Engineering Standard

I-SPE-STD-006 Alarm and Event Management

Document number: SPE-00357

Ver No.	Description	Document Owner		Document Approver		
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4	Amended Version	Team Leader Process & Analysis	Refer to supporting Info in Rex	Manager Service Delivery	Refer to supporting Info in Rex	16/04/2024

Version History

Rev	Date	Description	Author	SME	Owner	Approver
1	4/09/2017	Release Version				
2	[Publish Date]	Updated as per Review cycle comments				
3	5/03/2021	Updates to alarm escalation and suppression				
4	12/04/2024	Minor release				

(Refer Controlled Document in REX for Author, SME, Owner and Approver details)

Contents

1. Purpose

This Standard Specification provides the Principal's minimum technical requirements for the implementation, management and ongoing maintenance for Control Systems Alarm and Events at Seqwater. This document must be used in conjunction with the documents it references in order to assist in ensuring a fit for purpose asset.

This Standard Specification is not intended to be relied upon solely for design, supply and installation works; advice from specialist engineers and/or Manufacturers may be required on a case by case basis.

The Alarm System forms an essential part of the operator interface to the Monitoring and Control System of Seqwater. It is envisaged that the implementation and management of the Alarm System shall follow documented industry standards to achieve the desired outcome for the scheme.

2. Application of Standard Specification

This Standard Specification applies to all Seqwater employees, suppliers, contractors and consultants working for, or on behalf of, Seqwater unless otherwise stated. It applies to all new assets and to all existing assets undergoing refurbishment or modification.

Deviation from the requirements in this Standard Specification requires written agreement from Seqwater as per the deviation process detailed in X-PRO-STD-008 Asset Standards Management and Application. This process includes completion of an Asset Standards Deviation Request Form and submission via the Seqwater Project Representative (for external parties) or via Seqwater's Engineering Mailbox (engineering@seqwater.com.au) (for internal parties).

Where noted in this Standard Specification that Seqwater approval or acceptance shall/must be sought, approval or acceptance must be gained through the Seqwater Asset Standard deviation process, as identified above.

Responsibility for ensuring compliance with Seqwater Standard Specifications lies with those engaged in the management and execution of design, construction and maintenance activities on Seqwater assets. This Standard Specification must be used in conjunction with other relevant Asset Standards and project specific documents to define the technical requirements for asset design and construction.

The Contractor maintains responsibility for a fit for purpose design and compliance with all relevant Australian Legislation, Standards, Codes and Guidelines (including those produced by WSAA). Where no Australian Standard exists for a particular application, work must conform to the most current version of an industry accepted international standard.

In the case that it is identified that a specific requirement within this Standard Specification does not meet the requirements of project specific documents, another Seqwater Asset Standard or Australian Legislation, Standards, Codes or Guidelines, the conflict must be brought to the attention of the Seqwater Principal, Engineering Standards and Assurance (or their delegate) via the Engineering Mailbox, and written agreement must be gained prior to application of the requirement.

Advice must be sought from Seqwater to clarify any ambiguities regarding this Standard Specification.

Seqwater undertakes regular updates of Asset Standards. Before utilising this Standard Specification, the complete list of Seqwater Asset Standards should be reviewed, to ensure currency and applicability of standards applied to the works.

3. Definitons

The following definitions (Table Error**! No text of specified style in document.**-1) apply to this Standard Specification.

Table Error! No text of specified style in document.**-1 – Definitions**

Term	Definitions
Acknowledge	The operator action that confirms recognition of an alarm
Activate	The process of enabling an alarm function within the alarm system
Advanced alarming	A collection of techniques (e.g. state-based alarming, and dynamic prioritisation) that can help manage alarm rates in specific situations
Alarm	An audible and/or visible means of indicating to the operator an equipment malfunction, process deviation, or abnormal condition requiring a response.
Alarm attributes (Alarm parameters)	The settings for an alarm within the process control system (e.g. alarm setpoint, alarm priority).
Alarm dead band (Alarm hysteresis)	The change in signal from the alarm setpoint necessary to clear the alarm.
Alarm Escalation	An alarm can be configured to escalate to a higher level based on an event or time period. The escalation level can be combined with the static severity level to dynamically re-prioritise alarms in run-time
Alarm flood (Alarm shower)	A condition during which the alarm rate is greater than the operator can effectively manage. (e.g. more than 10 alarms per 10 minutes)
Alarm group	A set of alarms with common association (e.g. process unit, process area, equipment set, or service).
Alarm historian	The long-term repository for alarm records
Alarm log	The short-term repository for alarm records
Alarm message	A text string displayed with the alarm indication that provides additional information to the operator (e.g. operator action).
Alarm priority	The relative importance assigned to an alarm within the alarm system to indicate the urgency of response (e.g. seriousness of consequences and allowable response time).
Alarm setpoint (Alarm limit, Alarm trip point)	The threshold value of a process variable or discrete state that triggers the alarm indication.
Alarm system	The collection of hardware and software that detects an alarm state, communicates the indication of that state to the operator, and records changes in the alarm state.

Term	Definitions
Alarm type (Alarm condition)	A specific alarm on a process measurement (e.g. low process variable alarm, high process variable alarm, or discrepancy alarm)
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 which does not meet the criteria for an alarm
Allowable response time	The maximum time between the annunciation of the alarm and the time the operator must take corrective action to avoid the consequence
Annunciator	A device or group of devices that call attention to changes in process conditions
Chattering and Fleeting Alarms	A chattering alarm repeatedly transitions between the alarm state and the normal state in a short period of time (e.g. three or more times per minute). Fleeting alarms are similar short-duration alarms that do not immediately repeat. Fleeting alarms come in and clear very quickly
Clear	An alternate description of the state of an alarm that has transitioned to the normal state
Contractor	An entity engaged by Seqwater to undertake work in accordance with an agreed contract and defined scope of work.
Contractor	is the Contractor as defined in the Contract
Control system	A 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
Decommission	The change process to remove an alarm from the alarm system
Disable/ Out-of-service	The state of an alarm during which the alarm indication is suppressed, typically manually, for reasons such as maintenance
eDRMS	Electronic Document and Records Management System
Event	A deliberate change to the process state that is initiated by automatic controls or by a system Operator
Implementation	The transition stage between design and operation during which the alarm is put into service.
Interim alarm	An alarm used on a temporary basis (e.g. in place of an disabled /out-of-service alarm) without completing the management of change process
Manufacturers / Supplier / Vendor / Original Equipment Manufacturer (OEM)	The entity that manufacturers or supplies equipment to meet the specifications of the Contractor.
Master alarm database (MDA)	The authorised list of rationalised alarms and associated attributes
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).

Term	Definitions
Operator (Controller)	The person who monitors and makes changes to the process
Owner / Principal / Seqwater	The entity that engages the Contractor to undertake the work and takes custody of the outcome. The Owner may delegate responsibilities to other entities to act on its behalf (e.g. a consultant).
Plant state (Plant mode)	A defined set of operational conditions for a process plant (e.g. shutdown, operating).
Prioritisation	The process of assigning a level of operational importance to an alarm
Rationalisation	The 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
Remote alarm	An alarm from a remotely operated facility or a remote interface
Reset	The operator action that unlatches a latched alarm
Return to normal	The indication an alarm condition has transitioned to the normal state
REX	Seqwater Electronic Document and Records Management System.
Seqwater Approval / Acceptance	Written sign-off gained via the deviation process, as detailed in X-PRO-STD-008 Asset Standards Management and Application.
Shall	Indicates mandatory requirements
Shall / must	Indicates a mandatory requirement
Shelve	A mechanism, typically initiated by the operator, to temporarily suppress an alarm
Should	Indicates a recommendation
Stale alarm	An alarm that remains in the alarm state for an extended period of time (more than 24 hours)
Standing alarm	An alarm in an active alarm state (e.g. unack alarm, ack alarm)
Station	A single human-machine interface within the operator console
Suppress	Any mechanism to prevent the indication of the alarm to the operator when the base alarm condition is present (i.e., shelving, suppressed by design, disabled/ out-of-service).
Suppressed by Design	A mechanism implemented within the alarm system that prevents the transmission of the alarm indication to the operator based on plant state or other conditions.

4. Abbreviations

The following abbreviations (Table Error**! No text of specified style in document.**-2) apply to this Standard Specification

Table Error! No text of specified style in document.**-2 – Abbreviations**

Abbreviation	Description
CCP	Critical Control Points
EEMUA	Engineering Equipment and Materials User's Association
FAT	Factory Acceptance Test
HMI	Human-Machines Interface
I/O	Input / Output
IEC	International Electro-technical Commission
IEC62682-2014-10	International Standard, Management of alarms systems for the process industries
ISA	Instrumentation Systems and Automation society
ITC	Inspection Test Certificates
ITR	Test & Inspection Reports
MDA	Master Alarm Database
P&ID	Piping (or process) and instrument diagrams
PLC	PLC stands for Programmable logic controller. It is a digital computer used for automation of electromechanical process such as control of machinery on assembly lines or in manufacturing plants (like power stations or water treatment plants etc.)
POPT	Proof of Performance Test
REX	Seqwater's document management system
SAT	Site Acceptance Test
SCADA	SCADA stands for supervisory control and data acquisition system. The major function of SCADA is for acquiring data from remote devices such as valves, pumps, transmitters etc. and providing overall control remotely from a SCADA Host software platform. SCADA Host platforms also provide functions for graphical displays, alarming, trending and historical storage of data
TSI	Technical Support and Improvement
WSAA	Water Services Association of Australia Limited

5. Reference Documents

The documents listed in Table Error! **No text of specified style in document.**-3 and Table Error! **No text of specified style in document.**-4, and the requirements therein, are relevant to this Standard Specification. In their latest editions, these documents form a part of this Standard Specification. Note that this is not an exhaustive list of documents relevant to the works.

Table Error! No text of specified style in document.**-3 – Reference Seqwater Documentation**

Asset Standard Document Number	Document Title	REX Reference
X-PRO-STD-001	Asset Standards Document Classification and Naming Structure	PRO-01873
X-PRO-STD-002	Engineering Drawing Number Procedure	PRO-01872
X-PRO-STD-004	Development and Review of Asset Standards	PRO-01874
X-PRO-STD-006	Equipment Numbering and Naming Convention	PRO-02190
X-PRO-STD-007	Drawing & Spatial Data Standards	PRO-02187
X-PRO-STD-008	Asset Standards Management & Application	PRO-02205
X-PRO-STD-009	Engineering Design, Review and Approval	PRO-01617
X-TMP-STD-022	Asset Standards Deviation Request	TEM-00224
I-SPE-STD-013	Control Systems Design and Construction	SPE-00361
I-SPE-STD-011	Control Systems Testing	SPE-00360
E-SPE-STD-001	Electrical Design and Construction	SPE-00352
X-PRO-STD-015	Management of Change	PRO-02234
I-TMP-STD-007	Inspection Test Certificates for Control Systems	TEM-00212
I-TMP-STD-008	Master Alarm Database Template	TEM-00254

Table Error! No text of specified style in document.**-4 – Reference External Standards, Specifications and Codes**

Standard/Specification	Document Title
Publication No 191 ISBN 0 85931 155 4	EEMUA - Alarm Systems - A Guide to Design, Management and Procurement
ANSI/ISA-18.2-2009	Management of Alarm Systems for Process Industries
WSA 302 – 2016-1.1	Supervisory Control and Data Acquisition (SCADA) Guideline
IEC62682-2014-10	International Standard, Management of alarms systems for the process industries 2014

6. Alarm Philosophy

6.1. Purpose of Alarm System

An alarm system is the collection of hardware and software that detects an alarm state, communicates the indication of that state to the operator, and records changes in the alarm state.

The alarm system is an integral part of the SCADA system. The control system monitors the plant and equipment condition, and then annunciates the alarm when a predetermined alarm condition is active. Vital support is provided to the operators by the alarm system warning them of situations that require their attention. It also has an important role in preventing, controlling and mitigating the effects of any abnormal situations. To achieve this, the alarm system should direct the operator towards plant conditions requiring timely attention or action. The alarms should be configured to alert, inform and guide the operator to the cause of a disturbance or abnormal situation. The alarm system should log all alarms and events with the requirement for them to be stored for reporting and analysis.

The alarm system serves to notify operators of abnormal process conditions or equipment malfunctions. It includes 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. The alarm system also includes an alarm log and a mechanism for communicating the alarm information to the operator via SCADA, usually a computer screen or an annunciator panel. There are other functions outside the alarm system that are important to the effectiveness of the alarm system, such as alarm historian and alarm dial-out system.

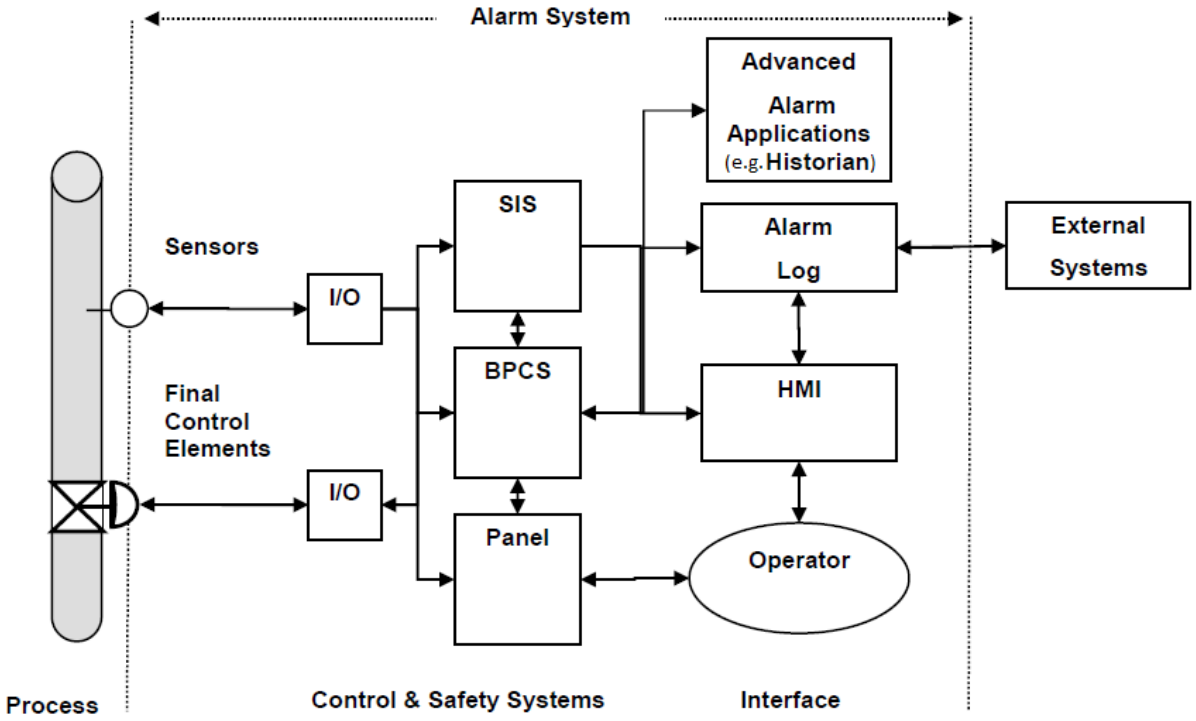

Figure Error! No text of specified style in document.**-1 Alarm System Data Flow**

6.2. Life Cycle Management of Alarms

The alarm management system is crucial to safe and productive operations. An effective alarm management system will:

- Reduce unplanned downtime;
- Increase safety;
- Improve operator effectiveness;
- Improve process performance and yields.

6.2.1. Alarm Management Lifecycle Model

The ISA 18.2 standard defines the Alarm Management Lifecycle which covers alarm system specification, design, implementation, operation, monitoring, maintenance and change activities from initial conception through decommissioning. The lifecycle model is useful in identifying the requirements and responsibilities for implementing an alarm management system. The lifecycle is applicable for the installation of new alarm systems or managing an existing system. Figure 5-2 illustrates the relationship between the stages of the Alarm Management Lifecycle model.

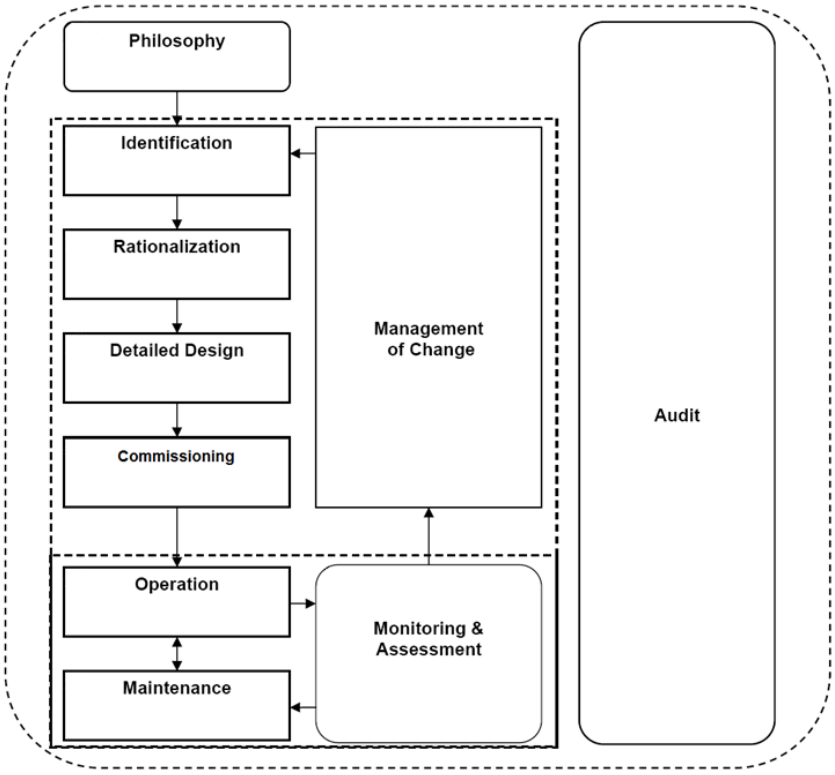

Figure Error! No text of specified style in document.**-2 Alarm Management Lifecycle**

6.2.2. Alarm Management Lifecycle Stages

The alarm management lifecycles shown in Figure 5-2 is divided into the following stages:

a. Philosophy – defines the processes and terms to be used during the design, implementation and maintenance of the alarm system.

b. Identification – collection of potential alarms for the alarm system.

c. Rationalisation – reconciles the need for an alarm and generates the supporting documentation for the alarm.

d. Detailed design – provides guidance on basic alarm design, HMI design and advanced alarm techniques.

e. Commissioning – is the rollout of both hardware and software that comprise the alarm system and verification of its function.

f. Operation – the alarm system is performing its intended function and includes operator training.

g. Maintenance – includes periodic testing or maintenance necessary to ensure the function of alarms.

h. Monitoring and assessment - methods used to evaluate the effectiveness of the alarm system.

i. Management of change – modifications to the alarm system are proposed and approved.

j. Audit – periodic reviews to maintain the integrity of the alarm system and identify areas of improvement.

6.2.3. Alarm Management Lifecycle Loops

In addition to the lifecycle stages, there are three distinct loops within the lifecycle where different lifecycle stages interact.

These loops are as follows:

a. 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.

b. Monitoring and Management of Change Loop - The operation, monitoring and assessment, management of change loop is triggered when routine monitoring indicates an alarm is working per design, but is not compatible with the alarm philosophy. The design may need to be modified or an advanced alarm technique may need to be applied. The alarm may remain in operation while the management of change process is initiated and the stages of the lifecycle are repeated.

c. Audit and Philosophy Loop - Audit and philosophy loop is the process of continuous improvement of the alarm system. The audit process shall identify any shortfalls in the lifecycle stages. This will ensure that Alarm System continues to meet the requirements of the operator in the future.

6.2.4. Alarm Management Lifecycle Stage Inputs and Outputs

Table 5-1 provides more information on the relationship between the inputs and outputs of the alarm management lifecycle stages and how each stage connects to others.

Alarm Management Life Cycle Stage	Activities	Inputs	Outputs & Deliverables
Philosophy	Define processes and terms for alarm management	Objectives and Standards.	Alarm philosophy
Identification	Determine potential alarms	HAZOP report, risk assessments, P&IDs, operating procedures, etc.…	List of potential alarms
Rationalisation	Rationalisation, classification, prioritisation and documentation	Alarm philosophy, and list of potential alarms.	Master alarm database
Detailed Design	Basic alarm design, HMI design and advanced alarm techniques	Master alarm database	Completed alarm design
Commissioning	Install alarms, initial testing, and initial training	Completed alarm design and master alarm database	Operational alarms, alarm response procedures
Operation	Operator responds to alarms, training	Operational alarms, alarm response procedures	Alarm response actions
Maintenance	Maintenance repair and replacement periodic testing	Alarm monitoring reports and alarm philosophy	Repaired Alarm
Monitoring & Assessment	Monitoring alarm data and report performance.	Alarm data and alarm philosophy	Alarm monitoring reports, proposed changes
Management of Change	Process to authorise additions, modifications, and deletions of alarms	Alarm philosophy, proposed changes	Authorised alarm changes
Audit	Periodic audit of alarm management processes	Standards, alarm philosophy and audit protocol	Recommendations for improvement

Table 5 1 Alarm Management Lifecycle stages Inputs and Outputs

6.3. Role and Responsibilities for Alarm Management

The design process for any alarm should be carried out with representation from operations, engineering and maintenance to ensure a suitable business focus. The developer of the alarm system, alarm philosophy and related documents shall be defined at the beginning of the design process. However, once the alarm system is implemented, there are two distinct roles in the operation and engineering / maintenance of the system. These roles are as follows:

a. The operations role is a user of the system and utilise the alarm system as a tool in the operation of the process plant.

b. The engineering / maintenance role manage, maintain and provide technical support for the alarm system.

6.3.1. Operations

The operator has the task of the safe operation of a process plant, pipeline or scheme. The alarm system provides feedback to the operator when the process moves from a normal to an abnormal situation. There is a responsibility for the operator to respond to the alarm system in order of alarm priority. The higher priority alarms shall provide adequate time for the operator to respond in the manner set out in the alarm design documentation or operator manual, to bring the process back to an acceptable state. To achieve this, operations personnel shall be trained to react with the appropriate response or action to realistic operation of the control system.

6.3.2. Engineering

Any alterations to the alarm system shall follow a change management process for modification of existing alarms and all new alarms subject to the design process. If there are regular discrepancies for the same alarms, then this should instigate a review of that alarm's design.

6.3.3. Maintenance

The regular review of alarm reports shall give a snapshot of the of the alarm system but shall also highlight the areas and alarms that require further analysis. This analysis shall determine whether the alarms were due to a design / tuning problem or an operational issue. There shall be a regular comparison of alarm settings against design settings to ensure the alarm system is being operated as per the design.

6.4. Key Design Criteria for Alarm Generation

The alarm system is one of the core support tools for operators to safely operate the processing plant and swiftly respond to process issues. The purpose of an alarm system is to direct the operator's attention towards plant conditions requiring timely assessment or action. Therefore, the key design principle of the alarm generation shall be centered on usability and information efficiency.

The Contractor must use the following criteria to design an effective alarm system:

a. The alarm is contextually relevant, pinpoints the root cause

b. Alarm is not spurious or of low operational value.

c. The alarm is unique.

d. The alarm provides adequate time for response. (as shown in Figure 3 4) with the exception of alarms indicating fault.

e. The alarm is prioritised such that problems with more severe consequences are identified and rectified first.

f. The alarm description is clear and unambiguously conveys its intended message.

g. The alarm shall allow the operator to diagnose the problem and identify exactly what has occurred.

h. The alarm shall be indicative of the action required by the operator.

i. The alarm shall draw the attention of the operator to the most important issues.

j. Field alarm inputs to the PLC shall use a closed contact for the normal condition, such that a loss of power or broken wire of the input will activate the alarm. Where the alarm input connects to a relay, the relay shall be energised under normal conditions and a normally open contact used so that failure of the relay or the relay power supply shall generate an alarm. Alarms are to be conditioned on Power status, so large amounts of alarms are not generated on power failure.

k. If an Alarm has halted a process or equipment, it shall be required to be acknowledged before equipment is reset and safe operation is resumed.

l. Alarm reduction philosophies, such as consequential alarm suppression (defined in section 6.2.2), shall be employed to ensure that the number of alarms resulting from any one incident is minimised, generally to one alarm. This shall still leave associated events in the log file for future analysis.

m. Major incidents such as loss of power to an area or the whole plant shall be accommodated by the software to ensure that under no circumstances shall more alarms be generated than are necessary to clearly identify the source of the problem.

n. Alarms shall have a facility to record operator notes on a per alarm basis and the ability to review the note history.

o. The alarm system must support the ability to filter active alarms by type, name and time/date.

6.5. Process Conditions Model for Alarm Generation

The Contractor shall follow the process condition model during the detailed design stage to identify and generate alarms.

The process condition model in Figure 5-3 (source from ISA18.2) shows the process conditions boundaries from target and normal conditions to the abnormal conditions of upset and shutdown or disposal. The indications and warnings in the model are not necessarily alarmed unless alarms are wanted and rationalised.

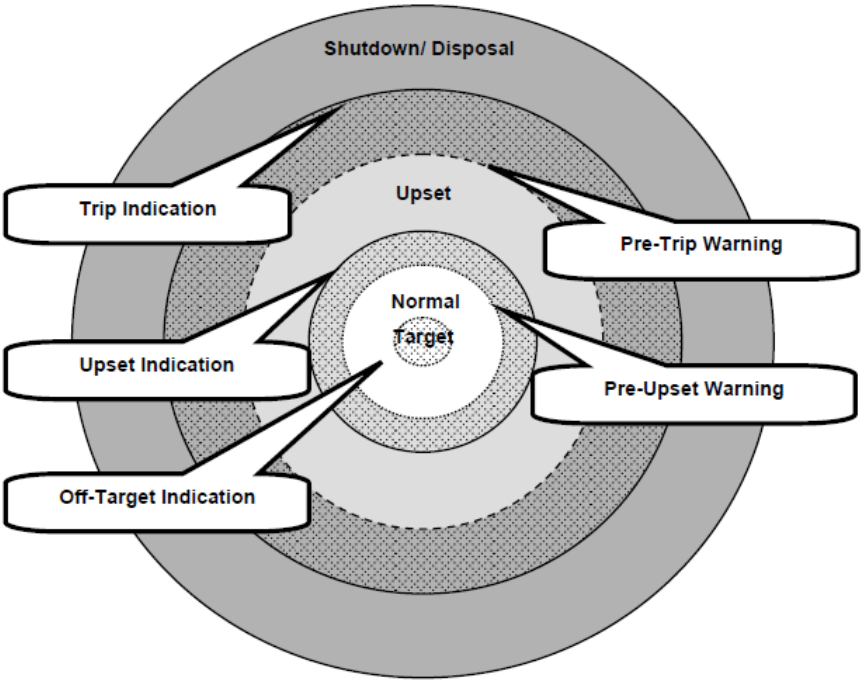

Figure Error! No text of specified style in document.**-3 Process Condition Model**

The design process for any alarm should be carried out with representation from operations, engineering

The process conditions shown in Figure 3 3 are described as follows:

a. Target – The target range is the set of optimal operating conditions within the normal range. These conditions may reflect highest yield, lowest cost, or target capacity operation of the process. Optimal conditions usually apply to only a subset of process variables. The target range may change with time or operating condition.

b. Normal - The normal range of operation is the expected operating envelope around the optimal target value. The normal range is sometimes called standard operating conditions.

c. Upset – The upset condition is an abnormal condition that may result in off-quality material, nonstandard product, increased emissions, or may lead to more severe consequences.

d. Shutdown / Disposal – The shutdown or disposal condition is the result of manual or automatic functions to avoid unacceptable operating conditions or unacceptable product.

The alarm system typically responds when the process conditions deviate from pre-determined normal or target boundaries. This would generally indicate an abnormal condition, a process upset and/or trip. The type of conditions that generate alarms, if the alarm has been rationalised is as follows:

e. Off-target indication - The off-target indication is triggered at the boundary of the target operating envelope. These indications provide the notification that a process variable is still in the normal range and is no longer in the optimal target range.

f. Pre-upset warning - The pre-upset warning provides advance notice of abnormal conditions. Where upset or nonstandard conditions have significant consequences (e.g. equipment damage or off-quality product), there may be a warning that provides enough time to avert the upset conditions.

g. Upset indication - The upset condition indication provides notification of the upset condition. When a pre-upset warning is not justified, this may be the first notification of an abnormal condition. Where pre-upset warnings are provided, the upset condition indication may be a confirmation of upset operation such as off-quality material or a permit violation.

h. Pre-trip warning - The pre-trip warning provides an opportunity to avoid the shutdown trip or condition that requires disposition of the product. Not all process indications provide warning of trip conditions. The term trip may refer to an emergency shutdown of a plant or a local process interlock on a single piece of equipment.

i. Trip indication - The trip indication provides an indication that a shutdown has occurred or a disposition limit has been violated. The disposition limit is the point of no return after which a product is unusable. Post-trip alarms may indicate the need for further action (e.g. failure of the trip function).

Typically for an analogue variable the high high (HH) and low low (LL) alarms will annunciate a “Trip Indication”. In this situation they would be used as trip interlocks in part of the control system. Where high (H) and low (L) alarms would annunciate either an “Upset Condition” or a “Pre-trip Warning” depending on the desired use of the alarm.

6.6. Alarm Response Time

The Figure 5-4 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. Using this figure, it is possible to map some states to this timeline to clarify the definition of terms related to time.

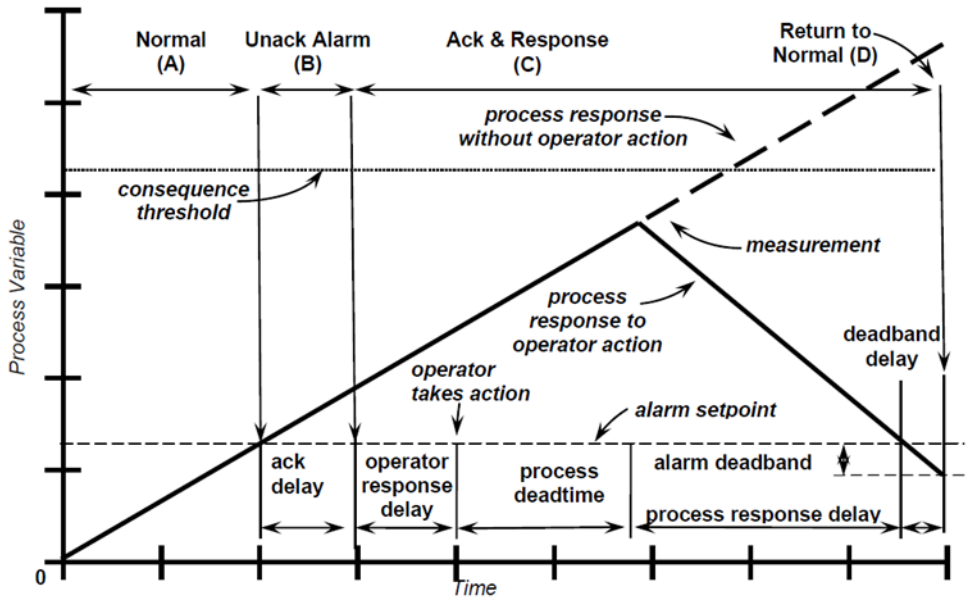

Figure Error! No text of specified style in document.**-4 Typical Response Time for a Process Alarm**

a. Normal (A) – The normal state is when the process is operating within normal specifications, the alarm is clear and all past alarms have been acknowledged.

   Unpack Alarm (B) – The unacknowledged alarm state results when the measurement crosses the alarm setpoint. There are several factors that affect the uncertainty of the alarm trigger time such as measurement accuracy, alarm delay time.

b. Pack & Response (C) – The acknowledged alarm state is reached when an operator acknowledges the alarm condition, after the acknowledge delay. In this state the alarm has not cleared. There are several factors that affect the uncertainty of the operator response time such as system processing speed, HMI design and clarity, operator awareness and training, operator workload, complexity of determining the corrective action, complexity of the corrective action. From the time the alarm is triggered until the operator takes the correct action is the actual response time for the alarm, or operator response delay. It includes the detection of the alarm, the diagnosis of the situation and determination of the corrective 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.

c. Return to normal (D) – The return to normal alarm state results from the correct operator action within the allowable response time. There are several factors that affect the uncertainty of the return to normal time. These include: the operator response delay, the degree of action taken, the process deadtime in response to the corrective action, the process response time to the corrective action, the accuracy of the process measurement, the deadband of the alarm setpoint, the operational speed of the alarm system.

d. Consequence Threshold – The consequence results when no operator action is taken, the 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. The total time from the alarm to the consequence threshold includes the acknowledge delay, the operator response delay, the process deadtime, and the process response delay.

7. Identification of Alarms

This section identifies the principles to be used in determining potential alarms for the alarm system or a change to an alarm. As part of the design process, the information collected should be clearly defined and formally documented. Identified alarms are the inputs to alarm Rationalisation stage. Alarm identification shall be done before alarm rationalisation.

The Contractor shall use the following procedures and documents to identify alarms.

a. Hazard and operability studies (HAZOPs),

b. Risk assessments,

c. P&ID reviews,

d. Operating procedures reviews,

e. Functional specifications,

f. Equipment manufacturers recommendations,

g. PLC & SCADA diagnostics,

h. Safety systems cause and effects matrices,

i. Incident investigations.

All identified alarms shall be recorded in Master Alarm Database and must be submitted to the Principal for review during the alarm rationalisation stage. The Principal reserves the right to require justification for the inclusion/omission of alarms from the Master Alarm Database.

The contractor shall use the I-TMP-SPE-008 Master Alarm Template for generating the Master Alarm Database.

8. Alarm Rationalisation

Rationalisation is the process to review potential alarms list generated in the Alarm Identification stage using the principles of the alarm philosophy, to select alarms for design, and to document the rationale for each alarm. Rationalisation produces the detail design information necessary for the design stage of the alarm lifecycle.

This information shall be correlated in the form of a master alarm database.

Contractor shall use the following information for each alarm to rationalise the alarm:

a. What is the root cause(s) of the alarm activation? Is the event a consequence of non-steady-state normal operation? (This will identify if any alarm suppression is required)

b. What is the consequence(s) of no action? Is there enough time to respond?

c. What response(s) is required? (If there is no operator response required there is no alarm, it may therefore be added as an event).

d. Is the alarm description correct and logical to the operator?

e. Is the deadband (if used) appropriate?

f. Is the priority appropriate?

g. Is the method of alarm annunciation fit for purpose?

h. Identify any procedural / housekeeping changes required.

i. Document the results in the Master Alarm Database (details in section 5.1).

j. The developed alarm response procedure.

8.1. Master Alarm Database

The Master Alarm Database is the output of alarm Rationalisation process and contains the alarm configuration requirements. The Principal and the Contractor shall use the I-TMP-STD-008_Master Alarm Database Template as the Master Alarm Database template for alarm rationalisation.

The Master Alarm Database shall include all the process alarms, diagnostics alarms and events. The following information for each alarm shall be addressed in addition to the details in Master Alarm Database:

- Hierarchical alarm requirement and trigger condition
- Corrective actions
- Allowable response time

The Master Alarm Database template (I-TMP-STD-008) shall be used to determine the CCP (critical and action) alarm setpoints, alarm delay and shutdown actions.

The Master Alarm Database is the single source reference for the alarm system. It shall be readily available to the operators, so that appropriate corrective actions can be initiated by the operators when an alarm is activated.

8.2. Alarm Prioritisation

The prioritisation of an alarm shall be determined by two factors:

a. Consequences of inaction or incorrect action; and

b. Time available for the operator response to take corrective action to prevent to consequence.

8.2.1. Priority

The alarm priority will highlight the severity of the alarm to the operator and the requirement for the operator to respond to it.

While the Seqwater alarm system has five (5) alarm priorities, there are only four (4) annunciated alarm priorities with the fifth being an event. The event type is not annunciated and only appears in the Alarm/Event Summary Page.

The alarm priority types are list in Table 5 1:

Alarm	Description	Application
Priority 1	Critical	CCP Critical or Plant Critical
Priority 2	Action	CCP Action or Plant Action
Priority 3	Warning	Non-Urgent alarms
Priority 4	Information	Information alarms
Priority 5	Event	Operator Setpoint entries, device start and stop state, Mode change from Remote Auto to Remote Manual and vice-versa

Table 7 1 Alarm Priority

The alarms shall be prioritised with the following categories where priority one (1) or Critical alarms shall be the highest priority with priority four (4) or Information alarms the lowest:

a. Critical – alarms indicating a fault that indicates a complete loss of control for an entire facility or area (for example: plant shutdown; loss of power; plant fire evacuation etc.). These are alarms that require immediate action by Operators to correct an abnormal condition.

b. Action – alarms indicating a fault that indicates a loss of control of the system (for example: high-high and low-low level alarms, overflow alarm, two pumps failed, loss of communications, loss of operational control). These are alarms that require timely action by Operators to correct an abnormal condition.

c. Warning – alarms indicating an impending fault that may cause loss of system control if the root cause is not addressed quickly (for example: single pump fault, high level and low-level alarms, loss of redundant communications path, loss of redundant server). These are alarms that require timely action by Operators to prevent an abnormal condition.

d. Information – alarms indicating a fault that requires maintenance but will not affect the operation of the system. These are alarms that require timely action by Operators and others to prevent an abnormal condition at some time in the future.

Contractor shall refer to the below guidelines to distribute alarms in different alarm priorities ranges.

e. Critical – <1% of the total alarms in the process system

f. Action – < 5% of the total

g. Warning – <15% of the total

h. Information – 80% of the total

Where a potential alarm does not meet the requirements of the priority matrices then it shall be configured as an event. Similarly, if there is a need to capture information about devices or the system then it shall also be configured as an event. This ensures the operator will only view the alarms they are required to respond to.

In order to determine an alarm's priority, the consequences of an alarm (across all areas) need to be addressed. This can be determined by assessing each category against the question "How severe are the consequences if the alarm occurs and no Operator action is taken in response?" This will determine if the consequence is Insignificant, Minor, Moderate, Major or Catastrophic.

8.2.2. Time Factor

The next step to generate alarm priority is to determine the time available for an operator to respond. The Response Time is how much time is available to take effective action from when the alarm is presented to the Operator, to when the consequences become unavoidable, regardless of the action. The table below matches the likelihood categories from the Seqwater Risk Matrix with a response time:

Likelihood	Description	Response Time
Almost Certain	The event is expected to occur in most circumstances	Within 1 minute
Likely	The event will probably occur in most circumstances.	Within 5 minutes
Possible	The event might occur, but not expected to occur under normal circumstances.	Within 15 minutes
Unlikely	The event could occur at some time, but only in unusual circumstances	Within hours
Rare	The event could occur only in exceptional circumstances	Events only

Where alarm dialler systems are required, consideration of the time it takes for Operation action needs to be determined, as the use of such systems may increase the response time.

8.2.3. Determining Alarm Priority

Once the above two factors have been determined, the following Table 7-1 shall be used to determine alarm priorities. The priority for each alarm shall be determined by the following process:

1. Determine the severity of the consequences that will occur if no action is taken in response to the alarm

2. Determine the time available for the Operator to successfully respond to the alarm to avoid those consequences.

Response Time	Likelihood	Consequence: Insignificant	Consequence: Minor	Consequence: Moderate	Consequence: Major	Consequence: Catastrophic
Within 1 minute	Almost Certain	Warning	Action	Action	Critical	Critical
Within 5 minutes	Likely	Warning	Warning	Action	Action	Critical
Within 15 minutes	Possible	Information	Warning	Warning	Action	Action
Within hours	Unlikely	Information	Information	Warning	Warning	Action
Events only	N/A	Event	Event	Event	Event	Event

Table 7 - 1 Determining Alarm Priority

8.3. Events

The fifth priority of alarm in the Seqwater alarm system is defined as an event. The events do not require rectification and are generated by a change in state to any equipment / process / system and display in the Alarm/Event Summary Page. The event has following characteristics:

a. Nothing for the operator to do to correct the condition

b. Event is not an indication of a problem

c. No consequences if no response is taken

d. Same problem indicated elsewhere (i.e. more than one alarm for one root cause)

Refer to I-SPE-STD-013 Control Systems Design and Construction standard for the detailed Events design and history preservation requirements.

9. Detail Design of Alarms

9.1. Design Basis of Alarm

The alarm condition shall be the logic state description for digital signals, or the type of alarm (high, low, etc.) for analogue signals.

Priority 1 and priority 2 alarms should be configured with audible alarms to further highlight an abnormal situation or operators. Refer to further requirements for audible alarms and alarm diallers specified in I-SPE-STD-013 Control System Design & Construction standard.

The alarm system shall be configured to have the following alarm states:

a. Alarm is active and unacknowledged,

b. Alarm is active and acknowledged

c. Alarm is inactive and unacknowledged,

d. Alarm is inactive and acknowledged,

The alarm messages shall meet the following requirements:

e. Clearly identify the situation that has occurred,

f. Be in the terms that the operator is familiar with,

g. Uses standard abbreviations from a standard glossary,

h. Uses a consistent message structure,

i. Unambiguously identify the asset / tag name under alarm.

Where there is an alarm message relating to analogue limits, the message shall have the alarm setpoint as part of the alarm description to indicate the alarm trigger point to the operator via the alarm pages.

Where Deadband is utilised, the table below provides recommendations which represent a starting point for common processes for both on-delay times and Deadband percentages:

Signal Type	Signal Type Delay Time (on delay)	Deadband (% of range)
Flow	15s	5%
Level	60s	5%
Pressure	15s	2%
Temperature	60s	1%

Table 8 - 1 Alarm Deadband & Alarm Delay Time Recommendations

9.1.1. Displaying Alarm

The requirements to display alarms on SCADA graphics and the color convention and symbols to be used for alarm priority shall be developed as described in I-SPE-STD-013 Control System Design & Construction standard.

9.1.2. Filtering Alarms

Alarm filtering and alarm groups shall be configured as per the requirements specified in I-SPE-STD-013 Control System Design & Construction standard.

9.1.3. Alarm Logging

Alarm filtering and alarm groups shall be configured as per the requirements specified in I-SPE-STD-013 Control System Design & Construction standard.

The alarm system shall be configured to record all alarms and events for performance reports and post-incident investigation as defined in I-SPE-STD-013 Control System Design & Construction standard for alarms and events history retention requirements.

9.2. Alarm Flood Suppression

While there are a number of ways to reduce the impact of alarms and flooding of alarms to the operator, the advanced techniques that are preferred in achieving this are detailed as follows:

a. When an alarm is designed, if it is identified as being consequential under certain operational modes (i.e. low flow alarm when the pump(s) are not running, consequential alarms during a major plant trip) then these alarms shall be suppressed under those conditions. The intention is to keep the initiating alarm in the operator focus.

b. Disabled – suppresses alarms when plant or equipment is out of service.

c. If a plant/equipment operational mode changes – shutdown, startup, steady operation, batching and plant maintenance, alarms that are likely to trigger during non-steady state operations shall be suppressed during the process. Alarms that are not relevant in the current mode of operation, such as during start-up or from offline equipment, shall be suppressed or their trip point shall be changed to minimise unnecessary standing alarms.

d. Model based – This allows the setpoints to be predictive due to a process model; e.g. a low flow alarm for a pump set will change depending on the number of pumps running.

e. Operator shall have a privilege to disable nuisance alarms.

f. Filtering of noisy signals – debouncing, filtering of analogue signals, the use of deadband, instance counting or temporary disabling shall be used with prior approval from the Principal.

Following subsections provide requirements for configuring of alarms, whenever it is specified in design.

9.2.1. Alarm masking

Alarm masking shall be handled in the PLC . When a fault condition causes multiple alarms to the system, these superfluous alarms shall not be displayed to the operator. An example of this is when an input or output card faults on a PLC. In this case, a single alarm is generated to alert the operator that a PLC I/O module is in fault, masking individual channel alarms and/or individual device alarms that are wired into the faulted module. Alarms that have been masked shall be retained in the Alarm/Event Summary Page as consequential alarms to aid trouble shooting of faults.

Similarly, when there is an I/O rack failure, all the corresponding I/O modules and I/O channels contained in that rack shall be masked to show just one I/O rack failure alarm.

9.2.2. Consequential Alarm Suppression

The consequential alarm suppression shall be implemented in the PLC. Wherever possible the alarm that is presented to the Operator shall be the best possible indicator of the root cause of the problem. In order not to overwhelm Operators with alarms that do not provide the best possible indicators of the root cause, such alarms shall be suppressed from presentation in the alarm banner and active alarm window. These alarms are known as suppressed by design and shall be configured as consequential alarms as defined for intelligent suppression of alarms and events in I-SPE-STD-013 Control Systems Design and Construction standard for PLC programming requirements on alarm suppression. Where alarms are designed as suppressed, the suppression configurations shall be compiled into the Master Alarm Database. The suppressed consequential alarms shall meet the following requirements:

a. not be displayed in the Alarm Banner and Active Alarm Page

b. be logged as an event and be visible in the Alarm Summary/Events Page,

c. display their underlying assigned Category and Priority

d. be able to be filtered and sorted to allow trouble shooting of faults

e. be able to be logged as a consequential alarm

An example of alarm suppression configuration is shown in the table below:

Parent Alarm	Child Alarm 1	Child Alarm 2	Child Alarm 3
Maintenance Mode			
	Power Supply Failure		
		Pump unavailable	
			Pump Low Flow Alarm
			Pump Motor Trip

Table 8 - 2- Alarm Suppression Configuration Example

In the above example, if the Parent alarm is active; then the Child 1 to 3 alarms will be suppressed. If the Child 1 alarm is active then all the Child 2 to 3 alarms will be suppressed. If the Child 2 alarm is active then all the Child 3 will be suppressed etc.

9.2.3. Hierarchical Alarms

A Hierarchical alarm is a summary alarm of a process area or assets which can monitor a mixture of single or children alarms. When the amount of children alarms are shown and exceed the threshold (e.g. more than 1), the children alarms shall be suppressed and the hierarchical alarm is shown to the operator and assigned with the highest active child alarm's priority.

For diagnostic purposes, the active children alarm that triggered the hierarchical alarm shall be logged as events and displayed in the Alarm Summary/Events Page. In the instance of only one child alarm arising, the child alarm itself is shown to the operator. This method limits the number of alarms shown to the operator.

Hierarchical alarm indication requirements can be on mimics/navigation pages only.

Figure 6 1 below illustrates an example of the hierarchical alarm tree from a raw water system comprising three raw water pumps and an air compressor. In this example Raw Water Pump 1 has 3 alarms being triggered; Raw Water Pump 2 has two alarms; Raw Water Pump 3 has one alarm; Air Compressor does not have any alarms. With threshold (>1 alarm) is set, only the top alarm (i.e. Raw Water System Fail Alarm) will be shown to the operator. Without the hierarchical alarm configuration, 6 alarms will be displayed on the Active Alarm Window. The red box = critical alarm, yellow box = action & warning alarms, green box = no alarm.

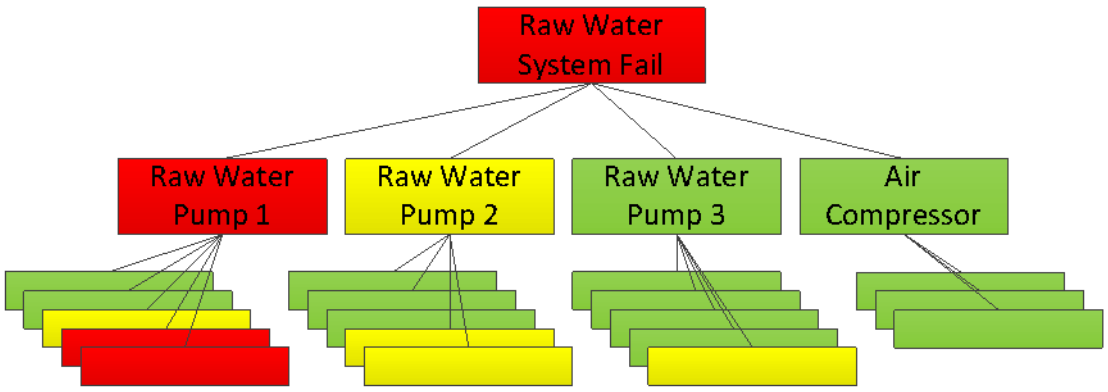

Figure Error! No text of specified style in document.**-5 Hierarchical Alarm Configuration Example**

9.2.4. Alarm Shelving

In order to deal with either malfunctioning alarms or malfunctioning equipment, there shall be a mechanism in place for an Operator to temporarily suppress alarms (this is known as “shelving”).

In Seqwater alarm shelving can be achieved by taking the malfunctioning equipment in “Disable “mode. Refer to I-SPE-STD-013 for further details of Equipment disable mode. The alarm shall be disabled and re-enabled as per User Roles and Privileges Levels of I-SPE-STD-013 Control Systems Design and Construction. Disabled alarms shall be displayed on the Disabled Alarm Page.

9.3. Alarm Escalation

This section is alarm escalation design requirements when identified in the design. The alarm response begins when the alarm condition is indicated to the Operator. In the event that an Operator fails to acknowledge an alarm within a given time, the alarm priority is escalated one level. The system then triggers the alarm indication appropriate to that priority level.

Table 8-3 provides the recommended times that an alarm can remain unacknowledged before being escalated. Refer to I-SPE-STD-013 Control System Design & Construction standard for alarm escalation configuration requirements.

Alarm Priority	Category	Time Unacknowledged Before Escalation
Priority 1	Critical	20 minutes
Priority 2	Action	40 minutes
Priority 3	Warning	60 minutes
Priority 4	Information	120 minutes

Table 8 - 3 Alarm Escalation Times

10. Commissioning

Commissioning of the alarm system requires a completed system design and the generation of Test & Inspection Reports (ITR), Inspection Test Certificates for Control Systems (ITC) and Operator Response procedures.

The standard, I-SPE-STD-011 Control System Testing, details the requirements for all ITR documents used during FAT, SAT and POPT activities which shall be followed by the contractor.

Designers must use ITC template, I-TMP-STD-007 Inspection Test Certificates for Control Systems as a start point for the development of project specific ITCs.

All alarms from the rationalised Master Alarm Database require a corresponding ITC. The following alarm/events information must be detailed within the ITC:

a. Alarm display (on alarm banner, active alarm window and summary alarm window)
b. Alarm description
c. Alarm setpoint/deadband or logical conditions
d. Alarm delays

e. Alarm priority
f. The audible and visual indications for the alarm
g. Any other functional requirement for the alarm as specified
h. Alarm filtering
i. Linking of alarms to process graphics
j. Alarm redundancy
k. Alarm masking / suppression (if applicable)
l. Alarm shelving (if applicable)
m. Alarm escalation (if applicable)
n. Alarm help (if applicable)
o. Remote alarm dial-out function (if applicable)
p. Alarm/event historical logging

The ITR and ITC documents will also be part of any periodic alarm system maintenance. Refer to section 9 Maintenance of Alarms of this document for details. The commissioning of the alarm system ends with the project handover to Operations. At this time the monitoring and assessment phase will commence.

11. Operation of Alarms

The operation stage is where the alarm system is in service and the operator is expected to respond to alarms. The Alarm system integrator must provide competency-based training to Seqwater Operators, Control System Maintenance Engineers and site Process Engineers in the operation of the alarm system.

11.1. Training

All training delivered by the alarm system integrator must address the following:

a. Use of the alarm system
b. Understanding the Operations and Maintenance manual
c. Understanding the Master Alarm Database
d. System features (e.g. alarm masking / suppression, alarm shelving)
e. Response actions to the alarms
f. Alarm system performance reports

The Principal must ensure conduct additional training including the following:

g. Monitoring and Control System Alarm and Event Management standard (this document)
h. How alarms affect Standard Operating Procedures
i. Alarms that affect Safety, Health and Environmental procedures
j. Alarm handling policies and codes

k. Maintenance procedures

l. Management of change procedure

m. Alarm system audits

11.2. Alarm Response Procedure

The alarm response procedure, Operation and Maintenance Manual and the Master Alarm Database completed in alarm the Rationalisation stage must be readily accessible to the Operators during the alarm response stage.

11.3. Shelved Alarm Review

Out of service alarms must be reviewed at the beginning of each shift.

A weekly review process shall be undertaken to determine whether the disabled alarms will continue being disabled or be re-enabled.

12. Maintenance of Arms

12.1. Disabled/ Out-of-service Alarms

There is a requirement to manage the maintenance of the devices that instigate alarms in the system. As part of this maintenance, the alarms related to these devices need to be managed in and out of service when these tasks are being carried out. The contractor must document the process an alarm can be disabled or taken out of service for maintenance and testing then returned to service once these activities are complete. This procedure must detail the following information:

a. Method of taking alarm out of service

b. Identifying equipment effected by alarm and test

c. Method of testing

d. Recommended and Required Test Interval

During maintenance, if the device is replaced and the replacement will change operating conditions or the alarm attributes, the Management of Change process (X-PRO-STD-015) must be followed.

When tests are carried out, an electronic record of the test shall be stored in the Seqwater REX eDRMS with the project Master Alarm Database for at least a one-year period or unless superseded. The record shall include the following information:

e. Approval details.

f. Date of testing.

g. Expected duration.

h. Name of person carrying out the test.

i. Equipment number from where the alarm is generated.

j. Details concerning interim alarms or procedures if required.

k. The reason for disabling the alarms or taking the alarm out-of-service.

l. Procedure to take the alarm out of service and take the alarm back in service.

m. Results of test.

I-TMP-STD-007 Inspection Test Certificates for Control Systems shall be used for out of service alarm testing. The test result shall be stored in the same location of the project Master Alarm Database for at least a year.

Where alarms are to be placed out of service for extended periods (more than a week) a review is required to determine whether an alternative alarm is necessary. If an interim alarm is necessary then it shall follow the Management of Change process (X-PRO-STD-015).

13. Monitoring and Assessment

The Monitoring and Assessment stage verifies that Design, Implementation, Rationalisation, Operation and Maintenance activities have resulted in satisfactory system performance.

13.1. Alarm System KPIs

The use of Key Performance Indicators (KPI's) will provide a measurable indication of the alarm systems performance and an indication of the result of plant changes. The following tables detail the international standard KPIs for an alarm system by alarm rate (source from ISA 18.2).

Alarm Performance KPI **Based upon at least 30 days of data**		
KPI : Annunciated Alarms per Time	**Target Value: Very Likely to be Acceptable**	**Target Value: Maximum Manageable**
Alarms Per Day	~150 alarms per day	~300 alarms per day
Alarms Per Hour	~6 (average)	~12 (average)
Alarms Per 10 Minutes	~1 (average)	~2 (average)

Metric	**Target Value**
Percentage of 10-minute periods containing more than 10 alarms (Alarm Flood condition)	~<1% (last 30 days)
Maximum number of alarms in a 10 minute period	≤10 (last 30 days)
Percentage contribution of the top 10 most frequent alarms to the overall alarm load	~<1% to 5% maximum, with action plans to address deficiencies
Quantity of chattering and fleeting alarms	Zero, action plans to correct any that occur.
Stale Alarms	Less than 5 on any day, with action plans to address
Annunciated Priority Distribution	~80% Informaiton, ~15% Warning, ~5% Action, ~<1% Critical Other special-purpose priorities excluded from the calculation
Unauthorised Alarm Suppression	Zero alarms suppressed outside of controlled or approved methodologies
Unauthorised Alarm Attribute Changes	Zero alarm attribute changes outside of approved methodologies or Change Management process

Table 12 - 1 – Alarm KPI Summary

13.2. Alarm System Performance Reports

The Contractor must program the system to generate alarm management reports of the KPI and metrics listed in above Table 10 1.

In addition, the following reports shall also be produced to demonstrate the overall health of the Alarm system unless specified otherwise in the scope of work of the project.

The reporting system shall provide a number of reports to enable analysis of the alarm system. These reports shall contain the following KPI's and must be as follows:

a. Top 10 alarms by frequency,

b. Top 10 alarms by duration,

c. Number of active / standing alarms at end of shift/day,

d. Number of shelved / disabled alarms at end of shift/day,

e. Number of devices and duration in maintenance mode,

All reports are to be reviewed annually by Operations, maintenance and ETS with a view to improving system performance.

The requirements for alarm logging are specified in I-SPE-STD-013 Control System Design & Construction standard.

14. Change Management of Alarms

The purpose of change management is to ensure that changes are authorised and subjected to the evaluation criteria described in this standard. The change management process ensures that the appropriate stages of the alarm management lifecycle are applied to alarm system changes.

Seqwater X-PRO-STD-015 Management of Change procedure shall be followed to perform change management of alarms.

The change management process must ensure the following considerations are addressed:

a. The technical basis for the proposed change

b. Impact of change on Health and Safety, Environment, Legal and Regulatory, Reputation / Social and Community, Financial and Water Quality and Supply

c. Modifications are in accordance with the alarm philosophy described in this standard

d. Time period for which the change is valid

e. Authorisation requirements for the proposed change

f. The level of safety is maintained if the change is implemented

If an alarm is no longer needed then it shall be decommissioned from the alarm system. SCADA graphics, Functional Description, Master Alarm Database and related documentation shall be modified within six months.

When the addition and deletion of alarms are necessary, the proposed modifications must follow the X-PRO-STD-015 Management of Change procedure. A list of referencing materials e.g. graphics, control logic, P&ID, operating procedures, and HAZOP affected shall be included as supporting documentation.

15. Alarm System Audit

The audit process is intended to maintain the integrity of the alarm system and alarm management processes and is conducted once every two years.

An audit reviews the managerial and work practices associated with the alarm system. It determines whether those practices are sufficient to adequately administer the system by reviewing practices versus procedures and procedures versus policy. The audit also includes comparison of the alarm management practices against industry guidelines. The work processes and procedures that ensure compliance with the alarm philosophy shall be evaluated for effectiveness on a periodic basis.

Personnel interviews or questionnaires shall be conducted as part of the audit to identify performance and usability issues.

The audit shall review work practice documentation which include the following:

- Verification that alarms require operator action to avoid a defined consequence.
- The project Master Alarm Database.
- Management of change documentation for alarms.
- Alarm performance monitoring reports.
- Documentation for disabled /out-of-service alarms.

Action plans shall be developed for problems identified during the audit processes. When defining an action plan, timelines, accountabilities, and review of results obtained shall be assigned to each item.

16. Changes from previous versions

This Standard Specification will be regularly reviewed and updated, including the consideration of requested alterations, in accordance with Seqwater Procedure X-PRO-STD-004 Development and Review of Asset Standards.

Section Number	Change
Various	Added Disabled along with Out of Service alarm
Section 8.1	The information details required deleted and has been guided to Alarm template document I-TMP-STD-008

17. Verification

Compliance with this document may be verified by internal audit.

18. Further Information

For further information please contact the owner of this document.