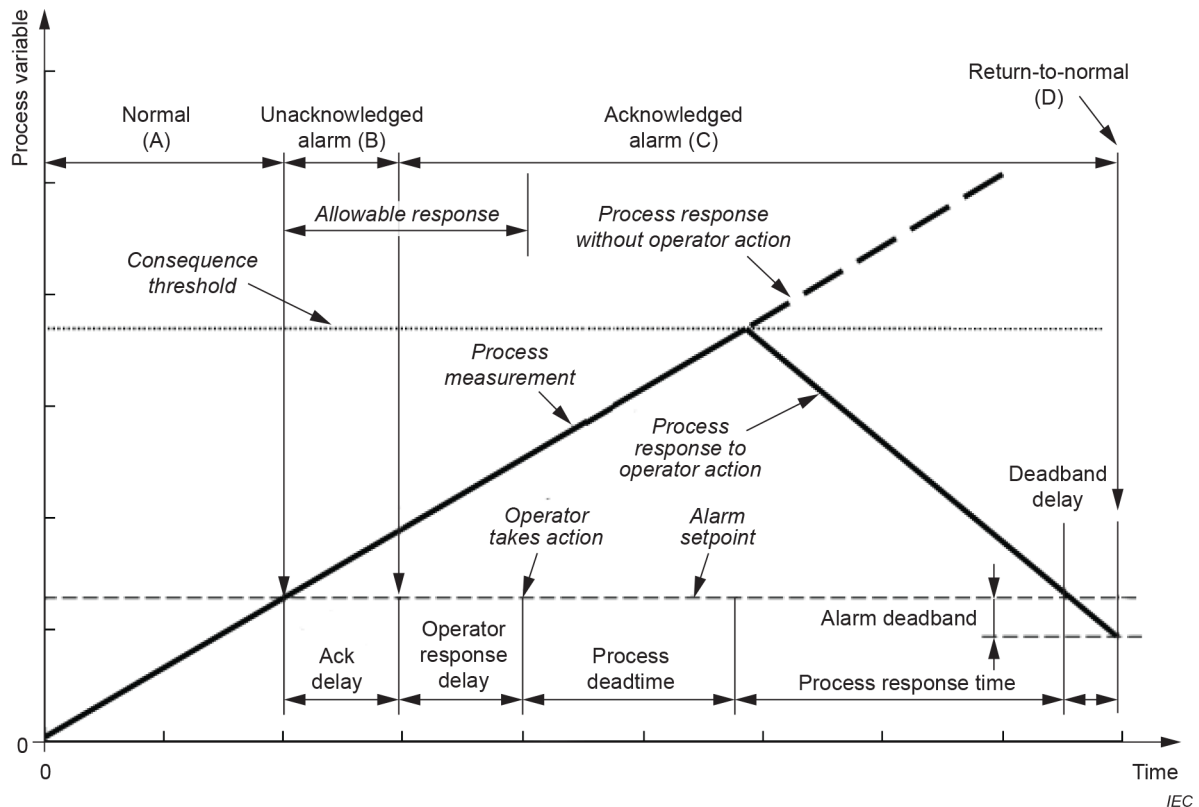
5.3.3.13 Transition from out-of-service to normal or unacknowledged (G → A or B)

The transition from out-of-service to normal or unacknowledged occurs when an alarm ~~can be~~ is returned to service when it is available after maintenance. Return to service is typically a manual operation. If the alarm is active, the transition should be to the unacknowledged state. If the alarm is not active, the transition should be to the normal state.

5.4 Alarm response timeline

5.4.1 General

Figure 4 represents a process measurement that increases from a normal condition to an abnormal condition and the two possible scenarios based on whether the operator takes the corrective action or not. It is possible to map some alarm states from Figure 3 to the timeline shown in Figure 4. ~~Figure 4 illustrates only one possible scenario to clarify the definition of terms related to time.~~



NOTE Ack delay, operator response delay and process deadtime can be zero.

Figure 4 – Alarm response timeline

5.4.2 Normal (A)

The normal alarm state is defined as the state in which the process is operating within normal specifications, the alarm is not active, and previous alarm occurrences have been acknowledged.

5.4.3 Unacknowledged (B)

The unacknowledged alarm state results when the measurement crosses the alarm setpoint. There are several factors that affect the alarm annunciation such as

- a) measurement accuracy,
- b) sampling interval, and
- c) alarm on-delay.

The alarm is not always immediately acknowledged by the operator.

5.4.4 Acknowledged (C) and response

The acknowledged alarm state is reached when an operator acknowledges the alarm-condition, after the acknowledge delay. In this state the alarm is active. The operator can take action before or after acknowledging the alarm. There are several factors that affect the operator response time such as

- a) system processing speed,
- b) HMI design and clarity,
- c) operator awareness and training,
- d) operator workload,

- e) complexity of determining the operator action, and
- f) complexity of the operator action.

The actual response time for the alarm is the time beginning when the alarm is annunciated and ending when the operator takes the corrective action. It includes the detection of the alarm, the diagnosis of the situation and determination of the operator action in response, and the execution of that response. The upper limit of the response time is the allowable response time, the point beyond which the consequence will occur even if action is taken.

5.4.5 Return-to-normal (D)

The return-to-normal alarm state should result from the correct operator action within the allowable response time. There are several factors that affect the time until the alarm returns to normal. These include the following:

- a) the operator response delay,
- b) the degree of corrective action taken,
- c) the process deadtime in response to the corrective action,
- d) the process response time to the corrective action,
- e) the accuracy of the process measurement,
- f) the deadband of the alarm setpoint, and
- g) the operational speed of the alarm system.

5.4.6 Allowable response time

The allowable response time is the time beginning with the alarm annunciation and ending at the last moment operator action can prevent the consequence. It can be estimated working backwards from the consequence threshold, considering the process deadtime, the rate of change of the process variable and the separation between the alarm setpoint and the consequence threshold. In Figure 4, the operator response delay is shown within the allowable response time.

5.4.7 Alarm setpoint

The alarm setpoint can be adjusted to increase or decrease the allowable response time. The process for evaluating the alarm setpoint is alarm setpoint determination.

5.4.8 Consequence threshold

The consequence threshold is the value of the process measurement at which the consequence begins to occur. The consequence results when no operator action is taken, incorrect or insufficient action is taken, or the action is not completed within the allowable response time.

~~The consequence begins to occur at the consequence threshold.~~

5.4.9 Alarm deadband

The deadband delay shown in Figure 4 illustrates that the alarm does not return to normal immediately after crossing the alarm setpoint.

5.5 Feedback model of operator-process interaction

5.5.1 General

A model of operator-process interaction is shown in Figure 5. In response to a disturbance or malfunction, the process or system undergoes some change. If that change deviates significantly from the reference or objective for the process, the operator takes action to bring the process back to the reference ~~and continues to monitor the measurement as it returns. In order for the action to occur, three stages of activity occur.~~

The following three stages of activity occur in the operator sub-system leading to action:

- a) the indication of deviation from desired normal operation (i.e., an alarm) is detected,
- b) the situation is diagnosed, and the corrective action is determined, and
- c) the corrective action is implemented to compensate for the disturbance.

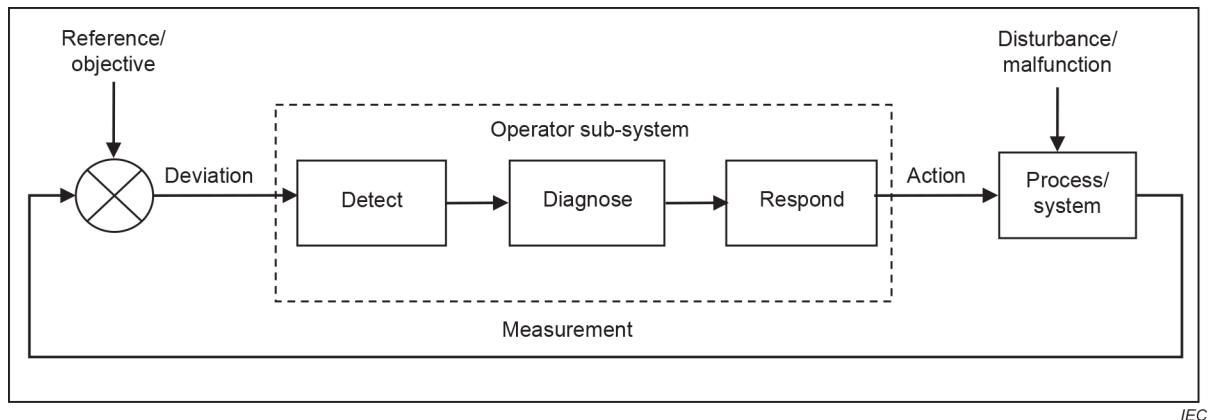


Figure 5 – Feedback model of operator-process interaction

5.5.2 Detect

The operator becomes aware of the deviation from the desired condition by an alarm caused by a disturbance. The design of the alarm system and the operator interface facilitates the detection of deviation.

5.5.3 Diagnose

The operator uses knowledge and skills to interpret the information, diagnose the situation, and determine the corrective action to take in response to the deviation. The alarm response procedures aid the operator's diagnosis.

5.5.4 Respond

The operator takes corrective action in response to the deviation and monitors the process to determine if the deviation is corrected.

5.5.5 Performance shaping factors

The ability of the operator to carry out the sub-system functions is affected by a variety of variables, including:

- a) workload,
- b) operator console ergonomics,
- c) HMI design, 24
- d) short term or working memory limitations,
- e) fatigue,
- f) training, and
- g) motivation.

6 Alarm philosophy

6.1 Purpose

~~Alarm philosophy is a separate stage of the alarm management lifecycle.~~ The alarm philosophy serves as the framework to establish the criteria, definitions, principles, and responsibilities for all of the alarm management life cycle stages. This is achieved by specifying items, including the methods for alarm identification, rationalization, monitoring, MOC, and audit to be followed. An alarm philosophy document facilitates:

- a) consistency across the alarm system,
- b) consistency with risk management goals and objectives,
- c) agreement with good engineering practices, and
- d) design and management of the alarm system that supports an effective operator response.

6.2 Alarm philosophy contents

6.2.1 General

~~Subclause 6.2 provides the minimum and recommended content to be addressed in the alarm philosophy.~~ An alarm philosophy document shall be developed to cover each alarm system. An alarm philosophy may cover more than one alarm system. The alarm philosophy shall include the required contents listed in this clause. The alarm philosophy shall be developed prior to rationalization. **25**

Due to the wide variety of equipment used within the process industry, the detailed content of the alarm philosophy can vary between industries and from one location to another. The required and recommended contents of the alarm philosophy are listed in Table 3.

Table 3 – Required and recommended alarm philosophy contents

Alarm philosophy contents	Required / recommended	Subclause
Purpose of alarm system	Required	6.2.2
Definitions	Required	6.2.3
References	~~Required~~ Recommended	6.2.4
Roles and responsibilities for alarm management	Required	6.2.5
Alarm design principles	Required	6.2.6
Alarm setpoint determination	Recommended	6.2.7
Prioritization method	Required	6.2.8
Alarm class definition	Required	6.2.9
Highly managed alarms (or site equivalent)	Recommended	6.2.10
Rationalization	Required	6.2.11
Alarm documentation	Required	6.2.12
Alarm design guidance	Required	6.2.13
Specific alarm design considerations	Recommended	6.2.14
HMI design principles	Required	6.2.15
Approved enhanced and advanced alarming techniques	Recommended	6.2.16
Implementation guidance	Required	6.2.17
Alarm response procedures	Required	6.2.18
Training	Required	6.2.19
Alarm shelving	Recommended	6.2.20

Alarm philosophy contents	Required / recommended	Subclause
Alarm system maintenance	Required	6.2.21
Testing of alarms	Required	6.2.22
Alarm system performance monitoring	Required	6.2.23
Alarm history preservation	~~Required~~ Recommended	6.2.24
Management of change	Required	6.2.25
Alarm system audit	Required	6.2.26
Related site procedures	Recommended	6.2.27

For alarm systems designed for new plants, the alarm philosophy should be drafted as part of the project planning and development and be fully defined and approved before alarm rationalization.

For existing alarm systems which are being remediated, and no philosophy exists, the alarm philosophy should be one of the first stages of the remediation effort.

The required contents of the alarm philosophy can exist in other site procedures. These procedures should be referenced in the ~~alarm~~ philosophy.

6.2.2 Purpose of alarm system

The purpose and objectives of ~~a process plant~~ an alarm system shall be ~~defined~~ ~~stated~~. The purpose and objectives ~~clearly defined~~ ~~stated~~ serve to orient participants in design and improvement activities and can facilitate the implementation and maintenance of an effective alarm system.

6.2.3 Definitions

The alarm philosophy shall include definitions of terms that will be encountered in the course of design and improvement of an alarm system ~~shall be defined~~ to ensure that all participants share a common understanding. The definition of an alarm shall be documented in the alarm philosophy.

6.2.4 References

The alarm philosophy should include a list of appropriate references ~~for alarm management shall be included~~. References can be internal company documents (e.g., MOC ~~procedure~~), external ~~standards~~, or published material.

6.2.5 Roles and responsibilities for alarm management

The alarm philosophy shall establish responsibility ~~by role~~ for the activities of the alarm management life cycle. Specific aspects ~~to cover~~ should include the following:

- a) the owner of the alarm system, the philosophy, ~~master alarm database~~, and related documents,
- b) the role responsible for management and regular maintenance of the alarm system,
- c) the role responsible for technical support to resolve problems with ~~the alarm system~~ alarms,
- d) the role responsible to ensure that the requirements outlined in the alarm philosophy are followed.

6.2.6 Alarm design principles

~~The definition of an alarm, with examples that meet and do not meet the definition, shall be documented in the alarm philosophy. The criteria for selection and principles for design of alarms shall be consistent with the definition of an alarm.~~ The alarm philosophy shall include the criteria for selection and principles for design of alarms, consistent with the definition of an alarm. The criteria and principles should ~~address~~ include:

- a) the role of the alarm system in identifying approaches to unsafe or ~~sub-optimal~~ abnormal operation, warning of malfunctions, and prompting the operator of actionable changes in the process,
- b) the methods to be used for alarm identification,
- c) the alarm states (e.g., normal, acknowledged, shelved, ~~etc.~~) that the facility will use.

6.2.7 Alarm setpoint determination

The alarm philosophy should provide guidance on the methods used for determination of alarm setpoints. Alarm setpoint determination can use several inputs (e.g., consequence thresholds, process dynamics, complexity of the operator response).

6.2.8 Prioritization method

Consistent priorities aid the operator in deciding the order of response during a period with a high alarm rate. ~~Specific elements that shall be covered in this section include the following:~~ The alarm philosophy shall address the prioritization, including the following:

- a) the basis for alarm prioritization (e.g., severity of consequence, time to respond, ~~etc.~~),
- b) the metrics for alarm ~~configuration~~ priority (e.g., ~~alarm count and~~ priority distribution),
- c) the impact of classification on prioritization, if any.

6.2.9 Alarm class definition

Alarm classes are used to set common requirements for managing alarms. An alarm may belong to more than one class. This alarm philosophy ~~should~~ shall include the definition of the alarm classes. ~~It should also, which can~~ include the following ~~class requirements~~:

- a) alarm prioritization considerations,
- b) alarm documentation,
- c) HMI design,
- d) operating procedures associated with the alarms,
- e) ~~operator~~ training and training documentation,
- f) alarm maintenance,
- g) alarm testing,
- h) alarm monitoring and assessment,
- i) alarm MOC,
- j) alarm history retention, and
- k) alarm audit.

6.2.10 Highly managed alarms

Highly managed alarm (HMA) classes are classes of alarms that require more administration and documentation than others. ~~Since the criteria can vary by process, industry or location,~~ If HMA are used, the alarm philosophy shall define the criteria for assigning alarms to HMA classes. The designation of alarm classes as highly managed should be based upon one or more of the following:

- a) alarms critical ~~to process safety~~ for the protection of human life (e.g., safety ~~related~~ alarms),
- b) alarms for personnel safety or protection,
- c) alarms for environmental protection,
- d) alarms for current good manufacturing practice,
- e) alarms for commercial loss,
- f) alarms for product quality,
- g) alarms for process licensor requirements, and
- h) alarms for company policy.

~~If HMA classes are used, this section of the alarm philosophy shall document the requirements for these alarm classes.~~

6.2.11 Rationalization

~~In order to maximize the functionality of the alarm system it is important that the operator receive only those alarms that require an operator response. Ensuring that an alarm requires a response is done through alarm rationalization.~~ The alarm philosophy ~~should~~ shall list the criteria to assess alarms and the information to be captured during rationalization. Guidance on the knowledge and experience of the rationalization team should include:

- a) operations,
- b) process,
- c) maintenance,
- d) control system, and
- e) alarm philosophy.

6.2.12 Alarm documentation

~~Appropriate documentation shall be addressed in the alarm philosophy.~~ The alarm philosophy shall specify the documentation for alarms. This ~~may~~ should include the following:

- a) rationalization information (e.g., a master alarm database), and
- ~~b) periodic alarm performance reports,~~
- b) specifications for advanced ~~alarm management~~ alarming techniques (e.g., designed suppression).
- ~~d) specifications for suppress by design.~~

Other documentation needs ~~may~~ can be identified by the requirements of the different alarm classes.

Appropriate documentation ensures that advanced ~~alarming~~ techniques are implemented consistently, providing expected behaviours to the operator across all modes of operation.

6.2.13 Alarm design guidance

The alarm philosophy shall provide guidance on the design practices. This guidance should address:

- a) alarm deadband,
- b) alarm on-delay,
- c) alarm off-delay
- d) alarm types, and
- e) composition of alarm messages.

6.2.14 Specific alarm design considerations

The philosophy document should specify rules and methods for the design of alarms covering specific circumstances where consistency is important (e.g., bypass alarms and alarms from redundant sensors). Alarm classes may be the source of such specific design considerations.

6.2.15 HMI design principles

~~Documenting the method, format, and coding (e.g., colour, symbol, and alpha-numeric) for alarm presentation to the operator establishes principles for display and annunciation so that they are consistent throughout the plant.~~

~~Specific elements that should be covered in this section include the following:~~

The alarm philosophy shall specify the alarm presentation method to establish principles for consistent display and annunciation.

The following elements should be specified for HMI design:

- a) the alarm presentation method (e.g., colour, symbol, and alpha-numeric),
- b) the mechanism used (~~e.g., panel, BPCS console screens, etc.~~ for example the HMI) to communicate the alarms to the operator,
- c) recommendations for the indications on the HMI of the alarm states (e.g., normal, acknowledged, shelved) that will be used at the facility,
- d) the types of displays that will be used (e.g., alarm summary, first-out, ~~etc.~~),
- e) the functions that will be available in the HMI, including shelving, suppression, and enhanced and advanced alarming techniques.

6.2.16 Approved enhanced and advanced alarming techniques

~~Approved enhanced and advanced alarming techniques and the conditions or criteria for their use, should be identified. Identification of approved enhanced and advanced alarming techniques supports the training of personnel on these techniques.~~

~~Not all sites will use the enhanced and advanced alarming techniques (see Clause 12). If a site does use enhanced and advanced alarming techniques, this section of the alarm philosophy shall be used to identify the techniques to be used and related responsibilities and work processes.~~

If enhanced and advanced alarming techniques are used, this section of the alarm philosophy shall be used to identify the approved techniques and related responsibilities and work processes. Identification of approved enhanced and advanced alarming techniques supports the training of personnel on these techniques. Not all sites will use the enhanced and advanced alarming techniques.

6.2.17 Implementation guidance

~~Defining the basic approach for initial training, commissioning, and checkout of the alarm system facilitates consistency throughout the plant or company. This assures the effective deployment of the alarm system.~~

The alarm philosophy shall specify the methods for initial training, commissioning, and testing of the alarm system.

6.2.18 Alarm response procedures

The alarm philosophy shall address alarm response procedures. Available alarm response procedures can reduce the time it takes the operator to diagnose the problem and take action.

the appropriate corrective action, as well as promote consistency between operators. The philosophy should include the following:

- a) the information included in the alarm response procedures (e.g., cause, consequence, corrective action), and
- b) the method to access the alarm response procedures (e.g., via the operator interface).

6.2.19 Training

The alarm philosophy ~~specifies~~ shall address how plant personnel are to be trained on the use, management, and design of the alarm system, including the training documentation requirements.

The following aspects of training shall be covered in the alarm philosophy or other equivalent documentation for each of the alarm classes:

- a) the ~~job~~ roles or personnel requiring training relating to the alarm system, and
- ~~b) an outline of the training contents, and~~
- b) when training is required.

6.2.20 Alarm shelving

The alarm philosophy should include guidance on how and when alarm shelving can be used, who can perform shelving, as well as authorization and documentation requirements. There are typically limits defined on which alarms can be shelved and shelving duration, based on class or priority.

6.2.21 Alarm system maintenance

The alarm philosophy ~~identifies~~ shall specify the activities necessary to maintain the alarm system. Specific elements ~~that shall be covered in this section~~ for alarm system maintenance shall include the following:

- a) alarm maintenance record keeping,
- b) the requirements for out-of-service alarms, and
- c) the policy on the use of interim alarms.

6.2.22 Testing of ~~the alarm system~~ alarms

~~This section identifies procedures to ensure consistent and adequate testing of the alarm system throughout the alarm lifecycle. Testing applicability, criteria, methods, and frequency shall be thoroughly documented by alarm classes.~~

The alarm philosophy shall address testing based on alarm classes or other methods. Testing documentation may be managed in other systems.

6.2.23 Alarm system performance monitoring

~~Metrics are used to monitor alarm system performance against the target performance levels. This section provides a basis for assessing performance to decide if improvements are required.~~

The alarm philosophy shall specify methods for assessing alarm system performance. Specific elements ~~that shall be covered in this section~~ for alarm system performance monitoring shall include the following:

- a) the objective for monitoring and assessment,
- b) the monitoring metrics and target values,

- c) guidance on frequency to review alarm system performance, and
- d) guidance on the approach to improve performance on the metrics.

6.2.24 Alarm history preservation

~~This section defines what aspects of the alarm history (e.g., annunciations, acknowledgements, return to normal, and operator actions) shall be preserved and the retention period (e.g., incidents, violation of safe operating limits). In some industries and regions, regulatory bodies or local statutes might require preservation of this information.~~

The alarm philosophy should specify the retention of alarm related records (e.g., annunciations, acknowledgements, return to normal, and operator actions). In some industries and regions, regulatory bodies or local statutes might require preservation of this information and tracking of changes to data.

6.2.25 Management of change

The alarm philosophy ~~identifies~~ shall identify the types of changes and the applicable MOC procedures. ~~A management of change procedure shall be documented.~~ Types of changes ~~may~~ can include:

- a) temporary changes to alarms (e.g., taking alarms out of service),
- b) permanent changes to the master alarm database, alarm attributes, or enhanced and advanced alarming techniques.

~~Permanent changes follow a management of change procedure to ensure~~ The MOC procedure ensures that changes made during design, implementation, operation, or maintenance are appropriately evaluated ~~and approved by the~~, authorized ~~parties~~, and documented. This typically includes documented assessment of each change, ~~records of system modifications,~~ description of each change, and authorization.

6.2.26 Alarm ~~system~~ management audit

The philosophy document shall specify the requirements of periodic alarm management audits. These requirements ~~may~~ include:

- a) audit frequency, which ~~may~~ can be specified based on alarm class,
- b) audit topics, and
- c) process for operator interviews.

6.2.27 Related site procedures

~~To avoid inconsistencies between the alarm philosophy and other site procedures,~~ The alarm philosophy should reference relevant procedures. The following documents can be related to the alarm philosophy:

- a) standard operating procedures,
- b) ~~operator~~ training policies and guides,
- c) safety, health and environmental procedures,
- d) maintenance procedures,
- e) alarm handling policies ~~and codes~~,
- f) application programming guidelines,
- g) commissioning or qualification processes and procedures,
- h) MOC procedure, and
- i) other site procedures related to the alarm philosophy ~~depending on the specific site.~~