Co-innovating tomorrow™

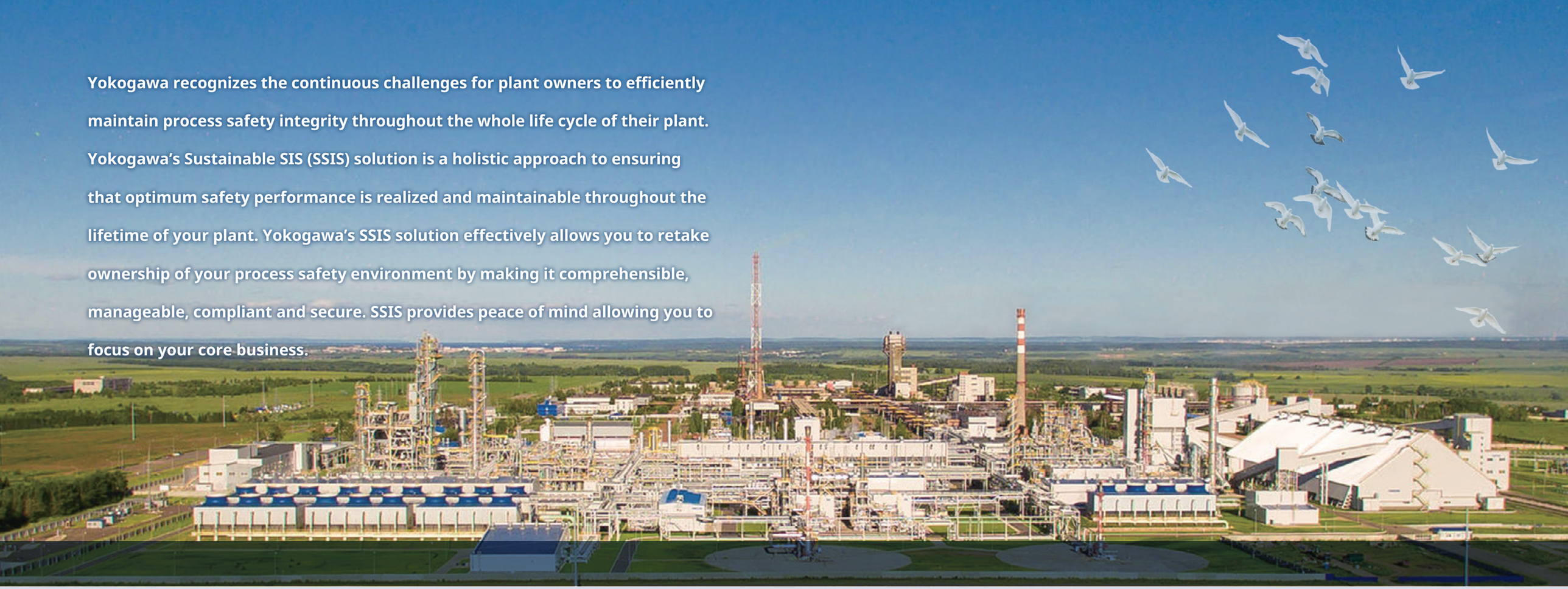
YOKOGAWA

OpreX™ Safety and Security

Sustainable SIS

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

Bulletin 32P01A10-01EN



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.

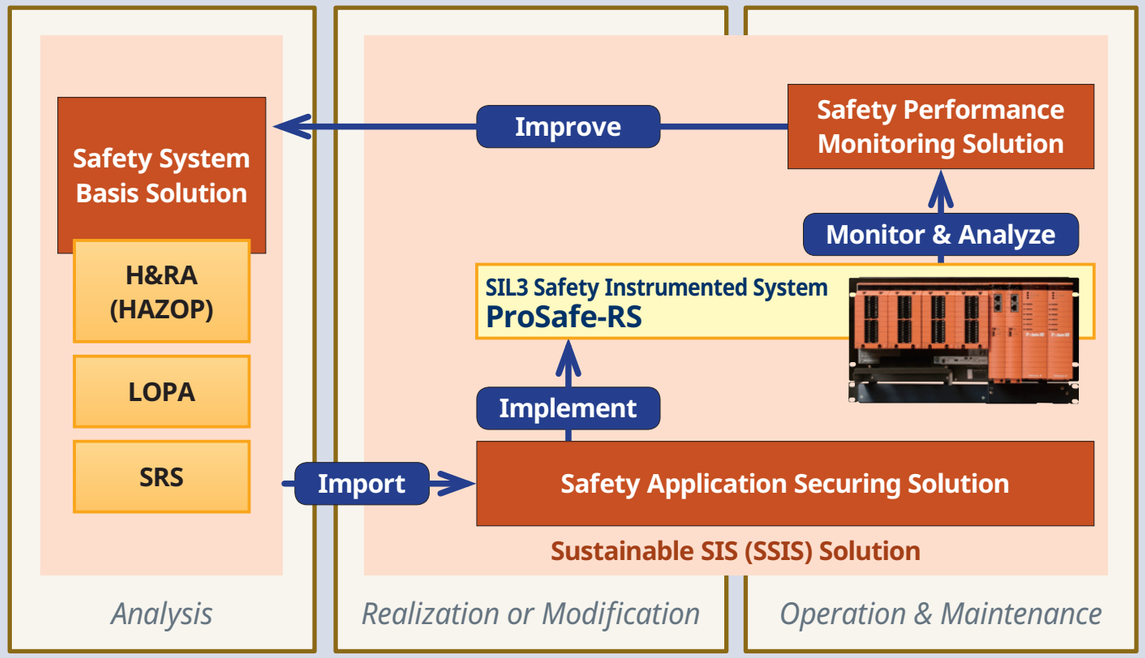


Figure Overview of Sustainable SIS (SSIS) solution in the process plant life cycle

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.**

Safety Application Securing Solution

SSIS allows your safety application to be easily and efficiently maintained at the required integrity level in accordance with functional safety standards IEC 61508 and IEC 61511 throughout the plant life cycle. This is achieved by providing the following solutions:

- **Clear visualization of your safety applications**
- **Implicit compliance by embedded functional safety management**
- **Management of the safety application for the life of the process**

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:

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

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.

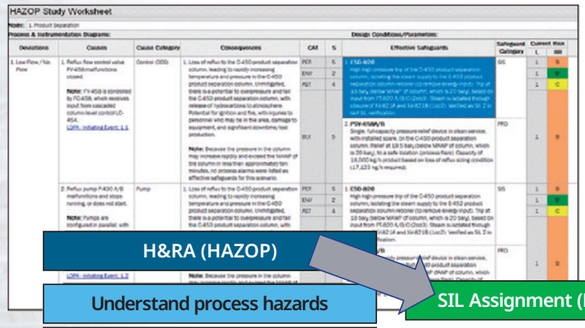
Comprehensive SIL assessments that meets your functional safety needs

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!

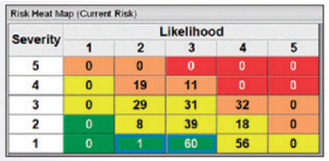
Design and operate your SIS to meet the needs of the process; don't operate your process to meet the needs of your SIS. SSIS Analysis Phase risk assessment services ensure that your SIS meets the exact needs of your process, so that it is neither under-designed nor over-designed, and so you can use resources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

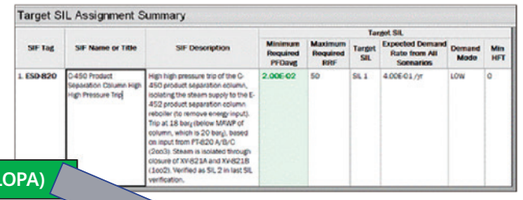
- Understand process hazards
- Understand what barriers are in place
- Understand where risk gaps exist
- Prioritize mitigation efforts



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

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

Clear visualization of your safety applications

Challenge 4

Considering the potentially huge impact of incidents in the process industries, every person involved with the Safety Systems on our site has a responsibility to assure operational integrity. With our many systems, understanding their current functionality and design is complicated.

Challenge 5

Recently I joined this company as an operator. I want to grasp the process safety related requirements of functional safety standard IEC 61511. However, it is challenging and difficult to interpret the SIS application program and it is worrying whether it can actually be effectively understood.

Challenge 6

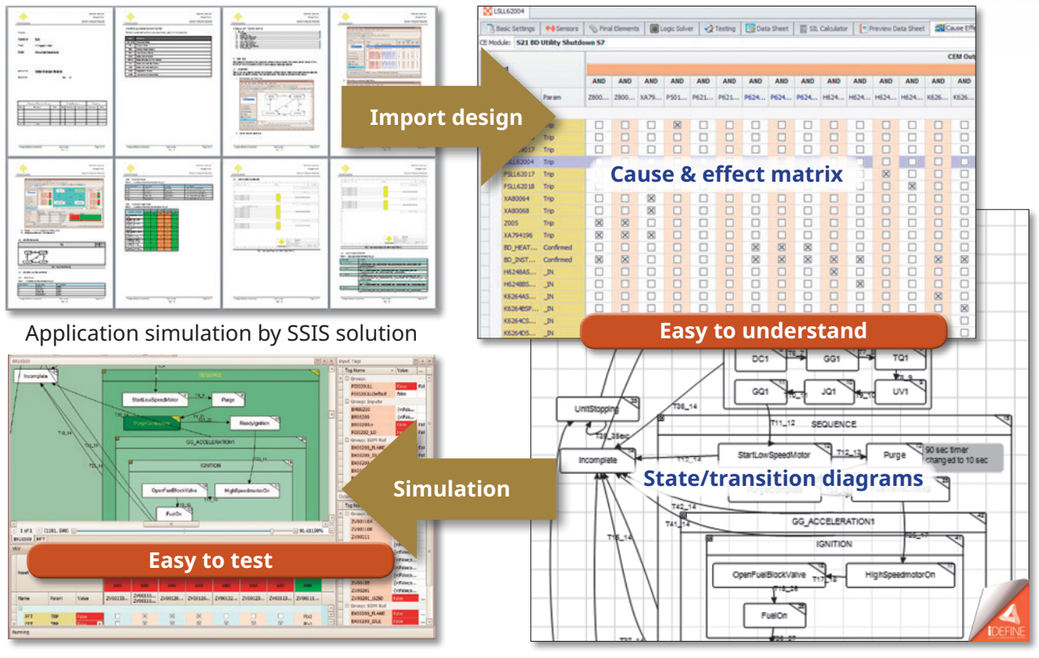
In the realization phase, I do not know whether the safety requirement specifications will behave as expected until testing begins. If a big problem is found in during testing, it will affect the schedule. I want to confirm correctness at an early stage, however it is difficult and time consuming to verify the logic on paper.

SSIS provides a more tangible visualization of your safety applications.

- SSIS represents process safety instrumented functions in the form of design documents, cause & effect matrices and state/transition diagrams. It makes the functionality easy to understand by all departments, not just application engineers.
- Operators, maintenance and process engineers can interactively support design and problem solving!
- The cause & effect matrix and state/transition diagrams can be dynamically simulated. Designs and modifications can be extensively tested with simulation offline before deployment.

Safety Requirements Specifications (SRS)

Application expressions by SSIS solution



Application simulation by SSIS solution

CHALLENGE — SOLUTION

Implicit compliance by embedded functional safety management

Challenge 7

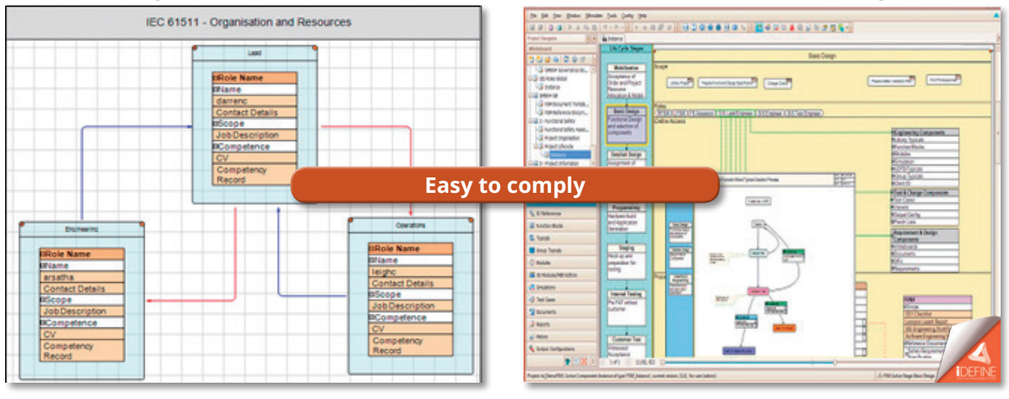
I need to install a safety instrumented system, so I want to choose a reliable partner who can not only supply a SIL3 logic solver but also provide certified SIL3 systematic capability as specified in functional safety standards IEC 61508 and IEC 61511. I need to shortlist potential partners based on compliance to these recognized standards.

Yokogawa have deployed a world leading globalized and governed functional safety management system to assure the appropriate Systematic Capability is always delivered. SSIS embeds key FSM elements to underpin this key requirement.

- SSIS has embedded management functions for assuring functional safety management in accordance with functional safety standards IEC 61508 and IEC 61511. These management functions mean that Yokogawa provide globally consistent safety engineering with homogeneous quality compliant with the recognized best practices.
- For extensions and modifications, SSIS provides high quality managed engineering. The change records and test scripts are captured and maintained in the database for smooth project execution. Furthermore, the potential direct and indirect impact of changes can be analyzed in detail by using the simulator features as recommended in the standards.

Organization definition

Procedure and resource management



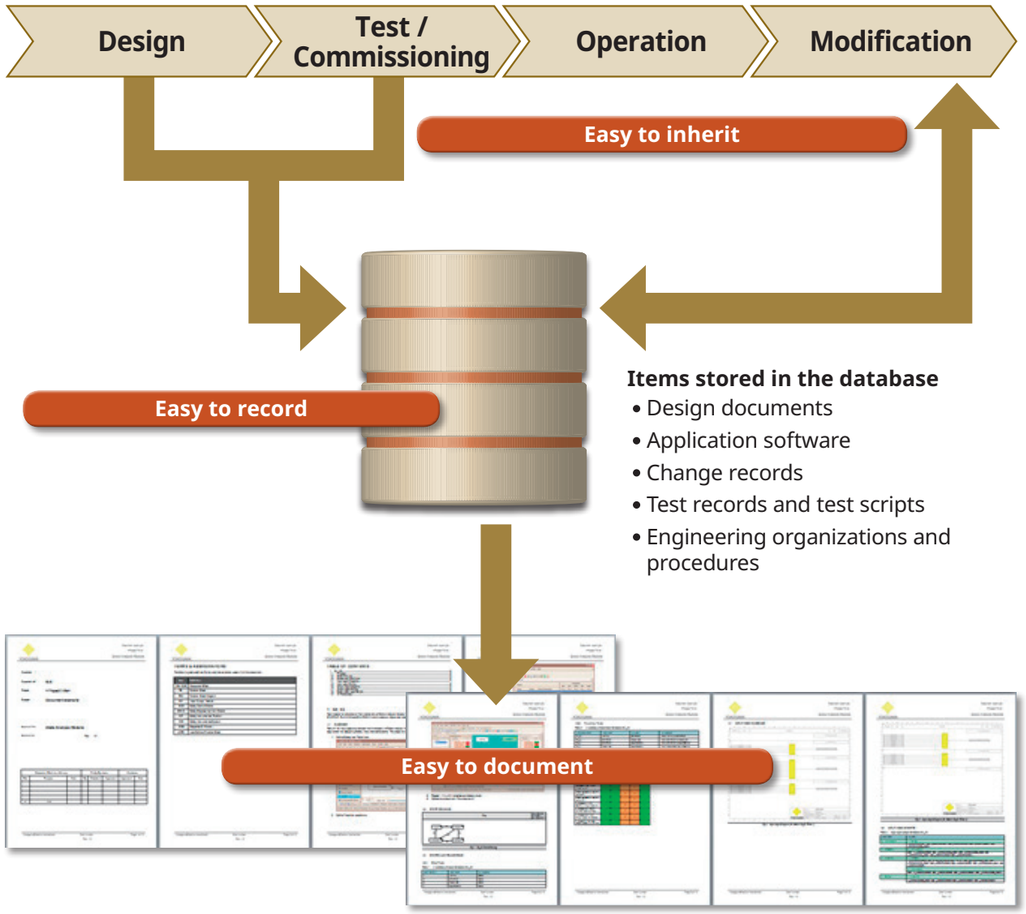
Management of the safety application for the life of the process

Challenge 8

I am thinking about modifying the plant, but the safety system was installed 15 years ago and the person in charge at that time has retired. I do not know what small incremental modifications have been carried out or why. I am concerned about whether the available design documents reflect the current SIS status.

SSIS securely maintains the "consistency" of the safety system information.

- All information for the safety instrumented system is registered in the SSIS database. It is easy to recover historical activities relating to engineering and changes.
- The latest design documents can be automatically generated at any time ensuring there is no inconsistency with the application currently being implemented. Modifications can be planned on a design document basis with peace of mind.



Items stored in the database

- Design documents
- Application software
- Change records
- Test records and test scripts
- Engineering organizations and procedures

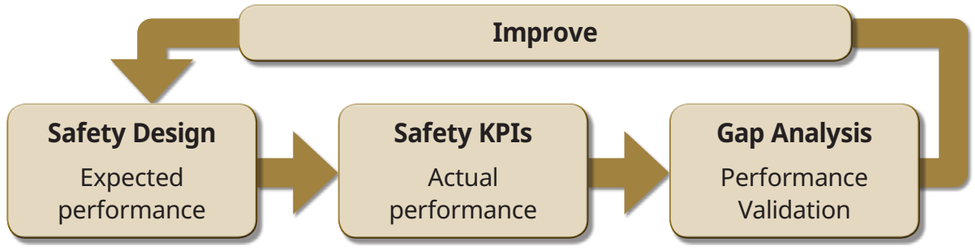
Dynamic safety performance monitoring

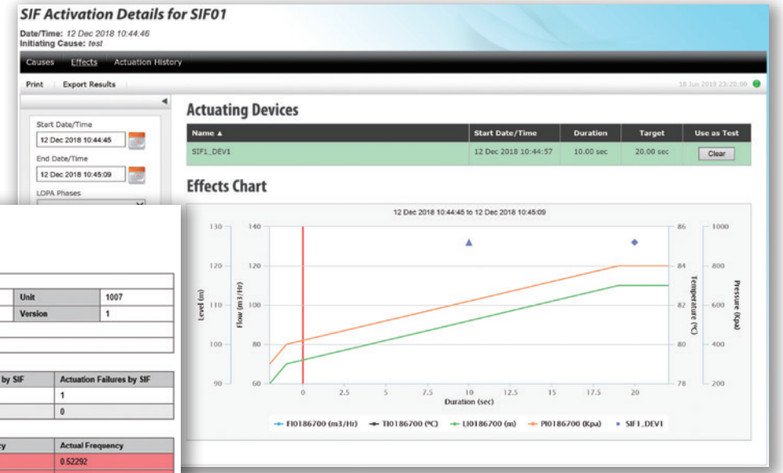
Challenge 9

I want to analyze the performance over time of my safety system to improve plant safety and availability throughout its life cycle. However, it is difficult to access and analyze past records to identify improvement opportunities.

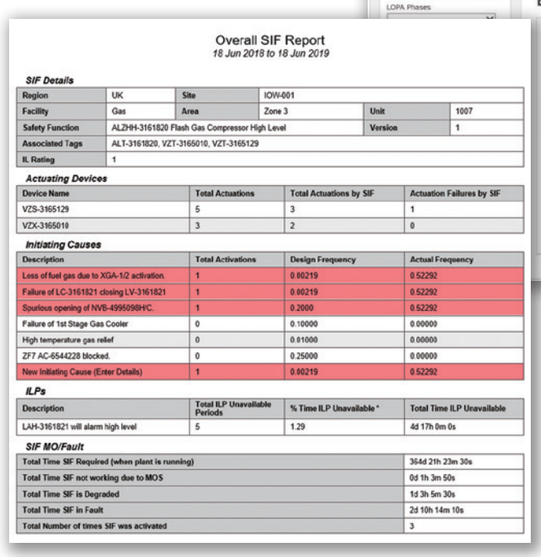
SSIS provides continuous improvements to plant safety.

- SSIS automatically collects safety statistics to be used for Safety Instrumented Function (SIF) improvement.
- 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 H&RA 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



Overall SIF Report
18 Jun 2018 to 18 Jun 2019

SIF Details

Region	UK	Site	IOW-001		
Facility	Gas	Area	Zone 3	Unit	1007
Safety Function	ALZHH-3161820 Flash Gas Compressor High Level			Version	1
Associated Tags	ALT-3161820, VZT-3165010, VZT-3165129				
IL Rating	1				

Actuating Devices

Device Name	Total Actuations	Total Actuations by SIF	Actuation Failures by SIF
VZS-3165129	5	3	1
VZX-3165010	3	2	0

Initiating Causes

Description	Total Activations	Design Frequency	Actual Frequency
Loss of fuel gas due to XGA-1/2 activation.	1	0.00219	0.52292
Failure of LC-3161821 closing LV-3161821	1	0.00219	0.52292
Spurious opening of NVB-4995098HC.	1	0.2000	0.52292
Failure of 1st Stage Gas Cooler	0	0.10000	0.00000
High temperature gas relief	0	0.01000	0.00000
ZF7 AC-6544228 blocked.	0	0.25000	0.00000
New Initiating Cause (Enter Details)	1	0.00219	0.52292

ILPs

Description	Total ILP Unavailable Periods	% Time ILP Unavailable *	Total Time ILP Unavailable
LAH-3161821 will alarm high level	5	1.29	4d 17h 0m 0s

SIF MO/Fault

Total Time SIF Required (when plant is running)	364d 21h 23m 30s
Total Time SIF not working due to MOS	0d 1h 3m 50s
Total Time SIF is Degraded	1d 3h 5m 30s
Total Time SIF in Fault	2d 10h 14m 10s
Total Number of times SIF was activated	3

Design Demand Rate versus Actual Demand Rate

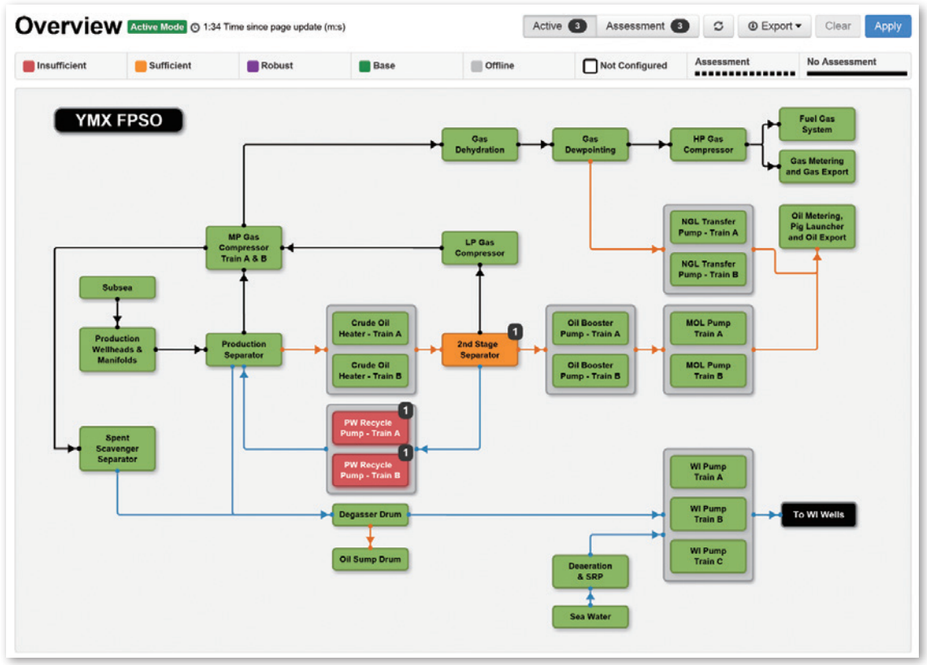
Pre-emptive impact assessment of safety overrides

Challenge 10

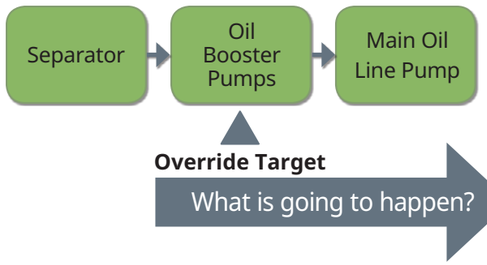
I need to override a Safety Instrumented Function (SIF) for maintenance. I want to assess the risk on-the-fly and understand the impacts and how they manifest in other areas of the plant. However, plant conditions are continuously changing and the process requires multiple and/or sequenced overrides.

SSIS facilitates decision making prior to applying overrides

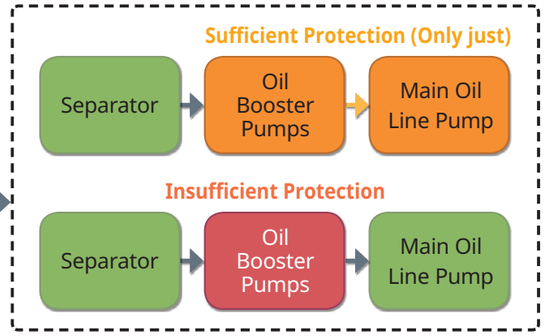
- SSIS helps you to assess the impact of overrides before their implementation, including effects which may manifest in other equipment.
- SSIS improves visibility of potentially unsafe situations and increases safety compliance by aiding policy enforcement and traceability of overrides.
- SSIS informs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



Current Plant State



If Override is Applied



See whether there is sufficient protection from other SIFs.

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 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 Application Securing Solution	iDefine for ProSafe-RS
Safety Performance Monitoring Solution	Exaquantum Safety Function Monitoring
	Exaquantum Override Safety Advisor

Synaptic Business Automation creates sustainable value by connecting everything in our customers' organization. To realize this, Yokogawa integrates its business and domain knowledge with digital automation technologies, and co-innovates with customers to drive their business process transformation.

YOKOGAWA ELECTRIC CORPORATION
World Headquarters
9-32, Nakacho 2-chome, Musashino-shi, Tokyo 180-8750, Japan
http://www.yokogawa.com/

YOKOGAWA CORPORATION OF AMERICA
12530 West Airport Blvd, Sugar Land, Texas 77478, USA
http://www.yokogawa.com/us/

YOKOGAWA EUROPE B.V.
Euroweg 2, 3825 HD Amersfoort, The Netherlands
http://www.yokogawa.com/eu/

YOKOGAWA ENGINEERING ASIA PTE. LTD.
5 Bedok South Road, Singapore 469270, Singapore
http://www.yokogawa.com/sg/

YOKOGAWA CHINA CO., LTD.
3F TowerD Cartelo Crocodile Building,
No.568 West Tianshan Road, Shanghai 200335, China
http://www.yokogawa.com/cn/

YOKOGAWA MIDDLE EAST & AFRICA B.S.C.(c)
P.O. Box 10070, Manama,
Building 577, Road 2516, Busaiteen 225, Muharraq, Bahrain
http://www.yokogawa.com/bh/

Visit our website at:
https://www.yokogawa.com/solutions/services/oprex/oprex-lifecycle/oprex-safety-and-security/

Represented by:

Printed in Japan, 907(KP) [Ed : 03/b]

YOKOGAWA Co-innovating tomorrow™