# SIS 401 - Smart SIS

**15 minutes**

In this course:



## Overview


Protecting the safety of your plant, personnel, and community requires an SIS with both very high safety and high availability. In the long run, IEC 61511 compliance will help you reach these goals more easily and profitably. But it can also require lots of up-front work. And while ensuring safety is always top priority, the words "spend as much time and money as you need" are seldom heard in plants.

Fortunately, advances in technology have led to the emergence of what's called a **smart SIS** — and eased the task of providing the safety and availability you require.

A smart SIS extends the proven technologies of digital plant architectures to safety applications. These technologies include microprocessor-equipped field devices, digital communications, asset management software, and related improvements in system design and integration.

As a result, a smart SIS delivers many of the same benefits such architectures provide in control-oriented applications — including easier implementation, operations, and maintenance; increased availability; and lower life cycle costs. But a smart SIS is built for safety-specific functions, and the system as a whole is designed to ease IEC 61511 compliance.

This course outlines both the key features of a smart SIS and some of the primary benefits it provides. By the end of the course, you'll have a better understanding of why a smart SIS is likely to be the best choice for many plants — possibly including yours.

**Hint**

As you go through the topics in this course, pay special attention to the following:

- Which components of a smart SIS are "smart"?
- What additional information does a smart SIS monitor and use in decision-making?
- How does a smart SIS detect and identify potential problems?
- How does it reduce costs?

## Why It Matters

Plants are inherently dangerous. The SIS is supposed to protect you against many of those dangers, but it can't do that unless all its components are working properly. The problem is that the performance of those components will eventually degrade or fail. With traditional SIS technology, you may have no warning such problems are coming, and possibly no way of knowing even after a failure has occurred — leaving your plant unprotected.

Sure, you can improve the odds that the SIS is working correctly by frequently shutting down the plant to run proof tests and do preventive maintenance. But the lost production and added labor costs make that an expensive solution.

It's a little like driving a car without being able to see the warning gauges on the dashboard. To reduce the risk of breakdowns, you'd have to stop every few miles to check the radiator, change the oil, and even perform a complete tune-up ... spending a lot of time and money without getting very far. If something went wrong between those frequent checkups, you'd still have no way of knowing about it until you saw smoke or the car ground to a halt.

As you'll see in this course, however, a smart SIS can give you a much better view of what's happening, so you can know it's doing its job — or if something needs attention.

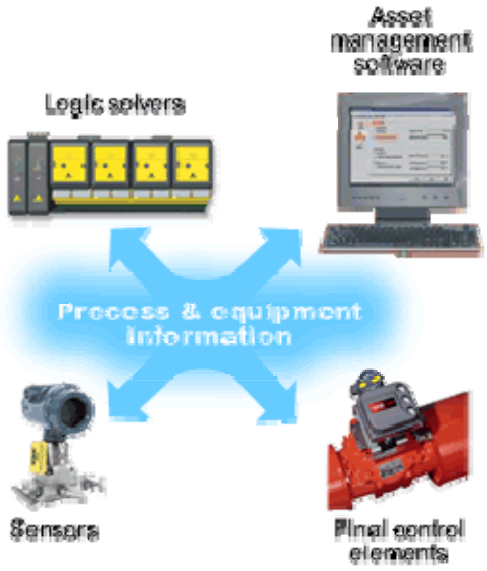
To take our dashboard analogy even further, a smart SIS also provides more than an uninformative "check engine" light indicating that something, somewhere, has already gone wrong. Instead, you get a clear picture of what and where the problem is, often while there's still time to take corrective action.

Many of the technologies behind this **predictive intelligence** also help overcome other limitations of traditional SIS solutions — from reducing the cost and difficulty of SIS design, implementation, operations, and maintenance, to easing compliance with IEC 61511.

Let's see what's behind those benefits.

## What is a Smart SIS?

A smart SIS includes the primary components of any SIS — sensors, final control elements, and logic solvers — but adds the benefits of **digital intelligence** throughout an integrated safety loop.




A smart SIS takes advantage of information flow throughout the complete safety loop. This flow includes not only traditional measurement and control data, but additional information on equipment and process health.

In the next five topics we'll take a closer look at key aspects of a smart SIS:

- Intelligent field devices
- Digital communications
- Smarter logic solvers
- Asset-management software
- Complete-loop solutions

## What is a Smart SIS? - **Intelligent Field Devices**

The difference between traditional and smart safety instrumented systems begins with intelligent SIS **sensors** and SIS **digital valve controllers**.

These devices use onboard microprocessors to collect, manage, and communicate not only process variables and control signals, but also information about the status of the devices themselves, related equipment, and even the surrounding process.

This information enables **diagnostics** to detect, identify, and even predict problems that could lead to poor safety or undermine SIS reliability — diagnostics that include not only the system components themselves but also the surrounding process and equipment.

For example, a smart temperature transmitter can signal when it detects a failed temperature probe. A Coriolis flowmeter can identify slug flow. Or a pressure transmitter can alert you when surrounding conditions — such as a steam leak — have raised the temperature in its electronics enclosure beyond normal operating limits.

Similarly, a smart digital valve controller can signal a loss of air supply pressure, or increasing stem friction

that could keep the valve from moving properly when needed.

But traditional 4-20 mA analog field communications carry only a single, one-way signal on each wire pair. How does all this new information move through the safety loop?

## What is a Smart SIS? - **Digital Communications**

HART communications carry the added information from intelligent field devices throughout the loop, as digital data superimposed on the normal 4-20mA signal.

The digital information can flow in both directions. Not only can a smart transmitter send its process variable and status information to the logic solver and asset-management application, but it can also receive data — for configuration or calibration, for example.

Although HART data can be used to predict and identify potential problems, it is not certified for use as the sole source of information for safety-related decisions. The expansion of all-digital protocols such as FOUNDATION fieldbus to safety applications is expected to provide even more robust and flexible communications in the not-too-distant future — including safety-certified information.

## What is a Smart SIS? - **Smarter Logic Solvers**

The logic solvers in a smart SIS have been specifically designed to take advantage of the added information available from the system's intelligent sensors and valve controllers.

For example, a smart SIS recognizes when an input is bad or even questionable. The logic solver evaluates the information and, depending on how it is configured for each set of circumstances, can respond by…

- raising an alarm to Operations or Maintenance
- bypassing the faulty measurement and using data from another device in a redundant set until the first can be checked, or
- tripping the safety function.

A smart SIS provides all of these options, and more.

## What is a Smart SIS? - **Asset Management Software**

Specialized **asset management software** documents, archives, and processes data about a smart SIS's intelligent field devices.

While the logic solver uses status information about the devices, the asset management software provides a central database and window into the wealth of information about these sensors and final control elements, including instrument configurations and changes, health information, and alarms. It also analyzes equipment and diagnostic data to identify problems and provide guidance on correcting them.

Information from the software can be accessed wherever it's needed, from operator workstations to engineering offices. However, it's used most often in the maintenance shop, where its analysis and reporting tools provide a single application for predictive diagnostics, documentation, calibration management, and device configuration.

## What is a Smart SIS? - **Complete-Loop Solution**

The ability to gather, interpret, and use information about the condition of the whole loop also enables a more comprehensive view of SIS status and reliability than can be achieved with traditional solutions.

The logic solver in a smart SIS not only knows whether it's working correctly, but also if the SIS field devices are doing the same. That means it knows whether it can use the information from sensors to make safety decisions, and whether the final control elements will respond if needed — and so do you.

That's especially important considering that — as you saw in SIS 201 — over 85% of problems affecting the operation of an SIS are related to the field devices, not the logic solver.


Source: Emerson analysis of OREDA data

A smart SIS uses diagnostics and digital communications to "see" what's happening not only in the logic solvers, but throughout the complete safety loop, including field-device problems that lead to most SIS failures.

In other words, with a smart SIS you'll know what's happening in the weakest links of the safety loop — usually with enough warning to take corrective action before SIS reliability is affected.

And that leads us to one of the greatest benefits of a smart SIS: increased availability.

## Higher Process Availability

An SIS must be available to do its job any time the process is running. If you know it's not available, you must shut down the process, which means the plant loses money.

But even bigger problems can occur when you **don't know** the SIS isn't working properly. An undetected failure of the SIS can result in

- a spurious trip and expensive unexpected shutdown, or
- a dangerous condition that can lead to a disaster.

That's why maximizing the scope of SIS diagnostics is essential to detecting failures. And a smart SIS helps you do just that — by monitoring equipment as well as process status so you can head off problems before they reduce availability.

Let's look at some of the ways a smart SIS increases availability.

## Higher Process Availability - **Diagnostics**

Because the diagnostics in a smart SIS can often detect the early warning signs of potential problems, you can take corrective action before SIS availability is affected — from replacing or repairing a device that's about to fail, to changing the way the process is running to ensure continued safe operations.

As you learned in SIS 301, knowing exactly which equipment is showing signs of deteriorating performance — and even when it might fail — also opens the door to the benefits of predictive maintenance, including less downtime, lower costs, and higher personnel efficiency. And because most diagnostics can be performed remotely using asset-management software, your maintenance technicians don't have to go into hazardous areas as often or for as long — increasing personnel safety.

In addition to device-based diagnostics, a smart SIS also includes extensive logic solver diagnostics. Some are based on **comparing** two or more identical circuits performing the same function to confirm that they generate the same output. Others use **reference** diagnostics, which test a circuit and compare the response to known expected values. These reference diagnostics allow a smart SIS to achieve better safety and higher availability than comparison diagnostics alone.

## Higher Process Availability - **Partial-Stroke Testing**

One particular type of diagnostic — partial-stroke testing of SIS final control elements — can further improve availability by extending the interval between full proof tests, which often require plant shutdowns.

A smart SIS can automatically initiate partial stroke tests by sending a HART command to the digital valve controller. The controller executes the test and logs thousands of data points before sending a pass/fail signal back to the logic solver. This alerts the operator to a problem, if one exists, and all of the details are logged at the maintenance station.

Executing the test in a digital valve controller has another advantage: The controller's onboard microprocessors, together with software written specifically for this purpose, can scan and process those thousands of data points more quickly and thoroughly than would be possible in a logic solver that's also monitoring the entire loop.

*For details of how partial-stroke testing can extend proof-test intervals, see SIS 201.*

## Higher Process Availability - **Alerts**

The nature and urgency of the diagnostic information determines who needs to know, and how quickly, in order to maintain SIS availability. The information is of no value unless it gets where it's needed, when it's needed.

In a smart SIS, equipment status data is available in real time to the logic solver. But for issues that can immediately affect process operations or safety, a smart SIS can also send an alarm to the on-duty operator, including information on likely causes and appropriate responses. Lower-priority alerts can be directed to Maintenance, Engineering, or other personnel for later attention.

A smart SIS also ensures that the relevant data is logged, and that all the actions that can be taken automatically are performed.

For example, the asset management software in a smart SIS can automatically generate a work order for a maintenance management package such as Maximo, or initiate pre-ordering spare or replacement parts with an enterprise management system such as SAP or Oracle.

## Easier Compliance

A smart SIS is designed to help you comply with IEC 61511. That includes easing the **documentation** that's required at each stage of the safety lifecycle — often completely automating it for you.

For example, a smart SIS can use its intelligent field devices and logic solvers together with engineering and asset-management software to automatically document

- Changes in device and system configuration
- "As found" and "as left" device calibration data, as well as other maintenance and repair activities
- Diagnostic results, including valve partial-stroke tests, sensor tests, and SIS loop health tests
- Alarms, alerts, and other system events.

Modular software design eases SIS validation by eliminating the need to validate each instance of software that serves the same function. A smart SIS also analyzes any new software downloaded to the logic solver to identify which software modules and I/O are affected, so only those portions need re-validation.

Intelligent **security** features also help block unauthorized or inappropriate changes that could cause a loss of validated status. These features include user-management tools to control who can change SIS configuration and functionality, as well as requirements for repeated confirmation of changes.

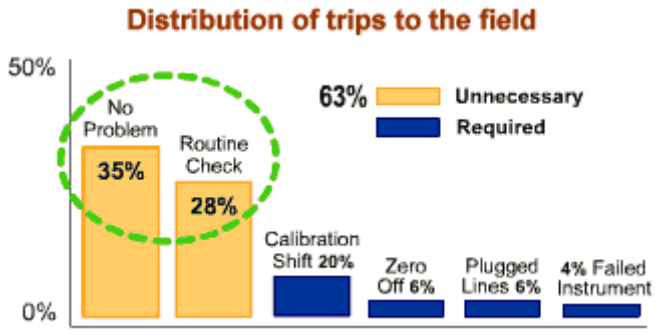
## Lower Costs

Like the digital plant architecture on which it is based, a smart SIS can significantly reduce **up-front costs** for engineering, installation, and commissioning. For example, graphical function blocks ease design and reduce system configuration time. And digital status checks eliminate the need to send a technician into the field with a walkie-talkie to manually "ring out" each device as it's installed.

But these activities are only the beginning of the safety lifecycle. The **operations and maintenance** phase lasts much longer and holds the greatest opportunities for cost control.

You've already seen how a smart SIS's automated **partial-stroke valve testing** can extend the intervals between proof tests. Besides the resulting savings from reduced downtime, this capability also reduces equipment and labor costs by eliminating the need for expensive field-mounted test panels, and for sending personnel into the field to conduct the tests and observe the results.

And we've already covered the increased availability that's possible using equipment **diagnostics**. But these diagnostics can also reduce labor costs by eliminating the need to send a maintenance technician into the field for routine equipment checks — especially when it turns out there's nothing wrong with the equipment.




Remote diagnostics reduce labor costs for unnecessary equipment checks.

Even when the equipment does need attention, a smart SIS helps reduce costs:

- Early detection and prediction of potential problems enable you to take corrective action before expensive repairs are needed, and to schedule the work when it can be done most efficiently.
- Knowing what the problem is before your technicians leave the shop means they can take the right tools and parts with them the first time. For scheduled shutdowns, they'll even know which parts to order to in advance.
- And automatic documentation cuts down on the time they spend on paperwork, while also reducing the risk of data-entry errors.

Finally, there's the biggest cost avoidance of all: A smart SIS makes it possible to detect and correct problems before they cause a false trip and resulting downtime — or, worse, keep the SIS from reacting properly to avoid a fire, explosion, or other safety incident.

## Smart Implementation

Even a smart SIS can't offer the protection you need if it isn't implemented properly. The best way to be sure the SIS will do its job when needed is to ensure IEC 61511 compliance throughout a safety project.

With the traditional project approach used by some system integrators, however, full compliance can be a challenging (and expensive) goal — especially if an audit of the completed project reveals a problem. Then you have to go back to the point where the problem began and redo much of the work that had already been completed.

A smarter approach uses procedures designed and certified to ensure IEC 61511 compliance right from the start. Such procedures might include writing a comprehensive safety requirements specification (SRS) and validating that each safety instrumented function (SIF) achieves the required risk reduction factor — as well as taking advantage of smart SIS features like automated testing and documentation.

The table outlines some example differences between the traditional and "smarter" approaches.

| Project phase | Traditional approach | Smarter approach | Impact |
|---|---|---|---|
| Project setup | None | Create safety certification plan defining required activities. | Up-front work ensures all activities required for compliance are clearly defined and planned...no omissions or last-minute surprises. |
| System design & configuration | Use integrator's standard procedures. | Use standard procedures certified to comply with IEC 61511. Plan all required tests, based on activities defined above. | In the traditional approach, success depends on the individual integrator's procedures and experience of personnel involved. With the smarter approach, compliance is |

| | | | |
|---|---|---|---|
| System test | Pre-FAT (factory acceptance test), FAT if required, and third-party audit of all project documentation for IEC 61511 compliance. | Complete system test according to predefined test plan. FAT if required. No 3rd-party audit required. | Smarter approach avoids cost and schedule impact of third-party audit — and provides all test documentation required by 61511. |
| Rework | Amend design, documentation, configuration, and SIF implementation as required by audit findings. | No rework required. System is automatically compliant. | Rework is not only expensive but can cause major schedule delays. |
| Certification | Third-party certification of portions of the project that were audited (typically not the entire | No certification required. System is automatically compliant. | Besides being less costly than third-party certification, automatic compliance covers the full |

## The PlantWeb Advantage

You've taken these courses to learn about safety instrumented systems, not to endure a sales pitch. That's why information specifically about Emerson products and services has been limited to the "PlantWeb Advantage" boxes in some courses — and this page.

We're making this exception because it's important for you to know that the advantages of a smart SIS are no longer theoretical. They're very real, and available today from Emerson.

Emerson's smart SIS extends the proven technologies of our PlantWeb digital plant architecture to safety applications — including digital intelligence and diagnostics to increase system availability while reducing life-cycle costs and easing regulatory compliance.

Other advantages include

- A complete, integrated loop — including intelligent sensors, final control elements, logic solvers, and asset-management software
- Components certified for up to SIL 3
- Automated performance monitoring, testing, and documentation
- Flexible, modular, and scalable design for applications of any size, anywhere — and for easier system changes as your needs change
- Embedded simulation for testing safety logic before deployment
- Function blocks that simplify safety-logic development
- Intelligent alarm management

…all backed by our global network of safety and automation specialists.

And because Emerson's SIS implementation services use TÜV-certified project engineering procedures, an Emerson safety project is automatically compliant with IEC 61511 and requires no expensive auditing from inspection bodies.

For more on Emerson's smart SIS, see www.EmersonProcess.com/SIS.

## Summary

In this course you've learned that:

- A smart SIS uses digital information about equipment and process health to maintain the reliability and performance of the complete safety loop — including sensors, final control elements, and logic solvers.
- Benefits include higher SIS availability, lower costs, and easier IEC 61511 compliance.
- Implementation procedures that comply with IEC 61511 and take advantage of smart SIS capabilities can reduce cost and schedule risks while ensuring compliance with the standard.