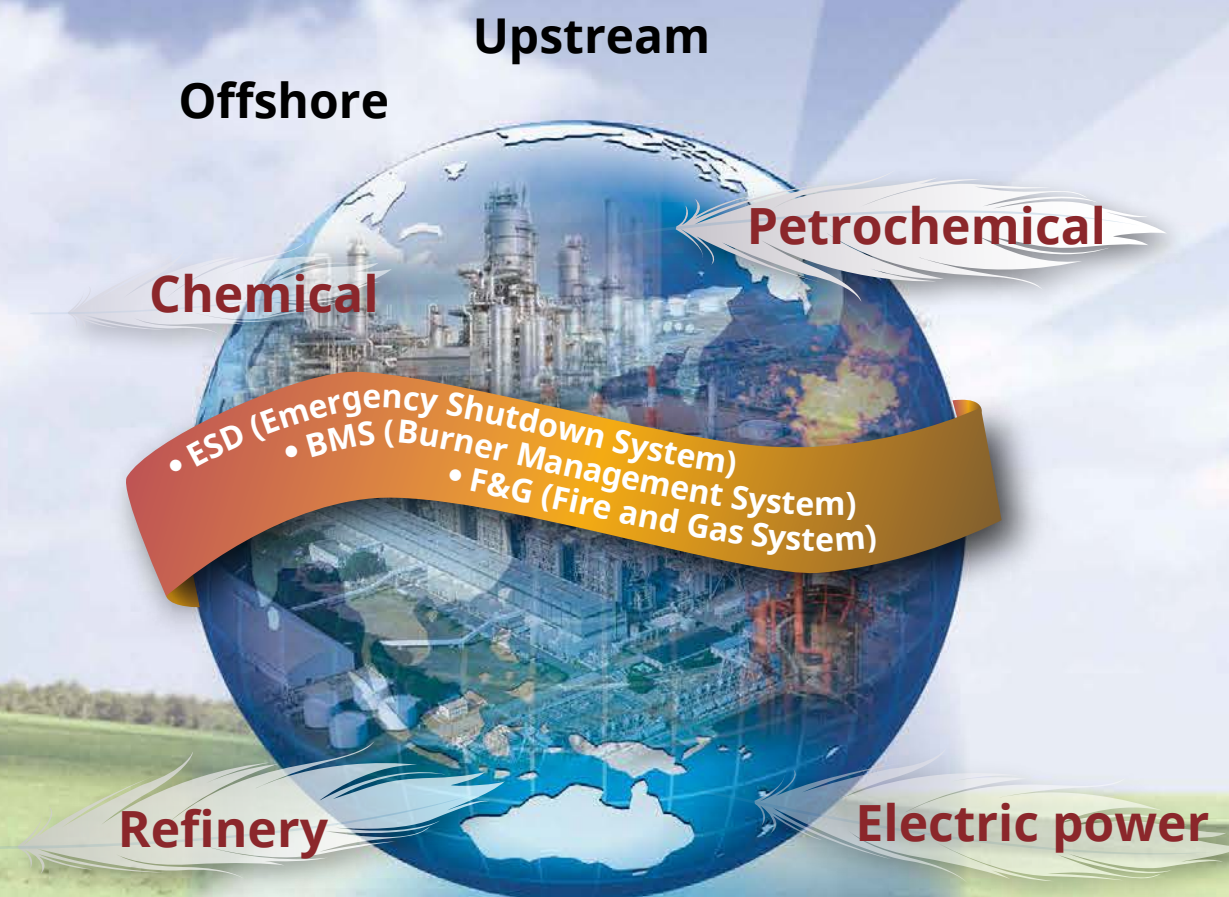**OpreX**™ Control and Safety System

Safety Instrumented System
ProSafe-RS

Securing the Safety Sustainability

Is your guardian vigilant?

Upstream

Offshore

Petrochemical

Chemical

- ESD (Emergency Shutdown System)
- BMS (Burner Management System)
- F&G (Fire and Gas System)

Refinery

Electric power

Downstream

ProSafe-RS

The Best and Most Dependable Partner for Safety Excellence

With its industrial automation solutions, Yokogawa is committed to being a vigilant partner for its customers and to helping them achieve Operational Excellence, Asset Excellence, and Safety Excellence. One such core solution is the ProSafe-RS safety instrumented system (SIS), which plays a crucial role in ensuring plant safety and draws from our supremely reliable distributed control system (DCS) technology and strong track record in the DCS and SIS businesses.

Before ProSafe-RS, DCSs and SISs were typically supplied by different vendors and required extra engineering for the individual systems and interconnections. Furthermore, these systems were more difficult to master and operate as they had different interfaces. ProSafe-RS overcomes these hurdles through complete integration with Yokogawa's CENTUM DCS – an industry first. The ProSafe-RS has been a global success since its debut in 2005, and is continually being improved.

The Best Safety Architecture

With its advanced diagnostics and dual redundant architecture in every module, ProSafe-RS achieves a high safety integrity level (SIL) and is highly reliable. All of the communication paths within the modules as well as links to other modules and systems are dual redundant as well. The unique architecture of this Yokogawa system ensures maximum safety and reliability.

The Best Performance

A high-speed CPU with a large memory ensures sufficient process safety time, even with large systems. With its outstanding scalability and suitability for widely distributed applications, this system offers both flexibility and unsurpassed performance, whatever the configuration.

The Best System Integration

Through its tight integration with control systems and asset management systems, the Yokogawa ProSafe-RS delivers Operational Excellence, Asset Excellence, and Safety Excellence to oil and gas upstream and downstream operations and to chemical, power, and steel plants.

The Best Lifecycle Support

With a variety of tools and functions, Yokogawa offers assistance and support through all phases of the plant lifecycle, from engineering to operation and maintenance. And through our global network of safety engineers and offices, we are well positioned to provide on-site support to our customers around the world.

The Best Safety Architecture : SIL3 and high availability through VMR technology

The Best Safety

ProSafe-RS has a unique and excellent dual architecture that is based on Yokogawa's supremely reliable DCS technology. The SIS has a modular design, and dual architecture is implemented inside each module . And the modules themselves can be installed in a dual redundant configuration. This is controlled by the SIS and is fully transparent to the user. This approach maximizes both safety and availability, independently and simultaneously. This flexible system configuration makes it possible for the user to configure redundancy on a module by module basis, achieving the required availability in each system component.
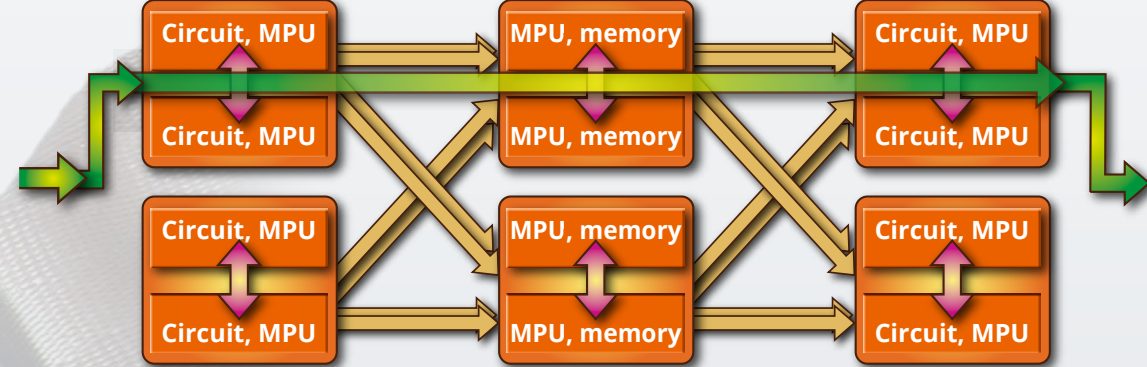
Simple, single SIL3

Using the latest electronic design techniques and component packaging, Yokogawa's designers have succeeded in miniaturizing the safety controller circuitry. Every ProSafe-RS processor, input module, and output module features a dual architecture, providing SIL3-level protection on a single card. This architecture is simple to understand, design, install, and maintain. Complete protection is available right out of the box.

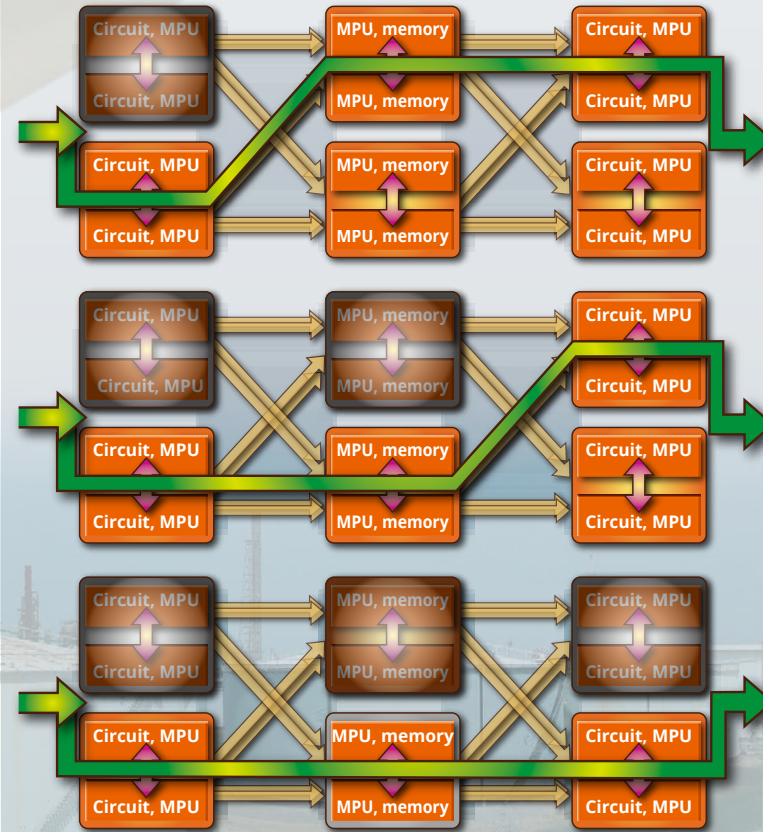| Circuit, MPU | MPU, memory | Circuit, MPU |
| Circuit, MPU | MPU, memory | Circuit, MPU |
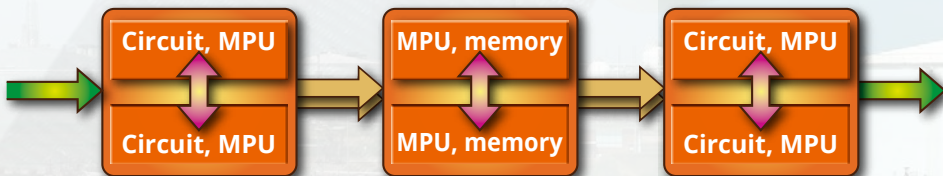
What is VMR ?

When an even higher level of system availability and fault tolerance is required, ProSafe-RS can be made dual redundant by simply plugging in an additional card. This flexible plug-in capability is called "VMR/Versatile Modular Redundancy™". Because the I/O and processing functions of ProSafe-RS are modularized right down to the function level, redundancy can be applied exactly where it is needed – to the input, output, and processor modules – providing the perfect combination of safety and economy. Any mix of dual redundancy can be configured. For example, users may opt for a single input module and dual redundant output modules, or dual redundant input modules and a single output module.

The green arrow shows signal path under normal conditions.

Circuit, MPU	MPU, memory	Circuit, MPU
Circuit, MPU	MPU, memory	Circuit, MPU
Circuit, MPU	MPU, memory	Circuit, MPU
Circuit, MPU	MPU, memory	Circuit, MPU

The green arrow shows signal path when a failure occurs.

VMR

By having a fully redundant configuration for extreme robustness, it is possible to maintain SIL3 even when the followings occur:
- Input failures
- CPU failures
- Output failures

Unlike systems which rely entirely on redundancy to achieve safety and availability, VMR does not have a degradation mode, nor does it impose time limitations on such a mode.

TÜVRheinland® CERTIFIED

Functional Safety Type Approved

www.tuv.com
ID 0600000000

The Best Performance : *First-rate processing and a compact size*

Small and Lightness

With a redundant CPU configuration, two CPU modules perform exactly the same actions. Should the control CPU fail, the stand-by module can assume control within 100 µs, with no impact on the process. The same applies to redundant I/O modules: switching occurs within tens of milliseconds and the process continues uninterrupted.

Control Bus (Vnet/IP)

MPU1	Comparator-A	Comparator-B	MPU2

Main Memory (ECC)

Application Program Memory (Flash Memory)

Control Bus Interface

SEN Bus Interface

I/O Controller · Red. CTL

CPU Module A · CPU Module B

The Best Performance

Based on Yokogawa's long experience in industrial automation, ProSafe-RS has been designed with a very high level of reliability and safety. As all safety loops require a quick response, ProSafe-RS can execute safety logic at world-class speeds of up to 50 ms, and allows many inputs and outputs to be scanned rapidly, meeting any application requirement.
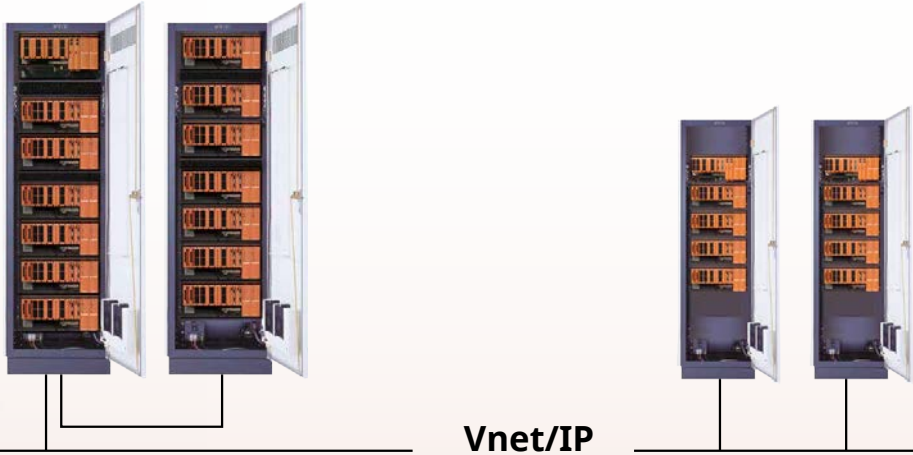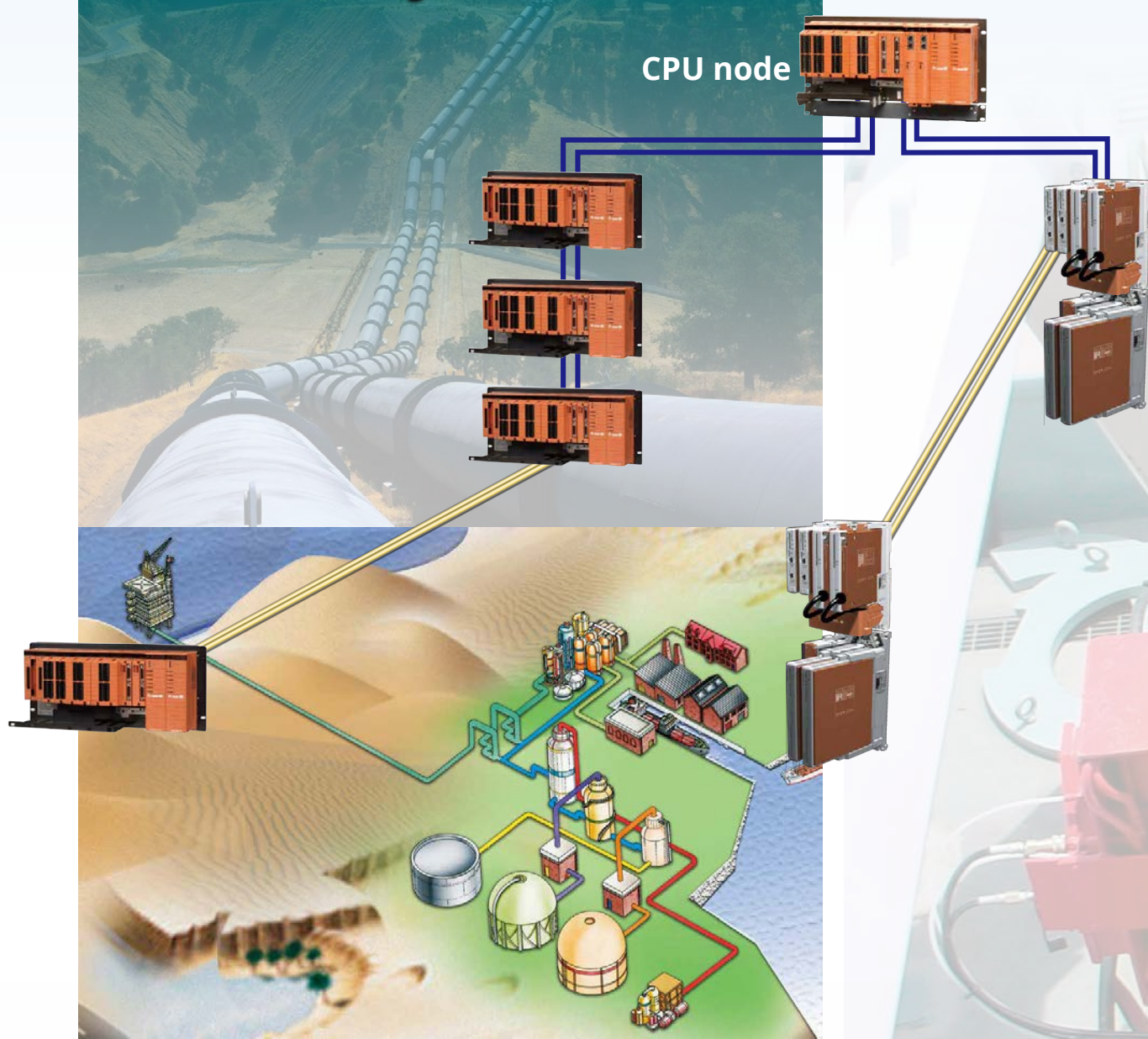
A Fully Capable Control System

Despite having a dual redundant circuit design, the CPU and I/O modules are exceptionally compact. The node height of just 266 mm (10.47 inches) permits installation in confined locations. Up to 14 nodes can be configured (one CPU node and 13 I/O nodes) per system, providing the flexibility to accommodate a wide range of I/O points requirements. Thanks to high-density I/O modules, up to 1500 I/O points can be handled per system. Even with the maximum configuration, all system nodes can be installed in three standard racks.

Further, Yokogawa's proprietary Vnet/IP network with its field-proven dual redundant technology can accommodate up to 64 systems per domain.

1500 I/Os for CPU rack and I/O racks

SOE Function

ProSafe-RS has a sequence of events (SOE) recording function. For digital inputs, it can acquire time-stamped event data from the DI modules with 1ms resolution. Events can be generated from the logic at each scan cycle, so the overall system behavior can be recorded. Up to 15000 events can be stored in each controlled. In addition, when trip events are specified, 500 pre-trip events and 1000 post-trip events can be stored.

Vnet/IP

The Best Performance : The wise choice for applications spread over a wide area

CPU node

Module Selection

I/O modules accommodate various signal ranges and levels including 4-20 mA, 1-5/1-10 V, TC, RTD, 24/48 V DC, and 120 V AC. For analog inputs, measurement outside the standard ranges is also possible. For example, as current levels in a 0-25 mA range can be measured, errors in a process or in a field device can be detected. And for 24 V DC outputs, various types of modules can be selected according to the output capacity and purpose.

In addition to conventional I/O modules for specific signal types, ProSafe-RS can offer the N-IO module, which handles different signal types: DI/DO/AI/AO at each channel.

All I/O modules have a line monitoring function for safety loops. The 4-20 mA input/output modules have a HART communication bridge function as a standard feature. The communication modules support the Modbus protocol.

N-IO

AI 4–20 mA
HART
COMMUNICATION PROTOCOL

AI 1–5/1–10 V

DI 24 V

DO 24 V DC (Max.2A)

DO 48V DC

DO 120 V AC

AO 4–20 mA
HART
COMMUNICATION PROTOCOL

Remote I/O

ProSafe-RS has an excellent remote I/O function that enables the linking in either a chain or star topology of I/O nodes that are up to 50 km (31 miles) apart. This makes it possible for controllers in a central control room to communicate with I/O modules in distant locations, thereby reducing system hardware and maintenance costs. And by combining distributed controllers on Vnet/IP, they can be allocated more flexibly.
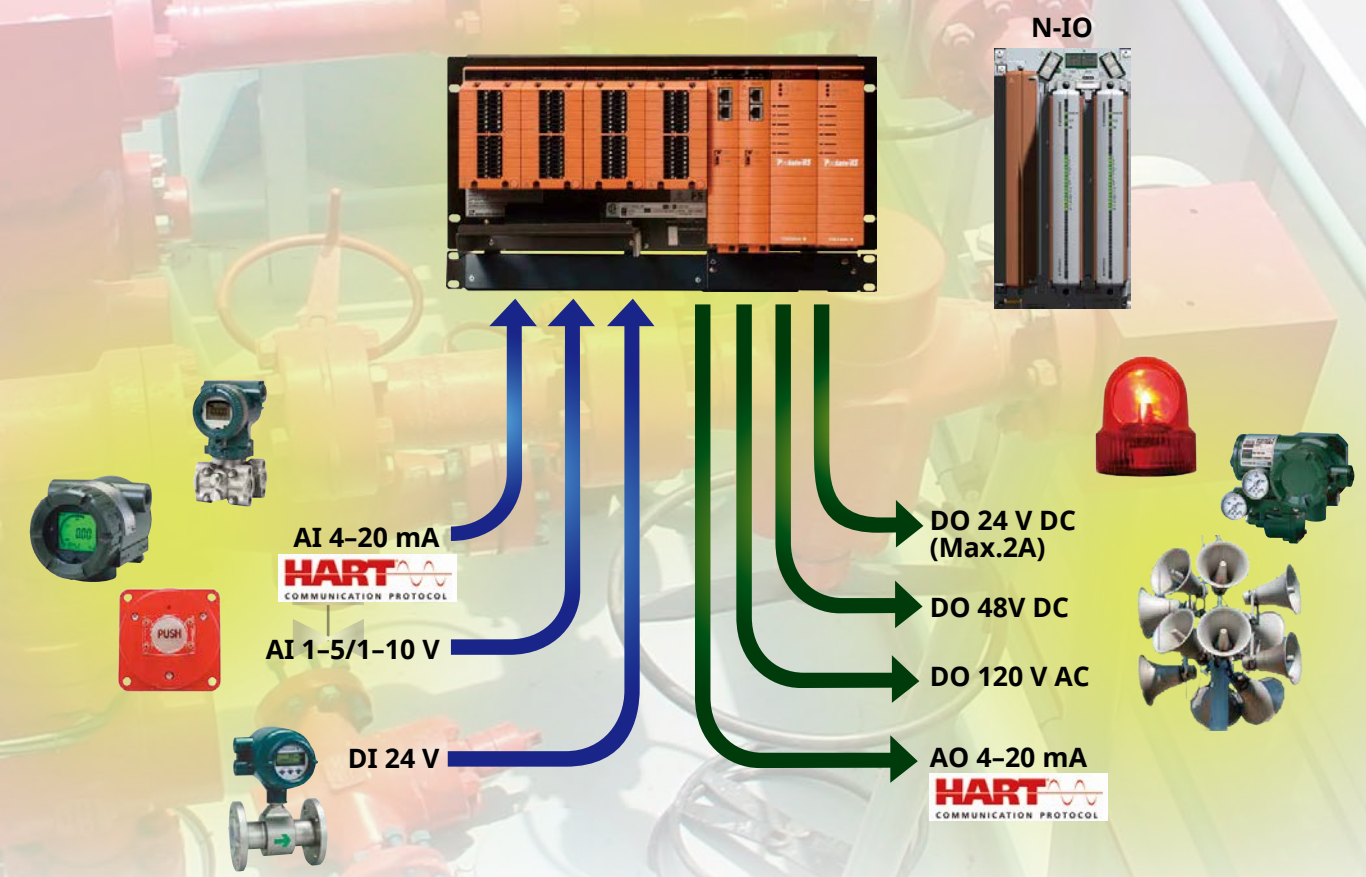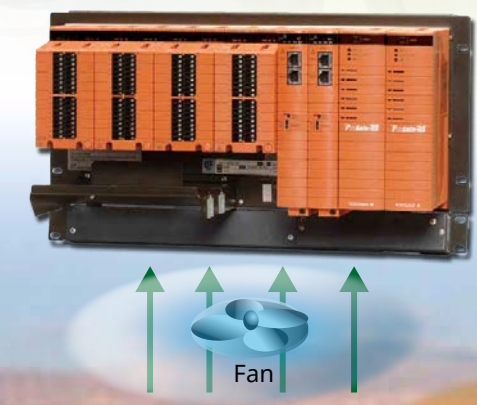
As remote I/O employs a fiber-optic link, the system response time from input to output through the CPU is the same as with local I/O. Even at the maximum distance of 50 km, the time lag is a mere 3 ms. Yokogawa's unique technology makes this possible.

Environmental Robustness

The safety control unit can withstand ambient temperatures ranging from –20°C to 70°C (–4°F to 158°F). Fans are available for high-temperature environments. It is thus possible to ensure safety at temperatures that are beyond the normal working temperature range of a DCS.

Fan

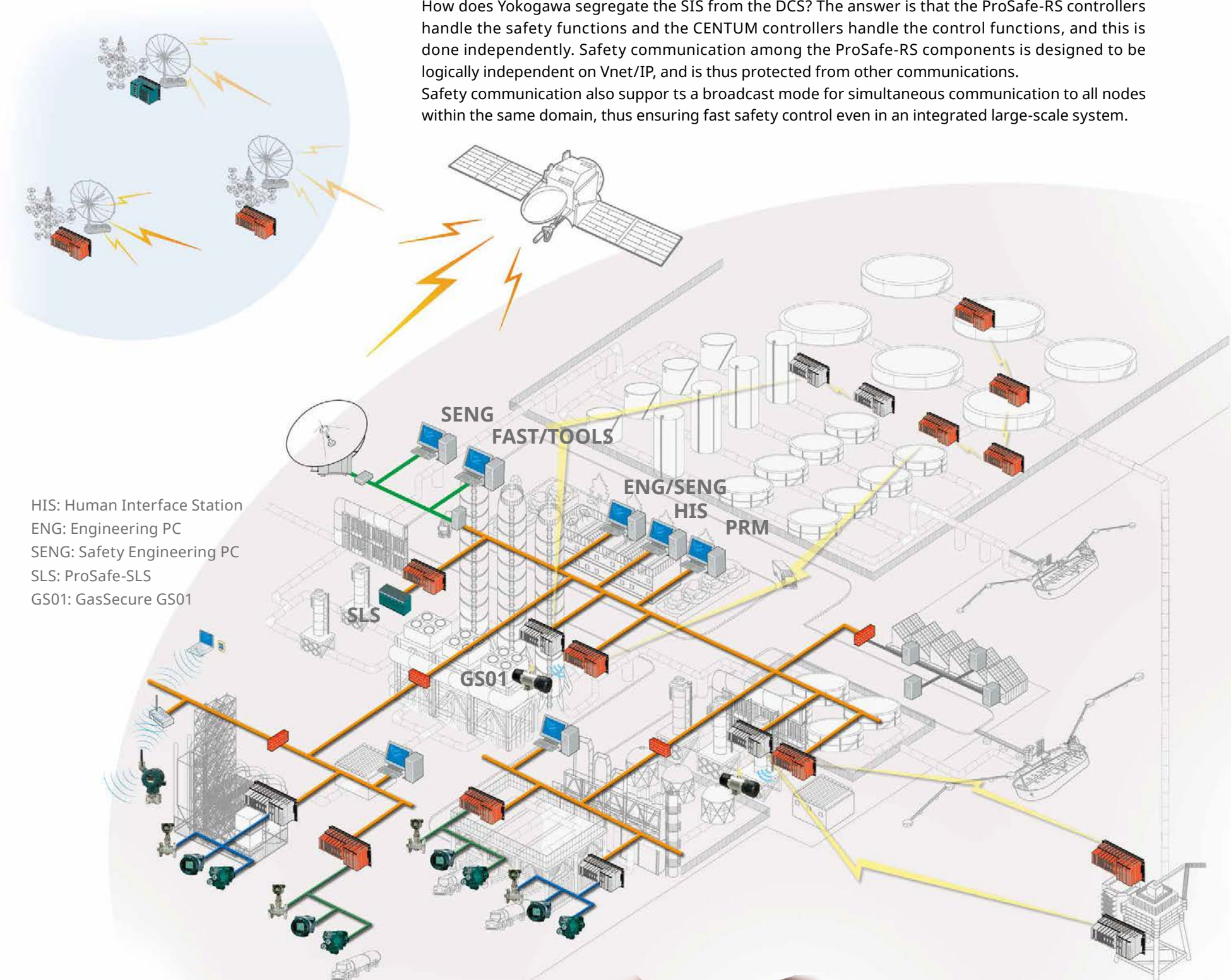# *The Best System Integration : One net work control of plant operation*

How does Yokogawa segregate the SIS from the DCS? The answer is that the ProSafe-RS controllers handle the safety functions and the CENTUM controllers handle the control functions, and this is done independently. Safety communication among the ProSafe-RS components is designed to be logically independent on Vnet/IP, and is thus protected from other communications.

Safety communication also suppor ts a broadcast mode for simultaneous communication to all nodes within the same domain, thus ensuring fast safety control even in an integrated large-scale system.

One Network

ProSafe-RS can function as an independent SIS, but is designed to deliver even greater benefits when used in combination with a DCS (CENTUM), SCADA system (FAST/TOOLS), and asset management system (PRM).

These Yokogawa systems can all be integrated on Yokogawa's Vnet/IP network, thus eliminating the time and cost of constructing separate networks for the control and safety instrumented systems.

In addition, the precise time synchronization function of Vnet/IP keeps the times in all integrated systems accurately synchronized (±1 ms within the same domain, ±5 ms across different domains), thus maintaining outstanding system reliability.

SENG
FAST/TOOLS

ENG/SENG
HIS
PRM

HIS: Human Interface Station
ENG: Engineering PC
SENG: Safety Engineering PC
SLS: ProSafe-SLS
GS01: GasSecure GS01

SLS

GS01

Security To prevent others from making undesired changes to the system, security settings can be configured for the safety controllers, the databases stored on the engineering workstation can be password protected, and access to the engi neering workstations can be restricted. Furthermore, security functions protect against virus and other forms of cyberattacks, ensuring safety even in an integrated networking environment.

Modbus   Vnet/IP

ProSafe-RS   OPC

Connectivity ProSafe-RS offers powerful performance and functions as an independent SIS, and can also be used with other venders' systems (DCS, PLC, etc.) as an alternative to Yokogawa products such as CENTUM and FAST/TOOLS.

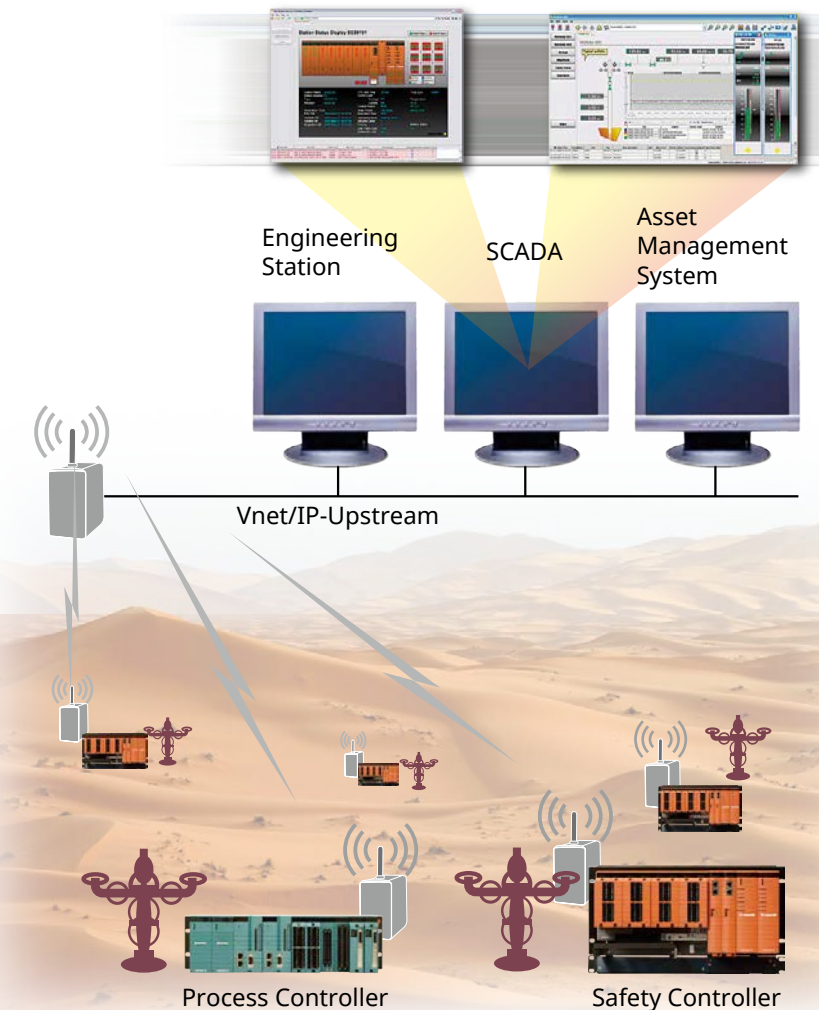# The Best System Integration : One window access to plant information

Unified Environment for Data, Alarms, and Device Status

Operators can access both DCS and SIS data from the control system's human-machine interface(HMI) station. This one window on the two systems simplifies the task of handling their data and eliminates the time consuming and expensive construction of separate monitoring environments. By using dedicated engineering tools which require no programming, an integrated environment can be built rapidly and effortlessly. Furthermore, the status of all the devices connected to the SIS, DCS, and SCADA system can be monitored from PRM. This vertical integration is key to achieving a vigilant plant.

DCS integration

Engineering Station

Operator Interface

Asset Management System

Vnet/IP

Process Controller

Safety Controller

One Window

Integration of the DCS with the SIS brings various benefits that are not possible with non-integrated systems. These include an operating environment with a unified user interface, integrated field device management, and remote engineering. Since the ProSafe-RS meets the control and safety segregation requirements specified by IEC 61508 when integrated with a DCS such as CENTUM and a SCADA such as FAST/TOOLS, it has been accredited by TÜV as an IEC 61508-certified integrated system. This makes it possible for users to design the ideal system for their processes, from upstream to downstream.

SCADA integration

Engineering Station

SCADA

Asset Management System

Vnet/IP-Upstream

Process Controller

Safety Controller

SCADA system integration

SCADA system integration through Vnet/IP-Upstream suits monitoring and control for widely located facilities such as oil/gas wellheads and pipelines.
By supporting a narrow bandwidth network (2 Mbps or more), communication via wireless links is applicable.
The buffering function on the safety controller also ensures the data continuity during the network failure.
In addition, AGA, American Gas Association, compliant gas calculation function with its report function and DNP3 communication protocol are supported.

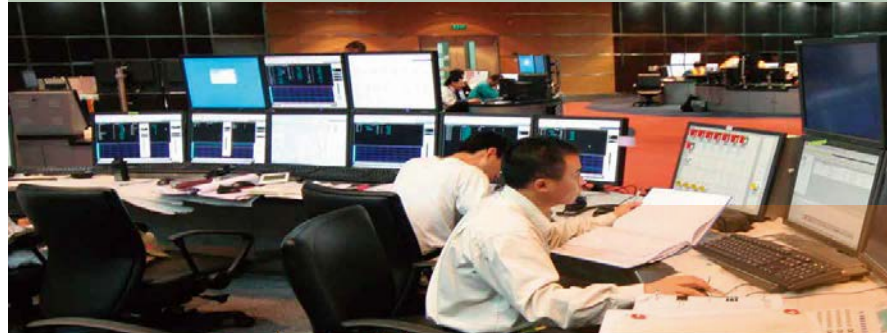# The Best Lifecycle Support : Safe, simple, and efficient in all phases

ProSafe-RS
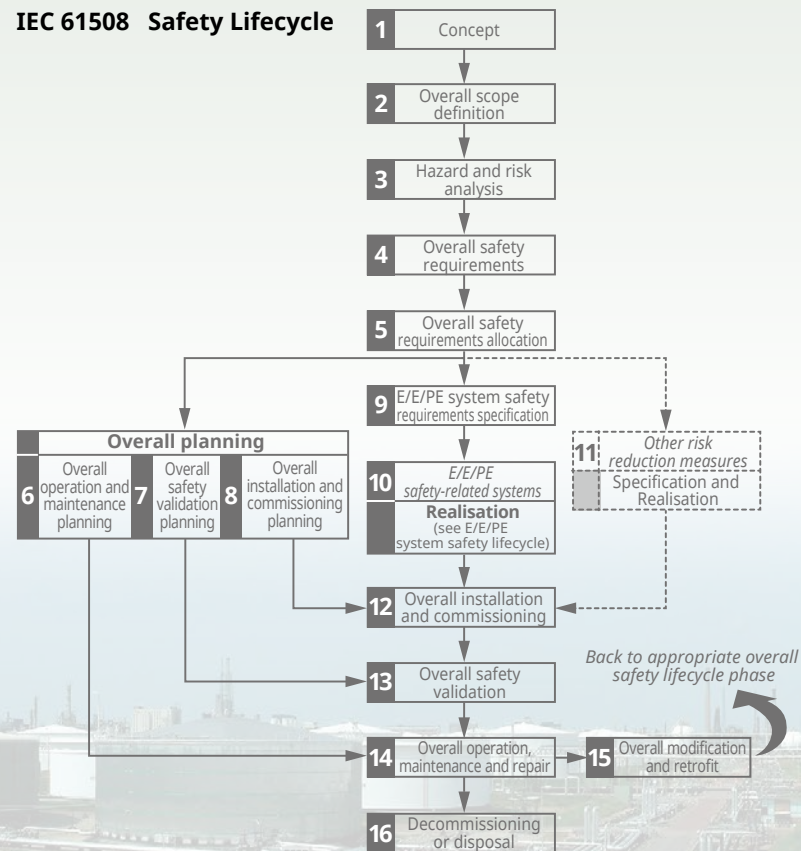

Engineering ➜ **Operation** ➜ **Maintenance**

Easier, Safer, and More Secure

A wealth of utilities and functions assist engineers and operators in all phases, from ProSafe-RS system design and configuration to installation, operation, maintenance, and updating. These help each task to be performed easily, safely, and securely.
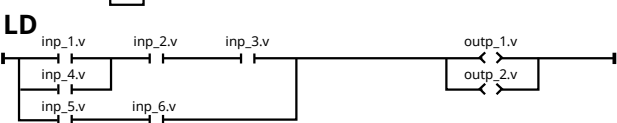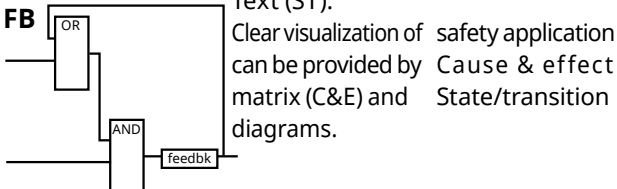
IEC 61508   Safety Lifecycle

1. Concept
2. Overall scope definition
3. Hazard and risk analysis
4. Overall safety requirements
5. Overall safety requirements allocation
9. E/E/PE system safety requirements specification

Overall planning

6. Overall operation and maintenance planning
7. Overall safety validation planning
8. Overall installation and commissioning planning

10. E/E/PE safety-related systems **Realisation** (see E/E/PE system safety lifecycle)

11. Other risk reduction measures Specification and Realisation

12. Overall installation and commissioning
13. Overall safety validation
14. Overall operation, maintenance and repair
15. Overall modification and retrofit
16. Decommissioning or disposal

Back to appropriate overall safety lifecycle phase

Programming Languages

Application logic can be programmed in any of three IEC 61131-3-compliant languages: Function Block Diagram (FB), Ladder Diagram (LD), and Structured Text (ST). Clear visualization of safety application can be provided by Cause & effect matrix (C&E) and State/transition diagrams.

FB

LD

ST

C&E

Analyzer Functions

Integrity Analyzer checks whether application programs are using certified elements. Cross Reference reports on any changes from the previous and on any impact this might have. These functions can dramatically decrease the time required to check and validate the check, loop check after a program prior to downloading it, and eliminate the need to perform a the download.

Integrity   Analyzer

SOE Viewer

This function allows the SOE data stored in multiple safety controllers to be acquired, viewed, and analyzed together with alarm data from the DCS. It enables in-depth analyses of the overall system behavior before and after a trip. Sequences of events can be automatically saved and also exported to CSV text files by a background task.

OTS Solution

Operator training with an operator training simulator (OTS) is necessary before a system can be put into operation, and periodic training on emergency response procedures is also required. As Yokogawa's OTS simulates the integrated ProSafe-RS and CENTUM systems, it needs only to be combined with a process simulator to simulate the actual operating environment.

PC	PC	PC
ENG/SENG	HIS Simulator	OTS (& process simulator)

PC	PC	
FCS Simulator	SCS Simulator	
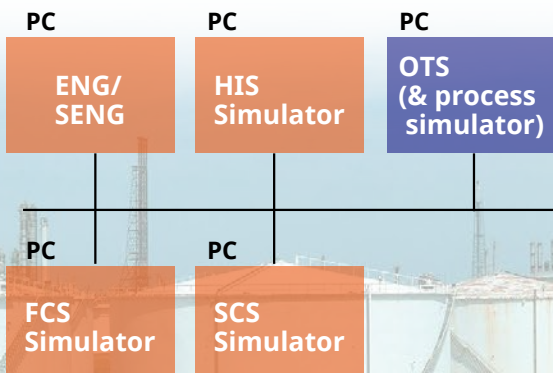
PST Solution

A partial stroke test (PST) is useful for ensuring the safety and reducing the maintenance cost of safety valves. As ProSafe-RS supports HART communications, users can use the PRM software to carry out PSTs on safety valves that are connected to ProSafe-RS. For more information about PSTs, see bulletin 32S51Q10-01E.


Online Maintenance

The following functions are used to perform various online maintenance tasks without interrupting the plant processes:

• **Auto-copy of module settings:** When one of a pair of dual redundant CPU or I/O modules is replaced, the settings of the module that remains in service are automatically copied over to the newly inserted module, thereby maintaining dual redundancy.

• **Online addition of I/O modules:** Useful when input and/or output modules need to be added to adapt to changes in plant configuration.

• **Scan time change:** Useful when the scan time needs to be changed to adapt to changes in the system environment.

• **POU change:** Useful for changing or adding SIS logic.

The Best Lifecycle Support

Not only have our products been certified according to international safety standards, they are backed by the safety expertise of Yokogawa Group engineers at certified offices and facilities worldwide. With this organization, Yokogawa provides strong safety system installation and operation support to its global customer base.
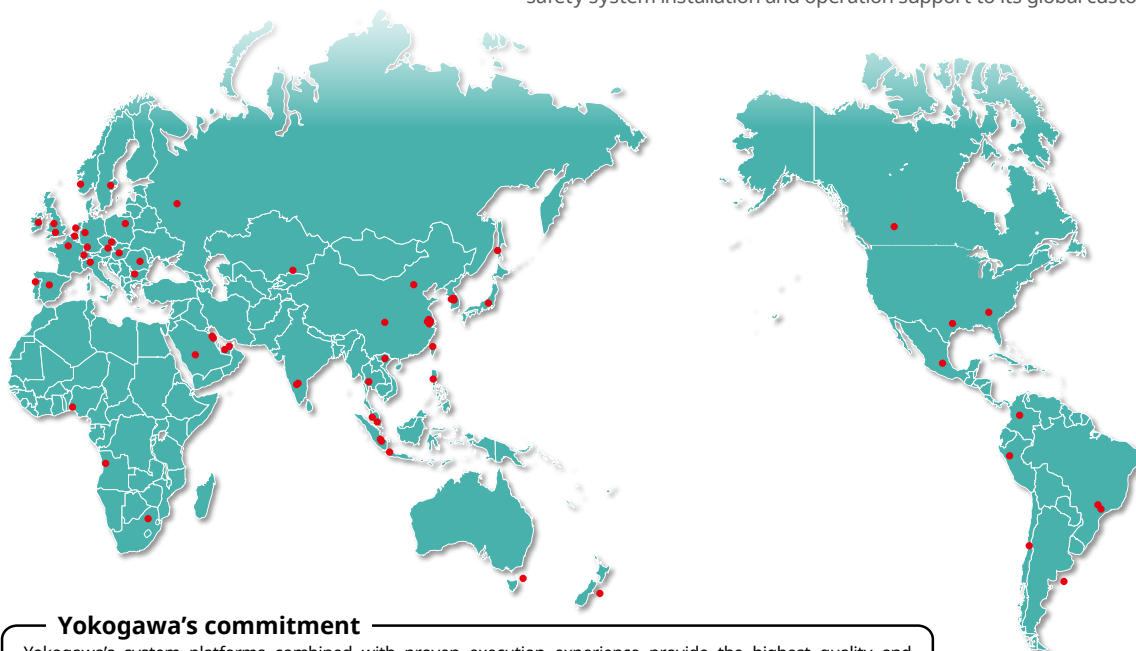
┌─ **Yokogawa's commitment** ─────────────────────────────────┐
Yokogawa's system platforms combined with proven execution experience provide the highest quality and innovative solutions for secure and optimized process automation and management. Yokogawa's global customer centric focus together with strong local support reduces users' business risks and provides the lowest total cost of ownership. With a long history of progressive compatibility, Yokogawa is your dependable automation partner.
└──┘

OpreX™
Yokogawa achieves operational excellence by providing products, services, and solutions based on the OpreX comprehensive brand that cover everything from business management to operations.

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/products-platforms/
control-system/safety-instrumented-systems-sis/**

Represented by:

Printed in Japan, 910(KP) [Ed : 16/b]

YOKOGAWA ◆ Co-innovating tomorrow™