

DEP SPECIFICATION

ALARM MANAGEMENT

DEP 32.80.10.14-Gen.

February 2017

ECCN EAR99

DESIGN AND ENGINEERING PRACTICE

DEM1



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PREFACE

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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the engineering of notification (alarms and alerts) systems.

The alarm management philosophy in this DEP is based on alarm best practices, such as those defined in EEMUA 191 and ISA 18.2.

This DEP specifies a rigorous work process that is to be applied to identify and document the set of notifications that are included in the alarm system. These notifications are based on plant operating limits obtained from equipment and process constraints, commonly referred to as the plant operating envelope. The DEP also specifies requirements of notification suppression logic, and the design of alarms of safety-critical sub-systems and equipment diagnostic alarms.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual (DEM) 1 – Application of Technical Standards.

This is a revision of the DEP of the same number dated February 2014; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

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This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases, the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

The word **may** indicates a permitted option.

1.3.2 Specific definitions

Term	Definition
Alarm	The notification type used to notify operators of the exceedance of a Critical Limit or a Standard Limit. See notification. On the control system, an alarm is an audible and/or visible means of indicating to the operator that a critical or standard priority equipment malfunction, limit exceedance, or abnormal condition occurred requiring a response.
Alarm Management	Activities related to monitoring, storing, reporting, analysing and auditing alarm and alert notifications, with the intent to improve the effectiveness and performance of the alarm system.
Alarm Operations	Alarm functions needed in real-time by the console operator, such as alarming, suppression, shelving and proactive monitoring. These functions also typically require high availability and high integrity.
Alarm Override	An alarm is overridden when the system is configured such that the alarm will not be generated even though the base alarm condition is present. Alarm overrides include inhibited, disabled, bypassed and shelved alarms. Alarm overrides exclude static and dynamic alarm suppression, and configuration changes that are subject to management of change – including temporary changes such as removing alarms from equipment that is out-of-service.
Alarm Philosophy	A document that establishes the basic definitions, principles, and processes to design, implement, maintain, and operate an alarm system. An alarm philosophy is a high level document that is supported by and refers to design specifications, implementation toolkits, as well as maintenance and operations work processes and work instructions.
Alarm System	Complete system for generating and handling <u>notifications</u> , including field equipment (instruments), signal conditioning and transmission, alarm processing and alarm display. The alarm system includes hardware, firmware, configuration and supporting information (e.g., alarm response procedures, management controls).
Alert	The <u>notification</u> type used to notify operators and/or operations support personnel of the exceedance of a Target limit or other event that is not a Critical or Standard limit exceedance. See <u>notification</u>. On the control system, an alert is an audible and/or visible means of indicating to the operator a target priority equipment event or limit exceedance that requires awareness, that is indicated separately from alarm indications, and which does not meet the criteria for an alarm.
Allowable Time in Exceedance	The time a <u>Standard limit</u> may be exceeded without the onset of potential degradation of equipment integrity.
Basic Process Control System (BPCS)	A configurable microprocessor-based process control system. The term includes DCS, PLC and SCADA process control systems but excludes the SIS.

Term	Definition
Configuration	The combination and the setting of parameters of predefined, application specific library functions and their parameters to implement the <u>alarm system</u> functionality.
Console Operators	The personnel assigned to a single or small number of facilities, utilities or systems responsible for the monitoring and control of the processes via the BPCS of the facilities, typically reporting to the shift team leader.
Constraint	An identified restriction on the equipment, materials of construction, or operating point,, such as the design pressure or design temperature of a vessel, a relief valve setting or an SIF setting, which limits or restricts the operation of the equipment or process. There are usually several constraints. See also Design, Integrity and SIF limits.
Constraint Owner	The person or role that is identified as responsible for maintaining the identified <u>constraint</u> , the <u>constraint</u> value and any supporting documentation of the identified <u>constraint</u> .
Control Room	The section of a control centre containing the essential equipment required to operate the plant optimally and safely.
Critical Limit	The value at which the operator has a last opportunity to timely diagnose a situation and respond to prevent an undesired event.
Deadband	The difference between the <u>limit</u> and the value of the process parameter at which the <u>notification</u> is de-activated. The <u>notification</u> is de-activated when the process parameter has moved into the safe direction further than the value of the dead band.
Demand	A process or equipment condition or event which requires an Instrumented Protective Function or an operator receiving a notification to take action to prevent a hazardous event.
Design Limit	The final limits for safe operations as established by the equipment designer. These limits correspond to the equipment constraints.
Display	What is seen on a Human-Machine Interface (HMI) or visual display unit (VDU).
Distributed Control System (DCS)	A configurable microprocessor-based process control system. Also referred to as BPCS (Basic Process Control System)
Enable State	The state of a notification e.g., enabled, disabled or inhibited.
Enforcement	A process by which the master alarm and priority data of the Master Alarm Database is used to update the control system re-establishing the master alarm values and priorities in the control system, either manually or through the use of a tool.
Enforcer Log	The log produced during the process of enforcement, It includes alarm system deviations from the master alarm data of the Master Alarm Database and the results of the enforcement.

Term	Definition
Equipment State Change	The change in equipment status, e.g., a change from on-line to off-line. A controller changing from auto to cascade.
Exceedance	When a process variable's value goes beyond a defined <u>limit</u> .
Executive Action	Programmed or configured action executed automatically, without input from the operator. Typically used when the operator does not have enough time to diagnose, analyse and respond.
Faceplate	A display pre-configured in the BPCS that resembles the display and controls of the equivalent conventional panel instrument. It could be, for example, a controller faceplate (allowing SP output and controller mode changes), an indicator faceplate, a switch faceplate (status and output changes).
Facility	The group of physical equipment that functions together, as a single unit, to perform a specific operation such as crude oil/gas production well, refining or chemical process, storage, transfer, (un)loading stations, treating or any other operations involved in the production, manufacturing and handling of crude oil, gas, oil products and/or chemicals, including but not limited to, process units (operating and idle), utilities, water and effluent treating units, tank farms and other storage, pipelines, pumping, compression, loading and unloading stations.
First-Out	Indication from a SIF/IPF about which specific trip initiator triggered a trip. Also known as First-Up.
Hazardous Situation	A situation with the potential to cause harm, including ill health and injury, damage to property, products or the environment, production losses or increased liabilities.
Human-Machine Interface (HMI)	All the areas where people interact with the system. In this DEP, it mostly refers to the DCS operator workstation but it may also refer to the engineering workstation.
Inhibited Notification	A notification whose function has been disabled and removed from the visibility of the operators and whose activation is not captured in the notification history.
Initial Setup (ISU)	The process by which <u>constraints</u> , <u>limits</u> , <u>settings</u> , consequences of deviation in the event a <u>limit</u> is exceeded, recommended steps to take to correct the deviation, and other information are collected for entry into the master alarm database. Maps to Identification and Rationalization phases in ISA/IEC lifecycle process.
Instrumented Protective Function (IPF)	A function comprising one or more sensors, a Logic Solver function and one or more Final Elements, for the purpose of preventing or mitigating Hazardous Situations. In IEC 61508 and IEC 61511, an IPF is referred to as a Safety Instrumented Function (SIF).

Term	Definition
Management of Change	A method of reviewing proposed changes and includes a review process by appropriate personnel and obtaining concurrence before the change is implemented. Examples of Management of Change methods include the Management of Change process or a site-specific change process.
Master Alarm Database	A database under Management of Change that contains all facility constraints, critical, standard and target limits, alarms, alerts, consequences of exceeding critical, standard and target limits, suggested operator responses and other related information. It has historically been called a Variable Table and the terms are used interchangeably.
Normal Operating State	The condition when a process is within all defined limits and behaving as expected.
Notification	Alarms and alerts, used to inform appropriate personnel of limit exceedances or the occurrence of events.
Notification Analysis Flowchart	A documented decision support tool to support the assignment of alarm and alert priorities to notifications.
Notification System	See alarm system.
Nuisance Alarm	Alarms that annunciate excessively, unnecessarily or do not return to normal after the correct response is taken.
Operations Acceptance Check	A step in the initial setup process when operators and other operations personnel are given the opportunity to comment on the Master Alarm Database work of the initial setup core team: limits, alarm settings, consequences of deviation in the event a limit is exceeded, recommended steps to take to correct the deviation and other information.
Operator Console	A group of equipment comprising VDU screens, keyboards, pointing devices and switches which are allocated to a defined part of the plant (e.g., "console for hydrogen units").
Operator Response Time	Time taken by the operator to diagnose and take mitigating or corrective actions following notification.
Points and Tags	The instrument, numeric, timer, flag, Boolean, or logical entities within the BPCS. Both words are used interchangeably, with "points" often being used to refer to calculated or inner variables of the BPCS. "Tags" generally refer to data coming from wired or data inputs to the BPCS.
Process Deadtime	Length of time the process value will continue to rise/fall following the completion of the assigned operator action

Term	Definition
Process Safety Time	Time period between a failure occurring in the process or the basic process control system (with the potential to give rise to a hazardous event) and the occurrence of the hazardous event if the SIF is not performed. The Process Safety Time determines the dynamic response requirements of the SIF.
Process Unit	See facility.
Risk Based Inspection (RBI)	The risk based development of inspection requirements for prioritising and managing inspection programs for new or existing Facilities based upon the identification of expected degradation mechanisms and a quantitative/qualitative analysis of failure probabilities, consequences and likelihood of detection.
Safety instrumented function (SIF)	A function comprising one or more sensors, a Logic Solver and one or more Final Elements whose purpose is to prevent or mitigate hazardous situations. A SIF is intended to achieve or maintain a safe state for the process, in respect of a specific hazardous event. A SIF is designed to achieve a required SIL which is determined in relationship with the other protection layers participating in the reduction of the same risk. Previously referred to as an Instrumented Protective Function (IPF).
Safety Instrumented System (SIS)	Instrumented system used to implement one or more safety instrumented functions. A SIS is composed of any combination of sensor(s), logic solver(s), and final element(s) (IEC 61511). In summary, an SIS is a collection of IPFs (including sensors and final elements) that together protect a process unit or major piece of equipment.
Setting	The value as set in the device (e.g., a switch) or BPCS (e.g., an alarm setting) to generate the <u>notification</u> at the desired limit. The setting will be in the engineering units of the device or BPCS, depending on the type of setting.
Shelving	Shelving describes a practice/ability provided to the operator to temporarily remove an alarm from the system in order to keep nuisance alarms from interfering with the overall effectiveness of the alarm system. Examples might be shelving an alarm during maintenance on the alarm or when the alarm triggering device is in override from operations.
SIF Limit	The value at which the Safety Instrumented Function takes automated action to prevent or mitigate hazardous situations.
Situational Awareness	Knowing the current conditions and activities occurring in and around the facility with respect to the process, equipment and other activities.
Span of Control	The functions and activities for which the operator is responsible

Term	Definition
Stale Alarm	An alarm that is in the alarm state for a long time (in excess of the <u>allowable time in exceedance</u> for standard alarms or more than 12 hours for critical alarms). An alarm can be stale during maintenance when it is spurious, i.e., not representing a genuine hazardous situation, or when the hazardous situation actually exists but has not been dealt with.
Standard Limit	The limit, when exceeded for longer than the allowable time in exceedance, where sustained or recurring short-term operations will begin to cause cumulative degradation of equipment integrity or reliability, other cumulative effects that could lead to undesirable consequences.
Standing Alarm	An alarm that is active at a specific point in time
State-based (Mode Dependent) Alarming	The technique that automatically or manually triggers the alteration of the <u>setting(s)</u> for one or more notifications where the constraints and normal operating values differ for various states (modes) of operation so that no setting can be found that satisfies all operating states. State-based (mode dependent) alarming requires either manual or automatic state detection that triggers the setting alteration.
Suppression-Dynamic	Automatic suppression of specific <u>notifications</u> resulting from an event (such as a facility trip) for a defined period of time if the operating circumstances following the event make it impossible for a hazardous situation to arise from the associated <u>limits</u> being exceeded. Dynamic suppression does not change alarm parameter settings; it only suppresses the notification.
Suppression-Static	<u>Operator-initiated suppression</u> of specific <u>notifications</u> that are associated with a facility or piece of equipment that is out of service. The out of service status of the unit/equipment makes associated <u>notifications</u> redundant if no hazardous situation could possibly arise from the <u>limit</u> being exceeded.
Target Limit	The limits of the range that business and operating targets may be set within, due to reliability, stability or operability constraints.
Time In Exceedance	See Allowable Time in Exceedance
Variable	Property or condition which may be measured (instrumented or not). A variable may also be calculated from measured variables.
Variable Table	See Master Alarm Database. This is an alternative name.

1.3.3 Abbreviations

Term	Definition
ASRS	Alarm System Requirements Specification
BPCS	Basic Process Control System
DCF	Diagnostic Coverage Factor

Term	Definition
DCS	Distributed Control System. Also referred to as BPCS (Basic Process Control System)
DEP	Design and Engineering Practice
EEMUA	Engineering Equipment and Materials Users' Association
ESD	Emergency Shut Down
F&G	Fire & Gas
FAT	Factory Acceptance Test
FF	Foundation Fieldbus
HAZOP	Hazards and Operability Study
HEMP	Hazards and Effects Management Process
HMI	Human-Machine Interface
HSE	Health, Safety and Environmental
IPF	Instrumented Protective Function, now known as SIF (Safety Instrumented Function)
IPS	Instrumented Protective System, now known as SIS (Safety Instrumented System)
ISA	International Society of Automation
ISU	Initial Setup
KPI	Key Performance Indicator
LOPA	Layer of Protection Analysis
MAD	Master Alarm Database
MOC	Management of Change
MOS	Maintenance Override Switch (bypass switch)
MVC	Measurement, Validation and Comparison
OOS	Operational Override Switch
P&ID	Process and Instrumentation Diagram (see PEFS)
PEFS	Process Engineering Flow Scheme (see P&ID)
PFD	Probability of Failure on Demand
PHA	Process Hazard Assessment
PLC	Programmable Logic Controller
PRV	Pressure Relief Valve
PV	Process Variable
RAM	Risk Assessment Matrix
SCA	Safety Critical Alarm
SCADA	Supervisory Control and Data Acquisition
SIF	Safety Instrumented Function
SIL	Safety Integrity Level

Term	Definition
SIS	Safety Instrumented System, the collection of IPFs that together protects a facility, unit or equipment.
SME	Subject Matter Expert

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (7).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a full revision of the DEP of the same number dated February 2014. The following are the main, non-editorial changes.

Section/Clause	Change
Throughout	Moved to use of only "Master Alarm Database". "Variable Table" was included in 1.3.2 to point to Master Alarm Database. This matches industry standard terminology
Throughout	Revised SHALL [PS] requirements to be more precise and unambiguous, to support implementation of PSBR 9 and address Major Accident Hazard barriers.
1.3.2	Removed a few unused definitions, slight modification to a few others.
1.3.3	Removed a few unused abbreviations, added CSU.
2.1	Added reference to IEC 62682-2014.
2.2	Complete re-write.
2.5	Removed table with acceptability of certain alarm rates.
3	Complete re-write to focus and simplify. Relocated SHALL [PS] requirement from (4) and added SHALL [PS] requirements that align with PSBR 9 implementation
4	Re-written, removed/relocated SHALL [PS] requirements. Modified requirements related to the ISU team. Added requirement to bring all of the process safety information together into the MAD.
5.5	Simplified SHALL [PS] requirement and removed priorities table
5.13	Added SHALL [PS] directly related to meeting PSBR 9 requirements
6.3	Added SHALL[PS] related to risk of suppressing high energy alarms.
6.4	Revised figures.
Appendix I	Removed Appendix of analysis checklist

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://swwww.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.