OpreX™ Control and Safety System

Sustainable SIS

Effective and Efficient Safety Performance for the Lifetime of your Industrial Processes

Yokogawa recognizes the continuous challenges for plant owners to efficiently maintain process safety integrity throughout the whole life cycle of their plant. Yokogawa's Sustainable SIS (SSIS) solution is a holistic approach to ensuring that optimum safety performance is realized and maintainable throughout the lifetime of your plant. Yokogawa's SSIS solution effectively allows you to retake ownership of your process safety environment by making it comprehensible, manageable, compliant and secure. SSIS provides peace of mind allowing you to focus on your core business.
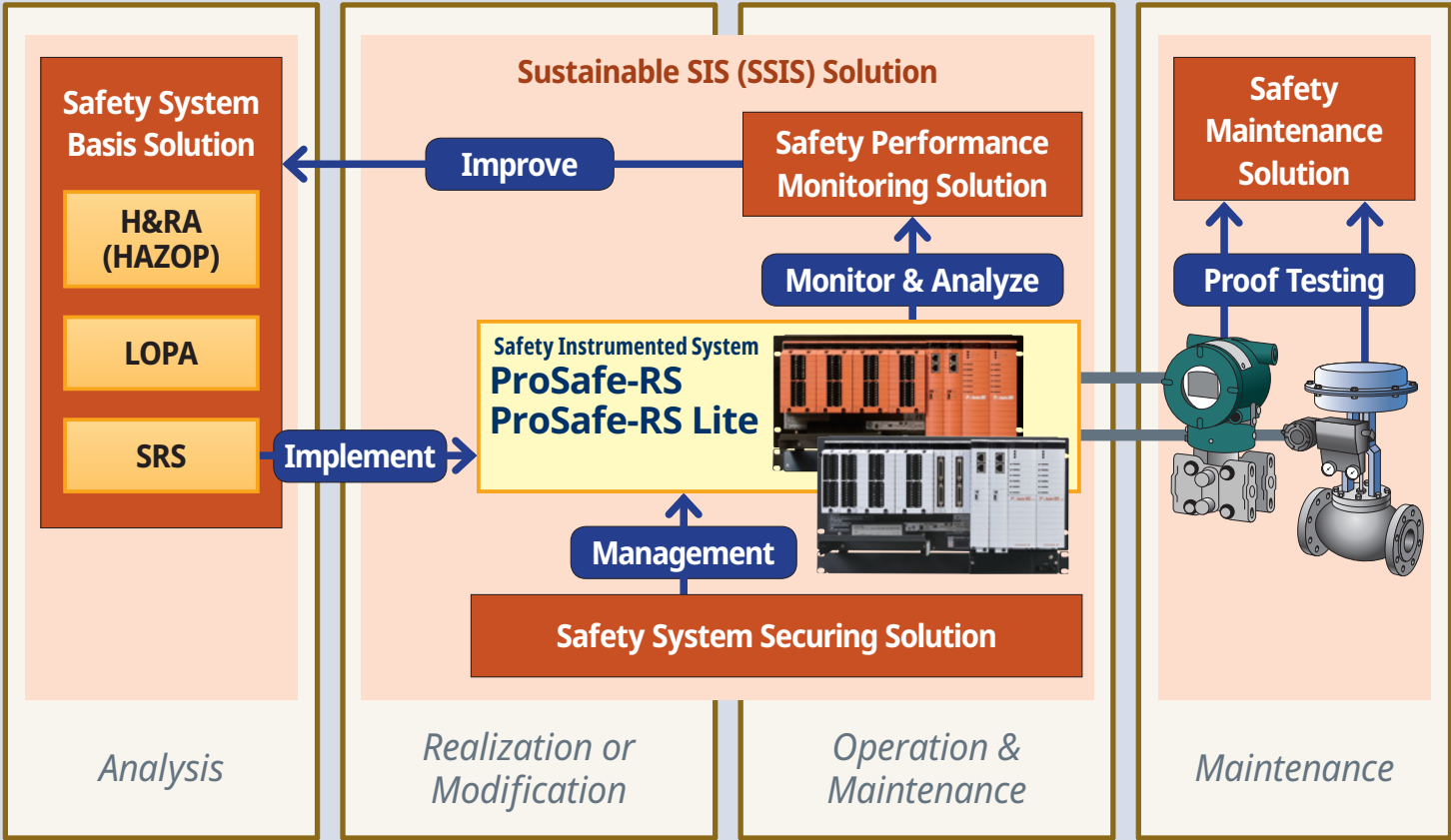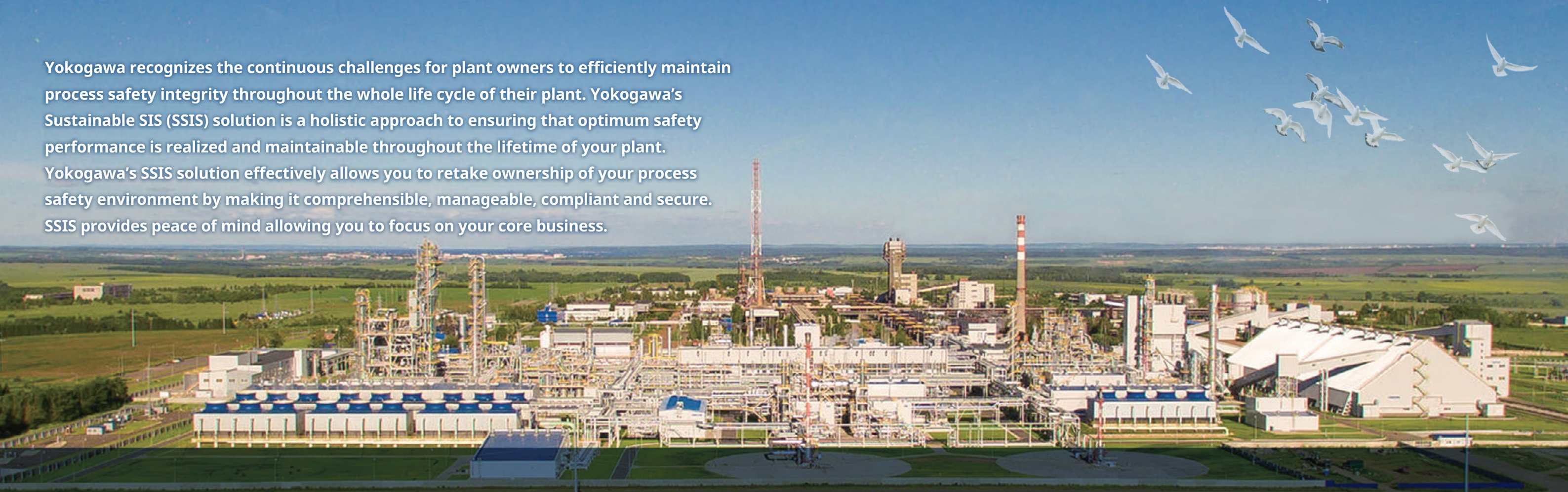

Figure Overview of Sustainable SIS (SSIS) solution in the process plant life cycle

Safety System Basis Solution

This solution consists of 3 main activities: Hazard & Risk Assessment (H&RA), SIL Assignment (LOPA) and Safety Requirement Specification (SRS). It provides an accurate and detailed assessment of facility risks. This supports seamless sharing of critical risk information across all activities related to the design, specification and modification of your SIS. This is achieved by providing the following solutions:

- **Independent risk identification with integrated data transfer**
- **Comprehensive SIL assessments that meet your functional safety needs.**
- **Digitized Safety Requirement Specification (SRS)**

Safety System Securing Solution

After testing the SIS in the factory and during operation, it is necessary to maintain the safety integrity of the SIS throughout the safety lifecycle. All modification and forcing of SIS must be recorded and readily available for functional safety audit. SSIS allows this to be perform easily by providing the following solutions:

- **Secure the safety integrity of the SIS configuration with access control and historical log**
- **Visibility of forcing status of all SIS on demand**

Safety Performance Monitoring Solution

Current safety standards require the actual safety performance of a process to be verified against the design performance targets and an impact assessment of plant safety before the SIS is bypassed. This is achieved by providing the following solutions:

- **Pre-emptive impact assessment of safety overrides**
- **Dynamic safety performance monitoring**

Safety Maintenance Solution

Periodical proof tests is required to reveal undetected faults that prevent the SIS from operating as intended. This testing causes disruption to plant availability. SSIS provides solutions to collect evidence of SIS activation that can be used as proof test evidence. In addition, SSIS provides automated sensor validation to improve the efficiency of proof testing. These are achieved by providing the following solutions:

- **Proof testing optimization with historical evidence**
- **Optimal Safety and OPEX with Automated Proof Testing**

Independent risk identification with integrated data transfer

Challenge 1

The risk assessments I have attended don't seem to align with my process. The hazards identified seem more extreme than my operating experience. The number of action items are too high, and many of them seem to be unnecessary. The whole exercise seems to push me toward something I do not need and cannot manage.

Challenge 2

My risk assessment is hundreds of pages long and completely unreadable. Finding the information I need in the risk assessment can be a full-time job, so it simply does not get used.
Ultimately, it lives in a filing cabinet in case a regulator comes to audit it. For all the time and effort I invested, I simply cannot leverage the information to support other risk management activities.

We understand that the data obtained during your risk assessment is used to do more than just design a safety system. And, we also understand that everything documented in the risk assessment needs to be managed with a high degree of accuracy and reliability. In compliance with the IEC standard, analysis phase risk assessment services provided within the SSIS solution are facilitated by independent risk consultants whose main goal is to ensure that an accurate representation of your facility's risks is developed.

- Scenarios are developed based on your specific process information, so that risks are precisely defined.
- Using the industry-leading software package to document studies, risk assessments are completed in a more efficient manner, and the data can readily be made available to support not only other safety life cycle activities, but also to support other activities conducted as part of your Process Safety Management program.
- Within the SSIS solution, H&RA data seamlessly feeds into your SIL Assignment activities. In turn, the SIL Assignment results can feed information to develop the SRS. Therefore, the data integration between the initial hazard identification and the specified safety solution is maintained.
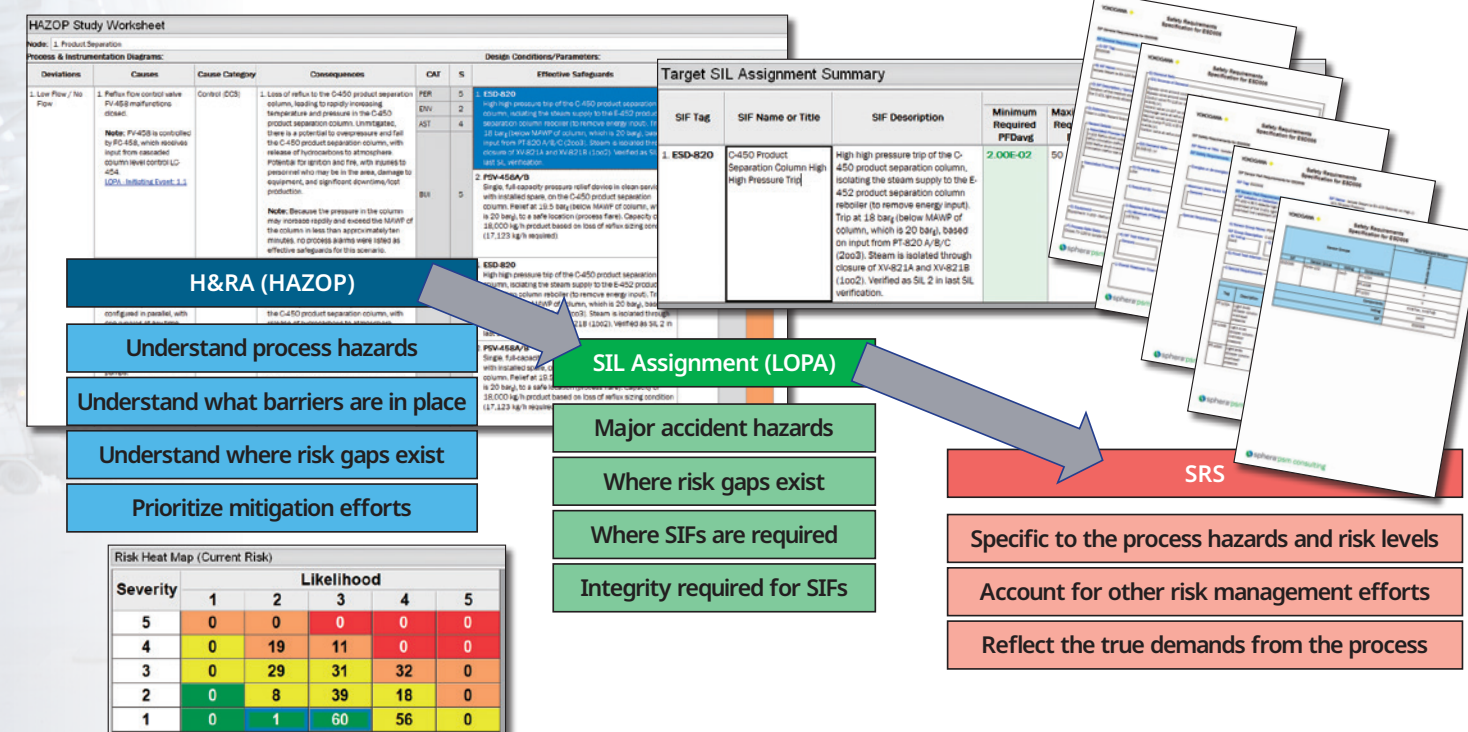
Comprehensive SIL assessments that meets your functional safety needs

Challenge 3

I want to be as safe as possible, but I don't have the resources to devote to maintaining a system that is too complex. I simply can't keep interrupting production to perform inspections. It can feel like I have passed the point where the trade-off between safety and production makes everything worthwhile!

Design and operate your SIS to meet the needs of the process; don't operate your process to meet the needs of your SIS. SSIS Analysis Phase risk assessment services ensure that your SIS meets the exact needs of your process, so that it is neither under-designed nor over-designed, and so you can use resources wisely to manage both your process, and the equipment that protects it.

- By ensuring a broad range of safeguards are considered to manage specific risks, the burden of maintenance is spread more equitably across disciplines, and the SIS is not over-specified.
- Because we understand the safety life cycle, your PHA is captured in a way that ensures the designers of the SIS have as much information as they need — and in the format they need it — to minimize delays, assumptions, and gaps. This helps to minimize the need for future modifications.
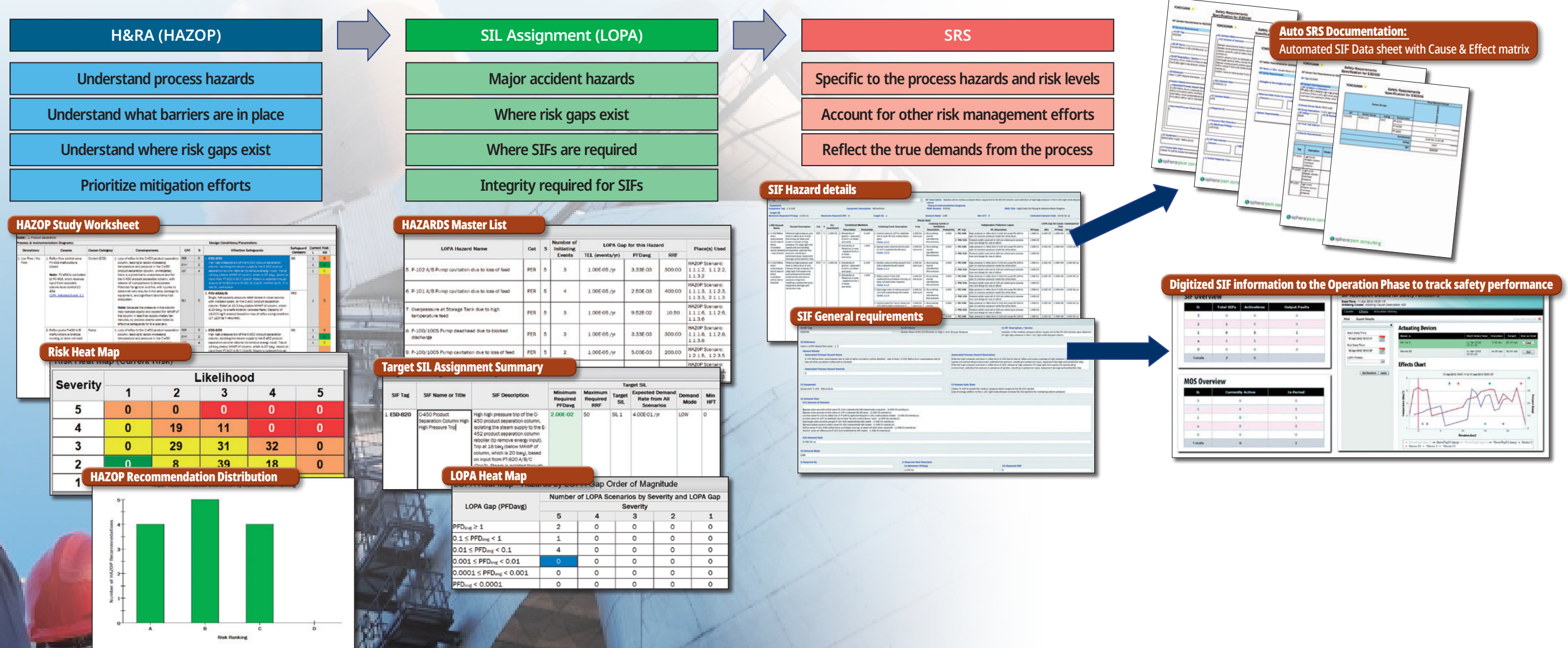

H&RA (HAZOP)
- Understand process hazards
- Understand what barriers are in place
- Understand where risk gaps exist
- Prioritize mitigation efforts

SIL Assignment (LOPA)
- Major accident hazards
- Where risk gaps exist
- Where SIFs are required
- Integrity required for SIFs

SRS
- Specific to the process hazards and risk levels
- Account for other risk management efforts
- Reflect the true demands from the process

Risk Heat Map (Current Risk)

Severity	Likelihood				
	1	2	3	4	5
5	0	0	0	0	0
4	0	19	11	0	0
3	0	29	31	32	0
2	0	8	39	18	0
1	0	1	60	56	0

Digitized Safety Requirement Specification (SRS)

Challenge 4

I have completed my hazard identification and SIL assignment. How do I ensure that information is accurately communicated to those who will design, install, and manage my safety instrumented system? My SIS will not be effective if it does not closely align with my risk assessment.

Those who design a SIS are often not involved in the risk assessment or SIL assignment upon which the design is based. Working through risk study worksheets to extract information such as all the different failure modes or all the operating mode (i.e start up, shut- down) can lead to an safety system that is poorly specified, and that may not achieve the risk reduction you expect.

- Within the SSIS solution, H&RA data seamlessly feeds into your SIL Assignment activities. In turn, the SIL Assignment results can feed information to develop the SRS. Therefore, the data integration between the initial hazard identification and the specified safety solution is maintained.

- A significant portion of the data required for a complete SRS can be directly populated into the SRS documents from the HAZOP and LOPA study within the same software package, reducing the potential for data to be lost, overlooked, or misinterpreted. As a result, SIF's that meet the actual needs of the process can be specified and implemented.

- Both designers (EPCs) and end-users can take advantage of the digitized SRS features to automatically generate the cause and effects matrix (C&E) for safety instrumented functions documented in the HAZOP and LOPA phases.

- Data from the digitized SRS can be imported seamlessly to other Operations-phase automated packages, allowing for more timely and simpler comparison of expected SIS results with actual system data. This makes monitoring of safety performance against set safety KPIs easier and more accurate. Customized deviation reports from automated packages can be used as inputs for HAZOP and LOPA study revalidation, and can aid in justification of FSM compliance to regulators.

H&RA (HAZOP)	SIL Assignment (LOPA)	SRS
Understand process hazards	Major accident hazards	Specific to the process hazards and risk levels
Understand what barriers are in place	Where risk gaps exist	Account for other risk management efforts
Understand where risk gaps exist	Where SIFs are required	Reflect the true demands from the process
Prioritize mitigation efforts	Integrity required for SIFs	

Auto SRS Documentation:
Automated SIF Data sheet with Cause & Effect matrix

SIF Hazard details

SIF General requirements

Digitized SIF information to the Operation Phase to track safety performance

HAZOP Study Worksheet

HAZARDS Master List

Risk Heat Map

Target SIL Assignment Summary

HAZOP Recommendation Distribution

LOPA Heat Map

Secure the safety integrity of the SIS configuration with access control and historical log

5 Challenge
I am having plant shut down, the maintenance team and engineering team need to access the SIS engineering PC. How to maintain governance of forcing activity by Maintenance and logic change by Engineering??
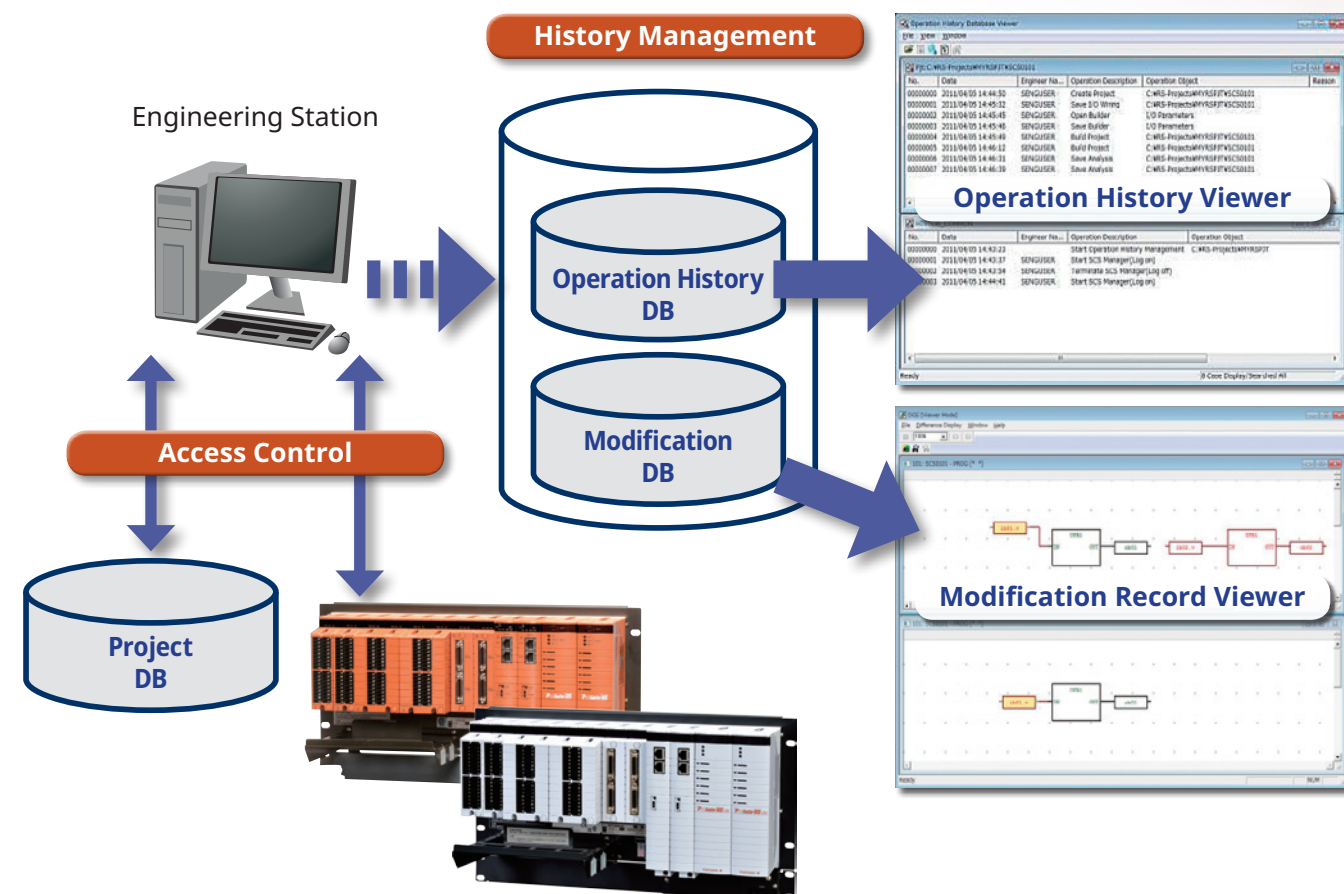
6 Challenge
We have few teams working on the engineering and proof testing of the SIS. I wish to know whether downloading and forcing has occurred. How to track these activities?

Since SIS is a critical system for plant safety, it is necessary to maintain the SIS configuration integrity to avoid unintentional changes or tampering of the controller.

SSIS provides security and traceability by the following.

- Easy to manage "What" can be handled by "Whom".
- "When", "Who" changed "What" can be logged.
- Prevent access to the system by unauthorized users.
- Easy traceability by chronological audit trail.

Engineering Station

History Management

Operation History DB

Operation History Viewer

Modification DB

Modification Record Viewer

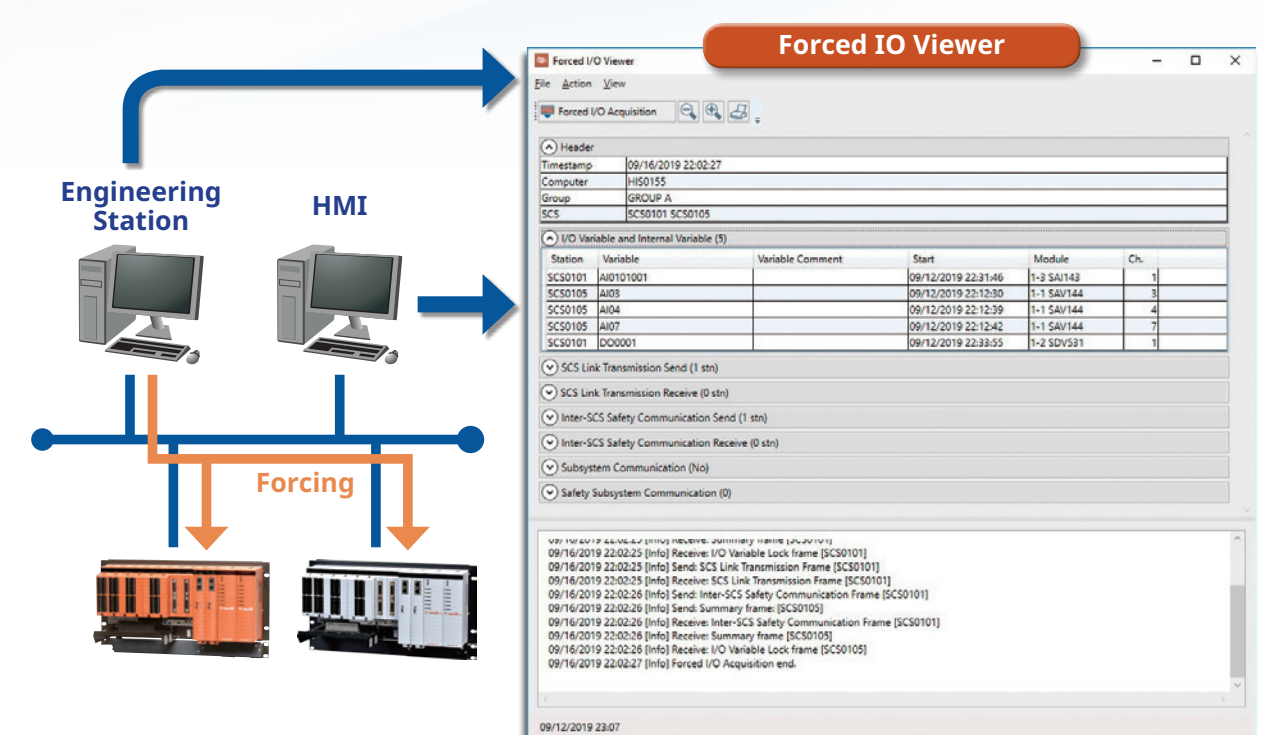**Access Control**

Project DB

Visibility of forcing status of all SIS on demand

7 Challenge
There are a lot of forcing of safety tags due to commissioning and/or maintenance activities as some process units are operational while some are not ready. Is there a way to extract all forcing tags from all SIS in one report on demand for handover to next shift?

SSIS provides tangible insights into your safety systems and reduce the risk of operational errors.

- Forced IO Viewer displays all IO variables that are locked by forcing function due to commissioning and/or maintenance. Forcing information can be exported to csv file for reporting purposes.
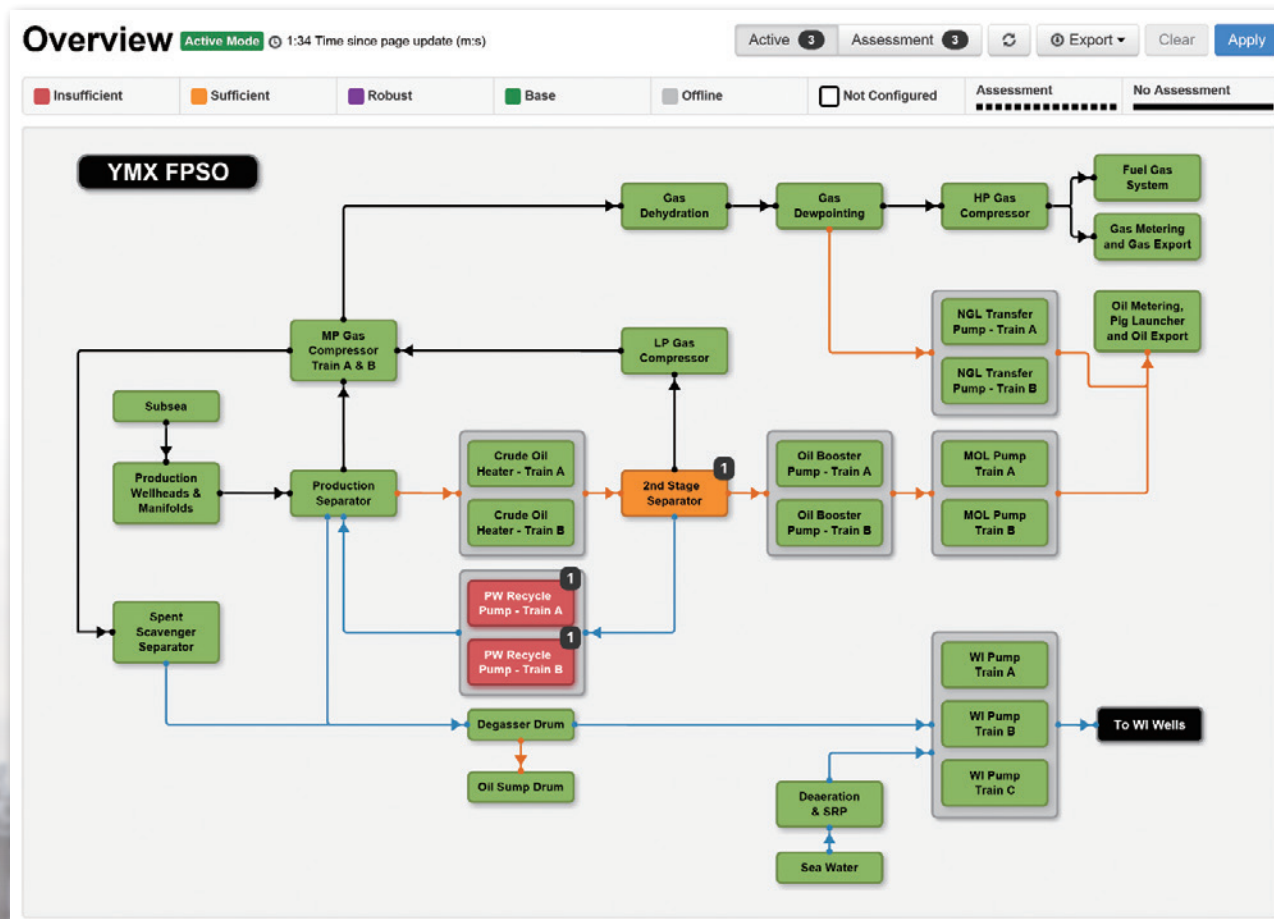
Forced IO Viewer

Engineering Station

HMI

Forcing

Pre-emptive impact assessment of safety overrides
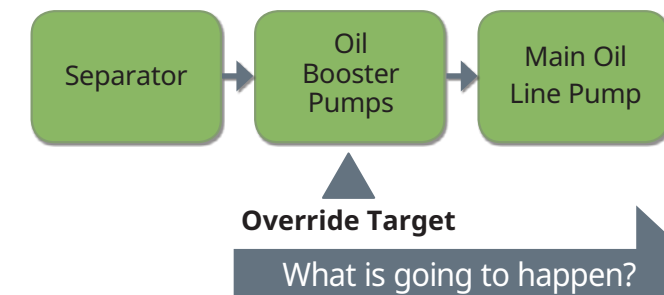
Challenge 8

I need to override a Safety Instrumented Function (SIF) for maintenance. I want to assess the risk on-the-fly and understand the impacts and how they manifest in other areas of the plant. However, plant conditions are continuously changing and the process requires multiple and/or sequenced overrides.

SSIS facilitates decision making prior to applying overrides

- SSIS helps you to assess the impact of overrides before their implementation, including effects which may manifest in other equipment.
- SSIS improves visibility of potentially unsafe situations and increases safety compliance by aiding policy enforcement and traceability of overrides.
- SSIS informs operators of active safety overrides and automatically generates shift handover reports to keep track of the override status.
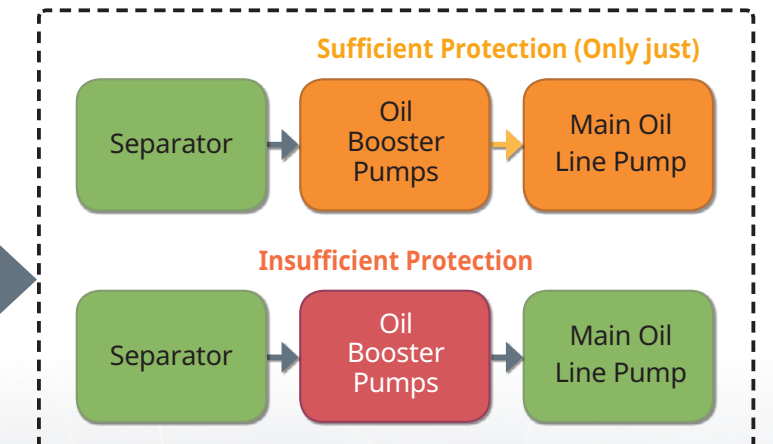

Current Plant State

Separator → Oil Booster Pumps → Main Oil Line Pump

Override Target

What is going to happen?

See whether there is sufficient protection from other SIFs.

If Override is Applied

Sufficient Protection (Only just)

Separator → Oil Booster Pumps → Main Oil Line Pump

Insufficient Protection

Separator → Oil Booster Pumps → Main Oil Line Pump

Dynamic safety performance monitoring

Challenge 9

I want to confirm that my safety systems are performing as assumed in our Layer of Protection Analysis (LOPA) report per IEC 61511. I want to quickly identify when design assumptions have not been met using real-time operational data such that I can take action to eliminate risk from the business.

SSIS provides continuous improvements to plant safety.

- SSIS automatically collects safety statistics to be used for Safety Instrumented Function (SIF) improvement.
- SSIS collects events from real-time operating data to ensure that risk levels remain tolerable on a regular basis.
- SSIS provides evidence of safety performance and SIF availability records for audit by regulatory authorities.
- The designed safety performance is compared against the actual operational safety function activity to identify issues, validate safety design, and optimize proof test scheduling, in the process helping users to improve the safety and availability of the plant.
- SSIS facilitates the revalidation of the Process Hazard Analysis (PHA) to take in to account events that have occurred during plant operations but are not yet included in the safety design.

Design Output Performance versus Actual Output Performance
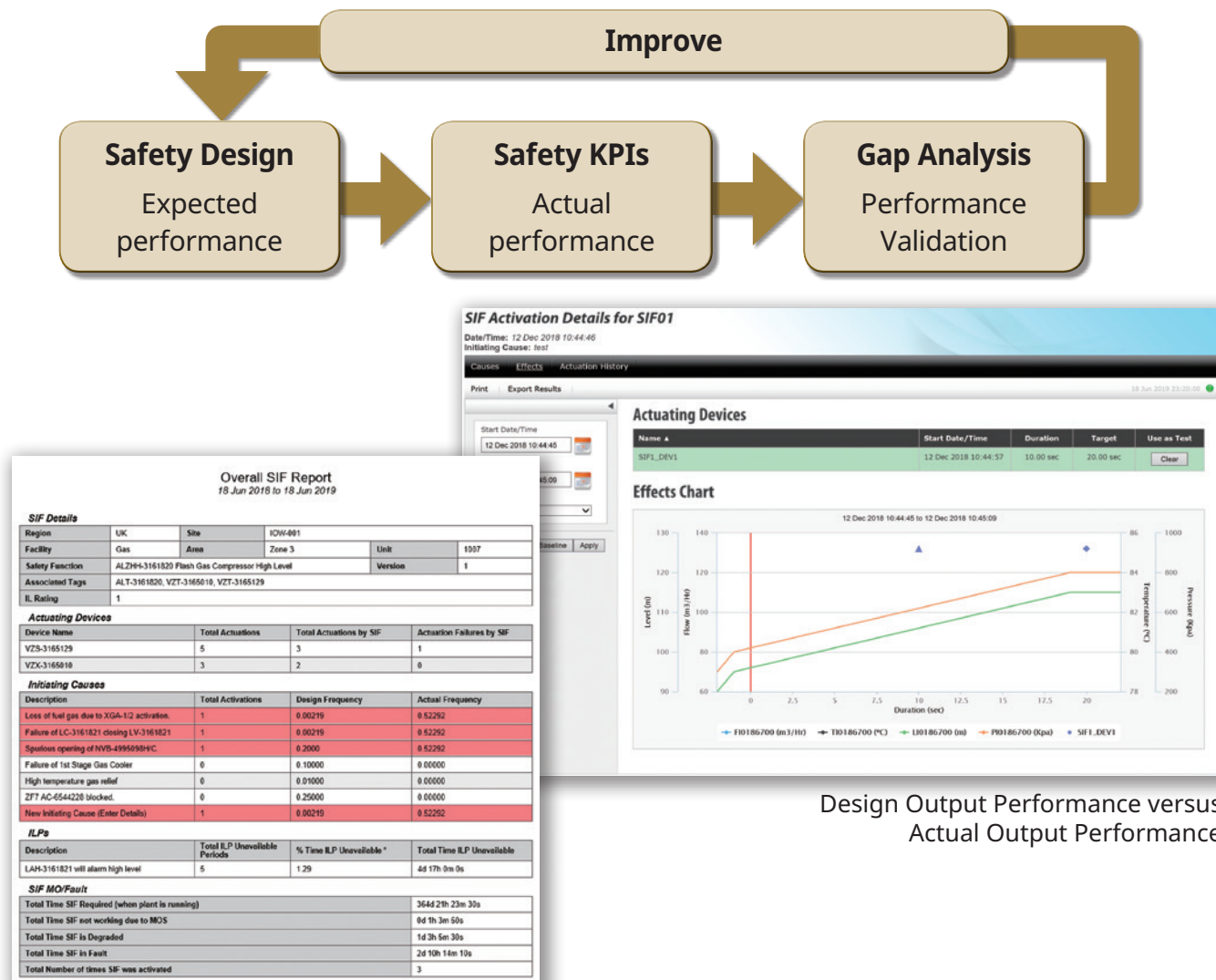
Design Demand Rate versus Actual Demand Rate

Proof testing optimization with historical evidence

Challenge 10

I need to ensure that we are functionally testing safety critical devices at periodic intervals to maintain the designed reliability. When a trip occurs, I want to be able to complete the verification such that the trip represents a function test, allowing us to reset the test interval to minimize labor requirements and maintain safety integrity.

SSIS enables a flexible approach to proof testing in segments

- SSIS supports testing in segments, offering greater flexibility compared to end-to-end, which can be spread over time to help maintain safety integrity and supports safety standards (NAMUR 106, IEC 61511).
- SSIS optimizes proof testing by conveniently tracking when trips occur on final elements (valves, actuators) and recording data before, during and after a trip which can be evaluated to ensure every device performed as intended.
- SSIS enables a proof test credit to be claimed due to shutdowns from actual demand on the SIS during operations if the identified SIF activation meets the criteria to be used as a proof test. Credit can be taken as a functional test, allowing the test interval to be reset, mitigating the need for periodic proof testing shutdowns dictated by the safety design.

Supports proof testing by marking SIF Activations as test replacement if device performed correctly

Single view of test replacements

Evidence of input and output

Filter reports based on Time, Plant, Safety Function, etc.

Display SIF Activations records eg. Time, No. of Activation

Display Valve Travelling Time Historical Record

Optimal Safety and OPEX with Automated Proof Testing
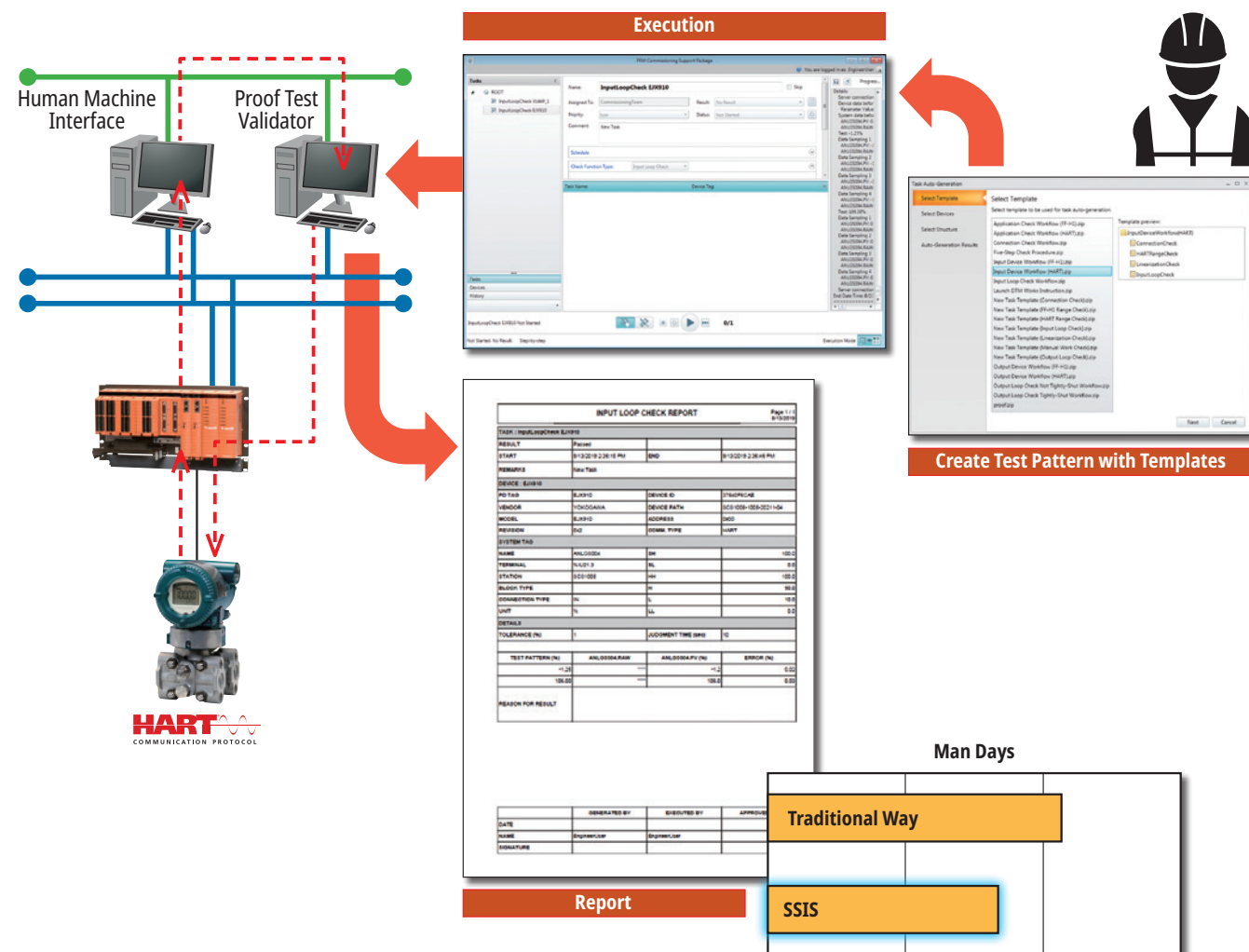
Challenge 11

Recently we have replaced all the older analog transmitters with HART transmitter. How can we fully utilize the digital communication to improve plant maintenance and recover our investment?

Challenge 12

In near future, we are retiring our experienced technicians and engineers. How can we continue to maintain the SIS loop with reduced workforce? Also, there is a lot of manual work and documentation (record keeping, management of change, etc.). Can we automate the maintenance process as much as possible and remain compliance with IEC61511?

SSIS maximize automation to realize OPEX efficient and maintain Safety Integrity.

- SSIS automates proof testing of HART transmitter. User can generate test pattern (task) for each types of transmitter using one of the templates. Thereafter, User can execute task step by step or continuous mode for single or multiple HART devices. SSIS will monitors progress and generates work report after completion.
- SSIS provide services for Safety Integrity Level (SIL) calculation and validate that the proof testing plan (proof test method, proof test interval and proof test coverage) meets the target SIL.

Human Machine Interface

Proof Test Validator

Execution

Create Test Pattern with Templates

Report

Man Days

Traditional Way

SSIS

Sustainable SIS

- How can I apply Yokogawa's Sustainable SIS (SSIS) to my plant?
  SSIS can be applied to your plant by selecting ProSafe-RS and following the SSIS solution enablers as shown in table below.

- What if my current SIS is not a Yokogawa solution?
  SSIS key enablers Sphera PHA-Pro® and Exaquantum are modular and can be deployed in stages regardless of the SIS platform. Please contact your nearest Yokogawa office for a consultation.

SSIS Solution	SSIS Enabler
Safety System Basis Solution	Sphera PHA-Pro®
Safety System Securing Solution	ProSafe-RS/ProSafe-RS Lite Access Control & Operation History Management
	ProSafe-RS/ProSafe-RS Lite Forced I/O Viewer
Safety Performance Monitoring Solution	Exaquantum Safety Function Monitoring
	Exaquantum Override Safety Advisor
Safety Maintenance Solution	Exaquantum Safety Function Monitoring
	PRMCSP (Supports ProSafe-RS only)

OpreX™ Through the comprehensive OpreX portfolio of products, services, and solutions, Yokogawa enables operational excellence across the enterprise.

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