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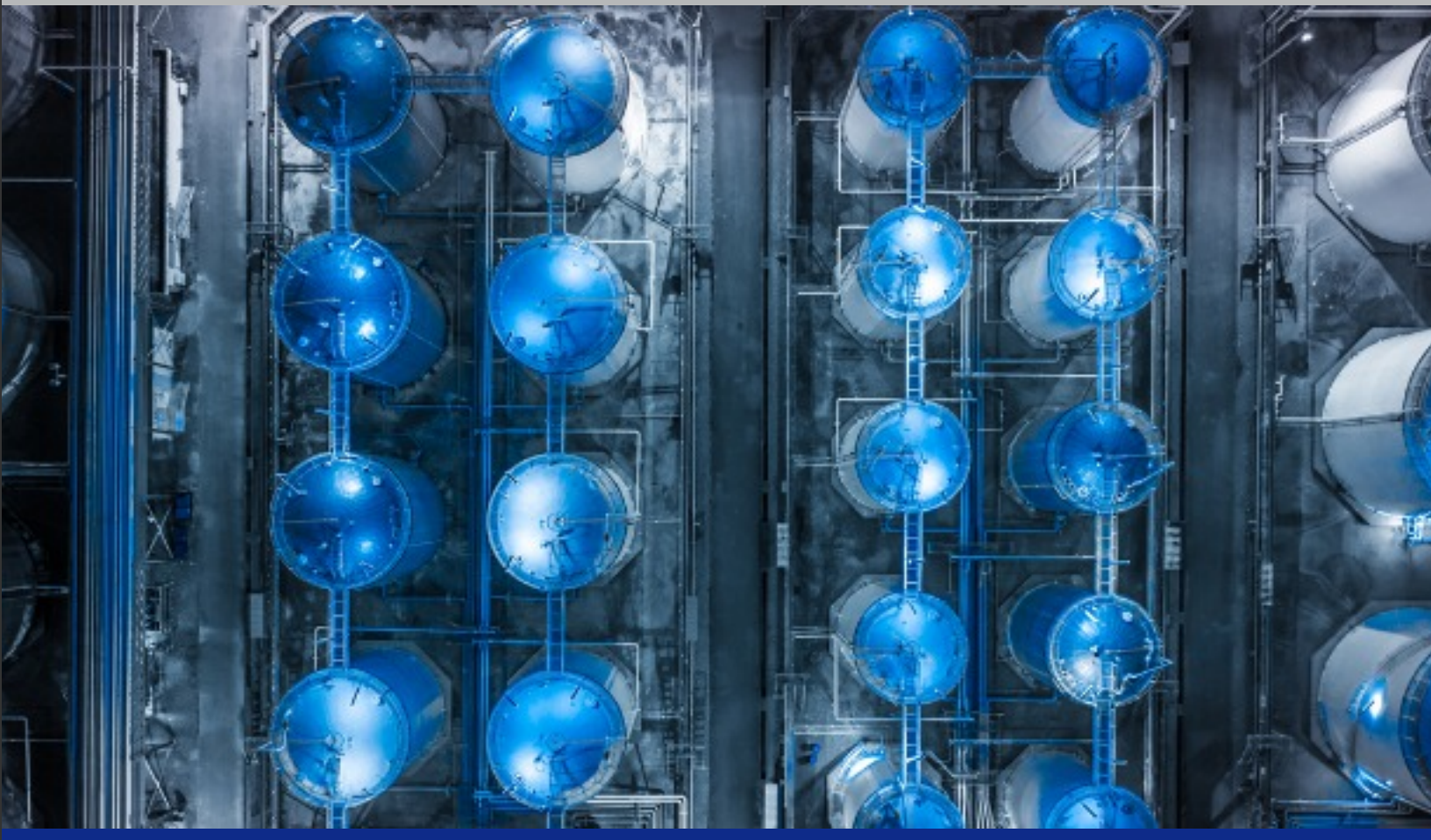
Functional Safety Assessments
Using SLM



SLM®
Safety Lifecycle Manager

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Table of Contents

1 Abstract

The IEC and ISA standards for Safety Instrumented Systems (SISs) describe basic requirements for Functional Safety Assessments (FSAs) (FSAs), but do not provide specifications or guidance on how to execute or document an FSA. This commonly results in FSAs that are incomplete, hard to use or inconsistent from one application to the next. From an enterprise perspective, this challenge intensifies with multiple functional areas or sites that operate independently. This paper discusses the requirements for FSAs of SISs and the advantages of using a Protective Systems Safety Lifecycle Manager, such as SLM, as the primary tool for standardizing and assessing.

2 Functional Safety Assessments

IEC 61511/ISA 84.00.01-2004 (Clause 5) identifies the stages of the safety lifecycle at which an FSA should be performed. The table below summarizes the stages and general focus areas of the FSA for each stage.

2.1 Functional Safety Assessment Stages

FSA Stage	Stage Description	Topics for FSA
Stage 1	Follows hazard and risk assessment; required protection layers have been identified and the Safety Requirement Specification (SRS) has been developed.	Review Process Hazards Analysis for compliance with organization and industry practices. Review identified safety functions including Safety Instrumented Functions (SIFs) and other Instrumented Protection Layers (IPLs). Review SRSs for completeness.
Stage 2	Following Safety Instrumented System (SIS) design.	Review SIS design relative to SRS requirements: • Have SIFs been implemented according to the SRS? • Does selected equipment meet all requirements? • Have all Validation, Operation, Maintenance and Proof Test Procedures been identified and planned?
Stage 3	Following installation, pre-commissioning and final validation of the SIS and development of operation and maintenance procedures.	Review the inspection and testing of the SIS: • Have SIFs and SISs been inspected, tested and validated against SRS requirements? • Have all Operation, Maintenance and Proof Testing procedures been prepared and approved? • Have personnel been trained? • Is SIS ready for operation?
Stage 4	Following a period of operations and maintenance.	Review of SIS and SIF performance: • Verify that performance has been tracked and assessed. • Compare demand rate to SRS requirements. • Compare fault and failure rates to SRS requirements. • Validate the adequacy of training and procedures.
Stage 5	After modification and prior to decommissioning of a SIS.	Review changes in SIS to verify they have been made in accordance with the Safety Lifecycle. Review all FSA stages with respect to changes, and verify that changes have not affected functional safety. Verify that decommissioning has not impacted the functional safety of the process or related processes. Verify that all appropriate documentation has been updated to incorporate the impacts of decommissioning.

3 SLM and the FSA Module

The full suite of integrated SLM modules can generate, store and analyze data for every stage of the safety lifecycle. Facility SIS personnel can leverage the tool's workflows to generate common reports and analysis required by US and international safety standards. If a plant has already completed portions of the safety lifecycle using third party industry tools, data from these programs can be imported. SLM offers a standard out-of-the-box solution, but can be configured for specific needs of the facility.

SLM provides a standardized and easy-to-use framework for FSA completion, allowing organizations to define, populate and validate FSAs with increased efficiency and effectiveness. The integration of all safety lifecycle data provided by SLM also allows for effective presentation of FSA data with other safety critical data, such as HAZOP and LOPA studies, Safety Requirements Specifications (SRSs) and SIS performance.

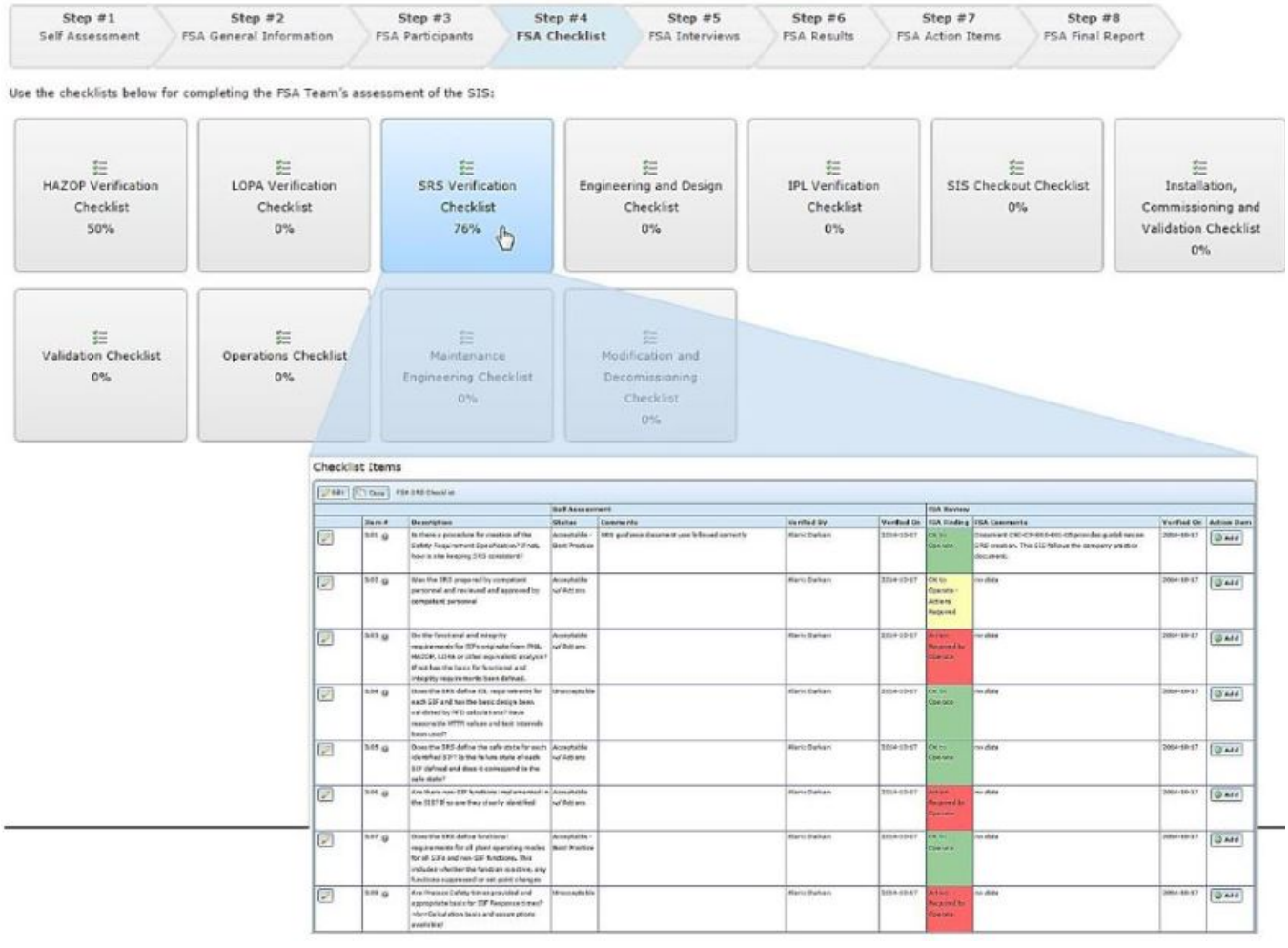
3.1 Module Benefits

- Setting a Standard: Interpretation of best practices differs by site and FSA assessor, allowing for inconsistency from one FSA to the next. Establishing a standard that is integrated with SIS lifecycle data limits questions about documentation requirements and establishes a foundation for repeated study.
- Visibility: The FSA exists in a web-based tool as a reference and example for future assessments across a site or enterprise. Onsite Safety and Instrumentation personnel can access and review all FSA information, allowing for unprecedented sharing of expertise and best practices.
- Lowering the Cost: lifecycle data is available in SLM with the click of button, requiring less time locating and synthesizing data.
- Leverage the FSA's Value: An organization must allocate resources to complete a time consuming report, maximizing its value to the organization. Completed FSA reports in SLM are easily accessible and integrated with evergreen data so it can be reviewed and used to inform day-to-day plant operations.

4 Conducting an FSA using SLM

The FSA process in SLM is guided through a built-in workflow. The user initiates an FSA and is presented with a view that allows the user to move through each of the FSA steps.

4.1 FSA Overview and Checklist



The user is presented with the appropriate checklists depending on what stage FSA is initiated (1-5). Through the intuitive workflow, users can complete the FSA checklists and track FSA personnel, interviews and key findings. Participants can access and make updates to the system simultaneously. The built-in document management system allows users to attach digital copies of supporting documentation directly to the FSA.

Step 1: Self-Assessment

SLM provides a Self-Assessment Step that can be performed by a Site or a Project Team, prior to conducting an FSA. This function allows the personnel responsible for the SIS design or operation to review the FSA Verification Checklists and provide their input on how they view the status of each of the checklist items. This checklist may be used at any time during SIS design to track completion, but should be completed a few weeks prior to an FSA to allow the assessing team time to review the data.

The personnel performing the Self-Assessment use the Verification Checklists within the interface. Space is provided for comments and identification of who performed the Self-Assessment and at what date.

Step 2: FSA Participants

The FSA Participants step allows the FSA team to identify participants in the FSA and their roles. The names of participants are drawn from the Personnel Module in SLM. This allows for tracking of individual participation in safety lifecycle activities and captures individual competencies, qualifications and approved roles.

Step 3: General Information

This step in the FSA allows for definition of basic information including an introduction and background to initiate the FSA. Introductory material is entered at the start of the FSA, along with the date of initiation and location where the FSA took place. This material is also incorporated into the FSA Final Report.

Step 4: FSA Checklist

Each FSA Checklist contains a list of verification items for the checklist topic. These are the same items as presented for the Self-Assessment Step, but have added columns for presentation of FSA comments and findings.

The Checklist view presents the entries by Self-Assessment and provides FSA Review columns for recording feedback, such as:

- The compliance level determined by the FSA team: a standard set of selections is provided, but the user may customize these.
- Comments by the FSA team.
- FSA team identification and date.
- Action Items identified by the FSA team.

Step 5: FSA Interviews

FSA teams conduct interviews to assess preparedness for SIS operation. Interviewees are typically operations or maintenance personnel responsible for the ongoing operation of a SIS. The FSA Interviews step allows for data and identification of Action Items that may have been otherwise overlooked.

Step 6: Results

This section includes a summary and discussion of the FSA findings for each checklist topic. The summary and key findings can be modified as the FSA progresses.

Step 7: Action Items

This section includes a summary and discussion of the action items added throughout the FSA. Action Items are not limited to the FSA. Any Action Items identified are tracked through SLM's Action Item Tracker and are globally accessible. The team may classify Action Items according to a user-defined category set.

For example, an Action Item may be identified as required pre-startup, required post-startup, a long-term item to be managed by operations personnel or a standing guideline. Using the "Add Action" button, users can add Action Items to specific items on the checklist that aggregate at the final report.

Step 8: FSA Final Report

SLM collects all information entered into the database during the FSA processes and automatically prepares a standardized final report. This report captures the introduction and background, FSA Summary, FSA Key Findings, Interview details and all FSA Action Items, and produces a viewable and printable Final Report. The user may also include a detailed report on the FSA checklists and comments and compliance level findings in the final report.

4.2 FSA Final Report Example

Step #1 Self Assessment | Step #2 FSA General Information | Step #3 FSA Participants | Step #4 FSA Checklist | Step #5 FSA Interviews | Step #6 FSA Results | Step #7 FSA Action Items | Step #8 FSA Final Report

Orange County Oil Refinery Business Unit

Unit: ISOM2 — Document No: ISOM-SIS-006-S3-FSA

Background

A Stage 3 FSA is being conducted for the SIS installed at the Bedrock Refinery No.1 Reformer Unit. The installation is a new SIS being installed to handle all SIF's and related auxiliary functions in the unit.

FSA Results

Date Started*: 2013-10-15

Date Completed*: 2013-11-13

Location*: Bedrock City Refinery

FSA Summary and Results:

The FSA was performed during the completion of Engineering and the start of Construction. Installation progress to date has been setting of the SIS cabinets in place and placing a few weather enclosures for field transmitters. Wiring for signal and power had not yet started. Most of the work is planned for the upcoming turnaround in September and October of 2013.

FSA - Part 1 Summary

Hazop, LOPA were complete and adequate with opportunities for improvement noted but not required for startup. Engineering was largely complete with exceptions around completion of logic which must be completed for programming to proceed and providing some detail around use of diodes at SOV's. Procedures and training for both Ops and Maintenance need completion, however personnel seemed well aware of SIS concepts and project details. Installation was progressing appropriately – and seemed well advanced ahead of the TAR with trip valves, field panels, SIS cabinet and instruments all being mounted. The SIS project is progressing well. Several Engineering items need resolution, otherwise, continuing to execute the project plan should result in timely SIS completion, should accomplish design intent and result in a Final FSA Report that supports unit startup.

Site staff are fully aware of the activities required to complete the SIS and ensure that Functional Safety is Achieved and have definite plans for completion of those activities.

FSA Part 2 Summary (post Turnaround/Pre-Startup)

Update - Oct 28, 2013 - The FSA Team reviewed the status of open action items at the completion of the turnaround and collected supporting documentation. This documentation was reviewed with Rick Stanley and a conclusion was reached that Functional Safety had been achieved and that all of the Category A FSA Action Items had been closed. This was documented in e-mails and communicated to Site Operations. The key supporting documents are attached to this FSA.

There are several open Category B and lower action items as defined in the FSA Action Items list. The Category B actions are required to be closed prior to final project close out.

FSA Key Findings

FSA HAZOP Checklist	All documents are available and complete. Suggest uploading to digital form.
FSA LOPA Checklist	Site staff are fully aware of the activities required to complete the SIS and ensure that Functional Safety is Achieved and have definite plans for completion of those activities.
FSA SRS Checklist	There are several open Category B and lower action items as defined in the FSA Action Items list. The Category B actions are required to be closed prior to final project close out.
FSA Engineering and Design Checklist	Installation progress to date has been setting of the SIS cabinets in place and placing a few weather enclosures for field transmitters. Wiring for signal and power had not yet started.
FSA Installation, Commissioning and Validation Checklist	There are several open Category B and lower action items as defined in the FSA Action Items list. The Category B actions are required to be closed prior to final project close out.
FSA IPL Verification Checklist	There are several open Category B and lower action items as defined in the FSA Action Items list. The Category B actions are required to be closed prior to final project close out.
FSA Maintenance Engineering Checklist	Site staff are fully aware of the activities required to complete the SIS and ensure that Functional Safety is Achieved and have definite plans for completion of those activities.
FSA Modification and Decommissioning Checklist	Installation progress to date has been setting of the SIS cabinets in place and placing a few weather enclosures for field transmitters. Wiring for signal and power had not yet started.
FSA Operations Checklist	There are several open Category B and lower action items as defined in the FSA Action Items list. The Category B actions are required to be closed prior to final project close out.
FSA SIS Checkout Checklist	Site staff are fully aware of the activities required to complete the SIS and ensure that Functional Safety is Achieved and have definite plans for completion of those activities.
FSA Validation Checklist	Installation progress to date has been setting of the SIS cabinets in place and placing a few weather enclosures for field transmitters. Wiring for signal and power had not yet started.

FSA Team Members

Name	FSA Position	Company	Phone Number	Email	Notes
Fred Stevens	FSA Chairperson	Clampett Energy	310-555-1121	fstevens@cec.com	Present for all review meetings
Jim Tatum	SIS Project Engineer	Clampett Energy	310-555-1455	jtatum@cec.com	Present for internal review and final review
Steven Johnson	Operations Rep	Clampett Energy	310-555-1234	sjohnson@cec.com	Operation Manager
Danny Woodward	no data	Clampett Energy	310-555-1123	dwoody@cec.com	no data
Jessica Bell	Independent Chairperson	no data	no data	no data	no data

FSA Interviews

Date	Interviewer Details			Interviewee Details			Location	Notes
	Name	Company	Role	Name	Company	Role		
2014-02-26	Fred Stevens	Clampett Energy	FSA Chairperson	Joe the Operator	Bedrock Refining	Operator	Control Room	Discussed the operation of the SIS. Operators have had general SIS training, but SIF specific Training has not yet been conducted. Joe is somewhat familiar with the SIS being installed, but only has general knowledge of the SIF's being installed.
				Steven Johnson	Clampett Energy	Operations Rep		
				Joe Mama	no data	no data		
2014-09-25	Name	Company	Role	Name	Company	Role	no data	no data
	Jessica Bell	no data	Independent Chairperson	Jim Tatum	Clampett Energy	SIS Project Engineer		

FSA Action Items

Item #	Date	Category	Description	Status	Action	Reference Contact
1.01	2014-02-26	B	Conduct follow on interview with PSM	closed	Send results of interview to SIS Coordinator at Clampett	Fred Stevens
1.01	2014-09-25	no data	no data	open	no data	Steven Johnson
1.01	2014-03-12	AP	Perform document search to locate SIS items	open	Locate and upload prior FSA documents to ProSys	Fred Stevens
1.01	2014-02-26	B	Conduct follow on interview with PSM	closed	Send results of interview to SIS Coordinator at Clampett	Fred Stevens

5 Conclusions

Using SLM for execution and documentation of FSAs results in effective, economical and repeatable FSAs. SLM provides the means of standardizing the inputs and results of FSAs and allows an organization to leverage FSAs for tangible improvements in SIS design and operation. When coupled with other SLM safety lifecycle modules such as HAZOP, LOPA, SRS and SIS/SIF performance, organizations can make dramatic improvements in the effectiveness of Safety Protective Functions and reduce the costs of implementing and operating these systems.