How Yokogawa’s DCS Hardware Satisfies the SDGs

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Yokogawa’s distributed control systems (DCS) have long been valued by customers for their long-term operability and high reliability. In particular, reliability is crucial throughout the plant lifecycle, from installation, startup, and engineering, to maintenance and scrapping. High reliability also helps satisfy the SDGs, which were introduced in 2015 and require sustainable development in the three fields of the economy, society, and the environment.

This paper introduces the features and hardware of Yokogawa’s DCS and shows how the company is working on achieving the SDGs.

INTRODUCTION

As industrial infrastructure, plants have a huge impact on the environment and society. Therefore, the requirements for distributed control systems (DCS) installed in plants have focused on the following points:

- Installation cost
- Production continuity
- System inheritance

However, since the SDGs were set as international goals and are recognized as environmental and social common values across companies and countries, plants need to deliver even greater value to society. Companies are often questioned about their efforts to achieve the SDGs. In particular, many plant owners are acutely aware of the SDGs because of the significant impact of their plants on the environment and society.

A DCS is required to operate 24/365. In addition, a DCS must help keep plants running throughout their long lifecycle while maintaining system inheritance.

Having accumulated know-how on plant optimization through its experience with DCSs, it is becoming increasingly important for Yokogawa to use this know-how to meet customer needs. We conducted a value architecture (VA) analysis (1) on needs and seeds regarding the hardware of system products (Figure 1). This paper describes the results and explains how Yokogawa’s hardware satisfies the SDGs.

REQUIREMENTS FOR PLANTS

Plants in the oil refining, iron and steel, and chemical industries support society. This industrial infrastructure is controlled by the DCS. Customers need to keep their plants running stably and safely for a long time because such plants

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are crucial for society. In particular, the hardware must keep functioning for at least 10 years, and for even longer depending on the operating conditions. An increasing number of customers want to extend the plant lifecycle as long as possible by partially renewing or upgrading the DCS while using the existing cables, wiring, and casing. Although this will help reduce costs and shorten the construction period, it is vital to ensure the safety of the equipment, including its mounting position in the cabinet.

To ensure plant safety, many customers inquire about the flame resistance of cables and their compliance with environmental standards. The latter concern seems to reflect the increasingly strict requirements of countries and the growing awareness of environmental conservation. Yokogawa is responding to such plant requests as follows.

**APPROACHES TO DCS ISSUES**

The installation environment of the DCS, which is inside the plant building, is often harsher than in general urban areas. Even under such severe conditions, the DCS is required to keep running and functioning properly for more than ten years, except during periodic inspections. This requires maintenance tailored to each phase of the lifecycle; with proper maintenance, some systems have kept operating for nearly 30 years.

For long-term reliability, Yokogawa designed its DCS considering fault avoidance, fault tolerance, and maintainability and focused on the following to improve plant reliability:

(a) Improve system reliability
(b) Improve operational efficiency
(c) Improve the environmental resistance of the hardware
(d) Achieve hardware inheritance

Improving the robustness of hardware helps extend the plant lifecycle and achieve a sustainable society.

By attaining (a) through (d), customers can help lay the foundation for industry and technological innovation (SDG 9). In addition, these measures will allow plants to be built in harsh environments, helping to provide energy to everyone in a clean manner (SDG 7). Achieving advanced plant control that delivers these social values will also play a useful role in consumption and production (SDG 12).

By helping customers to achieve all these goals, Yokogawa is laying the foundation for industry and technological innovation (SDG 9) (2).

**IMPROVING OPERATIONAL EFFICIENCY**

Plants are required to operate efficiently and stably for the long term, and so too is the DCS through unit renewal and other means. This will extend the plant lifecycle and bring benefits to the global environment.

**SYSTEM RELIABILITY**

**Basic Principles for Achieving High-reliability Design**

The high-reliability design of DCS hardware is based on the following principles, with typical examples of hardware measures for each principle.

(a) Fault avoidance (resistant to failure)
   - Parts selection, design margins for parts, evaluation tests, etc.

(b) Fault tolerance (continue to function normally even in the event of failure)
   - Redundant processor cards, redundant matching pair system (pair & spare system), etc.

(c) Maintainability (quick recovery from failure)
   - Online replacement of units, etc.

**Figure 1 Example of applying Value Architecture to DCS hardware**
When the reliability of hardware is improved with Yokogawa’s measurement, control, and information technologies, it will reduce the risk of plant shutdowns and improve the operational efficiency of plants.

Improving reliability not only reduces the running cost of the plant but also helps reduce CO₂ emissions and mitigate global warming, which is indispensable for constructing sustainable, resilient infrastructure.

**High-reliability Design**

In the design process, we secure enough derating for the specifications of components to be selected and design the system as a unit structure to allow partial replacement in the event of a failure. Furthermore, to ensure that the system keeps operating even after a failure, we make processor cards and CPUs redundant. For CPUs, we use the pair & spare system. These measures improve the reliability of the DCS system against accidental failures.

Among the high-reliability hardware designs, improving the efficiency of power supply reduces component failures due to heat. This kind of fault-avoidance function also directly reduces power consumption in plants that operate continuously, and thus has a significant impact on the environment. Figure 2 clearly shows that much energy is consumed “in use” in the product lifecycle.

**IMPROVING ENVIRONMENTAL RESISTANCE OF HARDWARE**

**DCS Installation Conditions**

The installation conditions of a DCS depend on the types of raw materials handled and the products manufactured in the plant. Since many plants are located in coastal areas, the DCS is exposed to more salt particles than in urban areas, even within buildings. These particles contain sodium chloride and magnesium chloride, which can corrode electronic equipment when combined with moisture.

Assuming that DCS hardware is exposed to such a harsh environment, we offer a coating option for G3-level gas. Figure 3 shows a coated device. This coating protects the electronic components on the circuit board from moisture and gases.

**Effect of Improved Environmental Resistance**

When an instrumentation room is affected by environmental factors, many of the electronic devices in the room become damaged over time. The more sophisticated the electronic components, the greater the impact they receive.

The G3 coating increases the environmental resistance and protects the hardware of the DCS from the adverse effects of external factors such as gases and moisture in the instrumentation room, increasing the flexibility of plant construction. This makes it easier to install the DCS in harsh environments such as oil and gas wellheads and geothermal power plants, helping achieve a sustainable society.

**ACHIEVING HARDWARE INHERITANCE**

Most of the products made in oil, chemical, and other plants are basic goods for society, and so such plants must keep operating continuously and safely for a long time. It is crucial to extend the renewal cycle of the DCS and shorten its shutdown period, which will minimize the period of plant shutdown and thus improve the operational efficiency of the plant.

In particular, system inheritance is important to extend the life of the plant. To achieve this goal, Yokogawa has taken...
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the following measures:
(a) System upgrade
(b) Unit update
(c) Compliance with various standards

The following sections describe these measures.

System Upgrade

CENTUM VP R6.03 released in 2016 is an update kit, allowing the CENTUM CS released in 1993 to be quickly upgraded to the latest CENTUM VP R6.

To facilitate the system upgrade, the field control station (FCS) is designed to have the same mounting positions of modules and terminal blocks. Each station can be upgraded while using the existing cabinet chassis and field cables as shown in Figure 4 (4). The latest FCS comes with improved processing capacity, expanded application capacity, increased number of input/output channels, and a control function that works with the network function.

The I/O part is compatible with the existing one and can be housed in an existing cabinet, allowing it to be updated by simply modifying components in the cabinet.

The system can be upgraded quickly while maximizing the use of existing assets at the site and minimizing the environmental burden, thus ensuring system inheritance.

![Figure 4 Example of upgrading CENTUM CS](image)

Unit Update

Unit upgrade solutions include updating the processor module in the DCS from CP461 to CP471 and replacing the module in the ProSafe-RS safety instrumented system (SIS) from SCP461 to S2CP471.

The relevant software should be downloaded from the safety engineering PC to the SCP461. After that, the SCP461 can be replaced with the S2CP471 while the system is in operation. Figure 5 shows an overview of this procedure.

Although the CP471 and S2CP471 contain dedicated microprocessors, their casing and interface have the same size and shape as their predecessors, the CP461 and SCP461, in order to ensure long-term stable supply at the component level.

![Figure 5 Example of replacing SCP461](image)

Supporting Various Standards

To ensure system inheritance, it is necessary to update hardware and software. In addition, each plant must comply with the RoHS Directive and other local environmental requirements. When installing and disposing of hardware, it is necessary to consider the impact on the environment and human beings.

In addition, the hardware needs to be designed to make sure that the plant operates safely in accordance with general safety standards and explosion-proof standards. Even if it can operate safely and normally, a system that does not comply with such standards may not be allowed to be used. Therefore, it is necessary to pay close attention to changes to the latest standards.

Benefits from Supporting System Inheritance

The following benefits are expected from updating customer plants by Yokogawa and the resulting long-term stable operation.

- Hardware meets the latest regulations and requirements of society.
- Introducing the latest field control units enables I/Os and applications to be added and the latest field digital devices to be connected, improving the performance of the plant.
- Improved operational efficiency shortens the work period.
- The use of existing hardware eliminates the need to procure new components.

CONCLUSION

Since launching its first DCS in 1975, Yokogawa has been working with many customers to improve the efficiency of plants through its reliable technologies.

Meanwhile, the SDGs adopted in 2015 have made environmental and social common values spread across countries and companies, requiring plant owners to consider their social contribution more than ever before.

Technological progress and innovation rely on stable
infrastructure. In other words, achieving long-term stable operation of the DCS through whole or partial system upgrades and compliance with various standards will have a broad impact on the economy, society, and the environment, and will help resolve issues.

We will continue to identify the needs of our customers and society in terms of DCS hardware and provide highly reliable solutions to more plants while fulfilling our social responsibility.

REFERENCES


(3) Yokogawa Electric Corporation, CENTUM VP Installation Guidance, 2020


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