

Lifecycle Excellence Services Capable of Improving Productivity and Safety

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Yokogawa provides customers with maintenance services to ensure effective maintenance of their plants with optimum cost throughout the plant lifecycle. Recently, Yokogawa has launched its VigilantPlant Services and reorganized its maintenance service system while adding necessary services. The new scheme is capable of visualizing problems in plants, improving the productivity and safety of plants, as well as maintaining plants with optimum cost. The service agreement framework has also been made more attractive. This paper outlines the new maintenance service scheme and its services.

INTRODUCTION

Instrumentation devices and equipment serve for plants as the eyes, ears, nose, tongue, and skin, which are responsible for the five senses, and act as the central nervous system and brain do for human beings. The reliability and availability of such devices and equipment are the most important requirements of customers. Yokogawa Electric Corporation and Yokogawa Field Engineering Service Corporation (YFE), which provides after-sales service for Yokogawa's products (hereafter, "Yokogawa" is used to refer to both Yokogawa and YFE), have enhanced their service system, dispatched service engineers trained in specific technical skills around the world, and offered services to secure the reliability and availability of Yokogawa's instrumentation devices and equipment appropriately in response to customers' requirements which have diversified with the evolution of instrumentation devices and equipment.

Yokogawa has been striving to construct a close partnership with its customers by offering solution-type maintenance services for Yokogawa's products. The solution-type maintenance services include preventive maintenance and predictive maintenance in addition to maintenance for repair, and are intended to help maintain the health of devices and equipment as well as optimize the Total Cost of Ownership (TCO).

Recently, Yokogawa launched its VigilantPlant Services and reviewed its maintenance service system to consolidate it into the VigilantPlant Services to improve the solution-type maintenance services in response to changes in environment including the recent economic situation and changes in devices and equipment. VigilantPlant Services is a comprehensive

brand of the suite of services to realize the "VigilantPlant - Ideal Plant" ^{(1), (2)}, that is, to achieve the ideal operation together with customers as a lifetime partner for operational improvement.

The new maintenance service system is capable of visualizing problems in plants quantitatively and improving the productivity and safety, as well as maintaining the plants, thus providing support to utilize instrumentation devices and equipment more effectively throughout the plant lifecycle.

This paper outlines the position and features of the new maintenance service system, services included in the system, and the support system for the services. It also introduces the framework of the newly established maintenance services.

OUTLINE OF THE LE SERVICES

In this paper, Yokogawa's new maintenance service system is referred to as "LE Services." "LE" stands for "Lifecycle Excellence," which is one of the excellences in Yokogawa's VigilantPlant visions, and is intended to optimize the TCO.

Lifecycle Excellence Solutions

Yokogawa's VigilantPlant offers solutions to achieve Operational Excellence from the perspectives of the four excellences shown in Figure 1.



Figure 1 VigilantPlant's four excellences

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- Securing safety (Safety Excellence: SE)
Maximize both safety and availability.
- Optimizing production (Production Excellence: PE)
Achieve continuous improvements in productivity.
- Maximum use of plant assets (Asset Excellence: AE)
Maximize reliability and minimize maintenance cost.
- Optimizing TCO (Lifecycle Excellence: LE)
Achieve improvements in operational quality.

The LE Services offer solutions from the perspective of optimizing TCO. Based on Yokogawa's accumulated maintenance technology and complete support system, Yokogawa offers the LE Services for maintaining the safety of plants and health of devices and equipment while optimizing plant operation continuously according to the state of operation. The LE Services enable long-term stable use of instrumentation devices and equipment and also reduce lifecycle costs by optimizing the maintenance costs for such devices and equipment.

Position of the LE Services and the Product Portfolio

Figure 2 shows the position of the LE Services within VigilantPlant Services. The VigilantPlant Services encompass the Opportunity Identification Services, Solution Implementation Services, and Lifecycle Effectiveness Services throughout the plant lifecycle from the perspectives of the four excellences. The LE Services consist of the Opportunity Identification Services, Solution Implementation Services, and Lifecycle Effectiveness Services from the perspective of Lifecycle Excellence.

Figure 3 shows the product portfolio of the LE Services. Although the LE Services are an upgraded version of conventional maintenance services based on continuously maintaining a partnership with customers, quantitative analyses and evaluations, such as the Comparative Effectiveness Analysis and the Regular Effectiveness Analysis, are newly added. These can visualize the problems in the entire plant, and help utilize instrumentation devices and equipment more effectively throughout the plant lifecycle by improving the productivity and safety as well as maintaining plants.

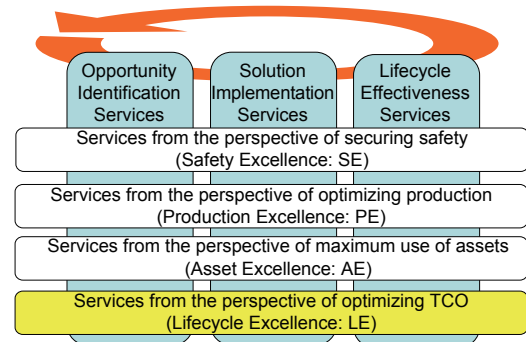


Figure 2 Position of the LE Services within the VigilantPlant Services

Evaluation Indexes for the LE Services

In the LE Services, the idea of RASIS indexes, which are often applied to information systems and communication systems, is adopted for evaluating the usefulness of instrumentation devices and equipment. In the LE Services, the following RASIS indexes are considered.

- Reliability
Reliability expresses how rarely malfunctions, troubles, or failures occur. It is expressed as the Mean Time Between Failures (MTBF) or the like.
- Availability
Availability expresses the rate of operation and how quickly operation is resumed after a malfunction or maintenance. It is expressed as the ratio of operating time to the total time (i.e. the rate of operation) or the like.
- Serviceability
Serviceability expresses the ease of recovering from a trouble or maintenance. It is expressed as the Mean Time To Repair (MTTR) or the like.
- Integrity
Integrity expresses how rarely data is destroyed or made inconsistent caused by overload or malfunction. It is also important that the data can be restored to the state just before malfunction.
- Security
Security expresses the degree of difficulty of intrusion from outside, falsification of data or leakage of secrets, and how PCs are protected from virus infection.

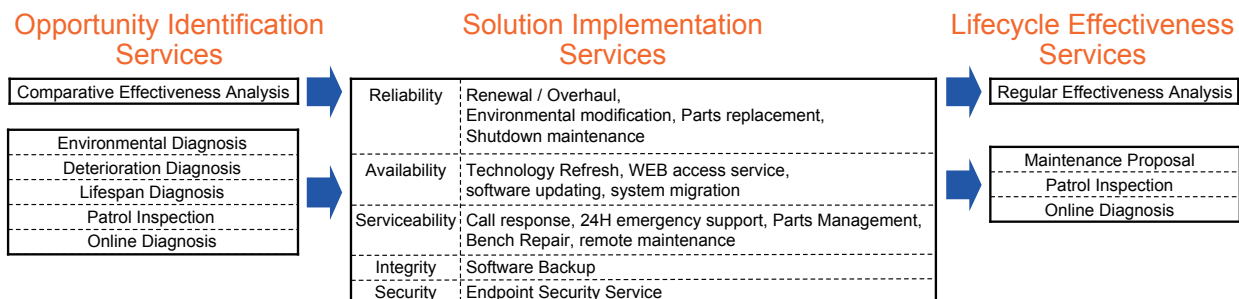


Figure 3 Product Portfolio of the LE Services

Features of Yokogawa's LE Services

Yokogawa's LE Services have the following features, which are significant for customers.

■ Prompt response

The most critical requirement from customers for maintenance services is prompt response in case of trouble.

The Yokogawa group deploys more than 2,000 service engineers around the world. It also has ten Global Response Centers (GRC) in Japan, South Korea, Taiwan, China, Singapore, India, Bahrain, Russia, Netherlands, Brazil, and the U.S. The GRCs dispatch service engineers and offer temporary measures as well as help customers to take measures by themselves. The GRCs also always store any and all spare parts in preparation for hardware malfunctions.

Maintaining and operating this system helps customers always utilize appropriate services without spending large expenses or man-hours, and the system is extremely effective as an infrastructure for measures against unexpected troubles.

■ Comparison with world's best practices

Utilizing a variety of diagnostic services and the Comparative Effectiveness Analysis in the Opportunity Identification Services, the issues concerning the improvement of reliability and so forth can be analyzed and evaluated using quantitative indexes.

These analyses and evaluations include comparison with not only the actual data of the target plant and other similar plants of the same company but also the data of the world's best practices accumulated in Yokogawa, enabling analyses and evaluations from a global perspective that are difficult for each customer to conduct.

■ Medium- and long-term maintenance planning

The results of the Comparative Effectiveness Analysis are used to make medium- and long-term maintenance plans, thus helping to prevent excessive maintenance costs in many cases.

Medium- and long-term maintenance plans are considerably effective for reducing the labor costs required for maintenance planning and budgeting as well as for curbing drastic annual changes in maintenance costs, thus helping to level the maintenance budget.

■ Quantification of the cost effectiveness of maintenance

It is generally difficult to quantitatively evaluate the cost-effectiveness of maintenance since it is impossible to actually grasp the results in case no maintenance is performed. Therefore, customers judge the necessity of maintenance by evaluating the risk in case no maintenance is performed utilizing the importance of each device or equipment, past results of maintenance, various knowledge and so forth.

Yokogawa not only contributes to the reduction of maintenance costs by supporting maintenance planning as mentioned above, but also offers new methods for properly judging the necessity of maintenance by performing risk assessment. This new risk assessment system offers a method to objectively grasp the cost-effectiveness of maintenance regardless of the scale and configuration of systems by visualizing the relation between risks and past results of

maintenance using RASIS indexes.

Schemes to Support the LE Services

Yokogawa has established schemes to offer effective services promptly on the basis of its many years of experience. Typical examples of these schemes are introduced below.

■ Qualification system of service engineers

In general, services have the following characteristics.

• Intangibility

Services are intangible and cannot be possessed unlike tangible products.

• Extinctiveness

Services cannot be possessed and cannot be stocked.

• Simultaneity or inseparability

Services are generally produced and consumed simultaneously on site.

• Diversity

Every person provides different services every time and services are offered depending on the customer and the time of provision.

In other words, since services are usually provided by people (service engineers), the quality and level of the services depend on the person. Furthermore, since the output of services is difficult to capture as a visible object, the results of services are difficult to evaluate. Accordingly, Yokogawa has adopted a qualification system for service engineers.

Service engineers are properly qualified based on the results of evaluation of not only their experience of products but also practical experience with combinations of type of occupation and type of products. Accordingly, engineers with little practical experience are not allowed to acquire advanced qualifications. Additionally, they must obtain multiple official qualifications besides product knowledge and practical experience. Thus, ceaseless efforts are required for service engineers to acquire and maintain high-level qualifications. On the other hand, because new employees need experience and training, the qualification system is flexibly operated; for example, they are given entry-level qualifications on condition that they have the minimum necessary technical knowledge and business ethics so that they can assist field work.

■ Organizational backup

As for the problems and customers' requirements that cannot be resolved by Yokogawa's service department alone, Yokogawa copes with them with an escalation program in which its relevant departments such as the product development department, engineering department, and sales department are organically connected centering on a GRC considering the significance and priority. This enables such issues to be addressed using the total capability of Yokogawa.

LE SERVICE PRODUCTS

Typical examples of LE Services are outlined below following the cycle of the Opportunity Identification Services,

Solution Implementation Services, and Lifecycle Effectiveness Services.

Service Model to Secure Proper Reliability

High reliability is one of the most important requirements for optimizing the TCO and is required in every instrumentation device or equipment.

■ Opportunity Identification Services

As for hardware that deteriorates with time, the times for maintenance can be predicted by quantifying the tendency of deterioration and the risk of malfunction. For this purpose, the Environment Diagnosis for evaluating the installation environment of devices and equipment and the Deterioration Diagnosis for checking the deterioration of each device or equipment are included in the Opportunity Identification Services.

The Environment Diagnosis measures the temperature, humidity, and amount of dust and corrosive gas at the sites where devices and equipment are installed, and evaluates their influence based on standards such as the standard of the International Society of Automation (ISA) or the Japanese Electronic Industry Development Association (JEIDA). As shown in Figure 4, devices and equipment accumulate little damage in a good installation environment, but much more damage in a severe environment.

The Deterioration Diagnosis evaluates the extent of deterioration of devices and equipment, which have been operated for a certain period in a certain environment, through visual inspection, characteristic evaluation tests, and deteriorated part characteristic tests, and then quantifies the extent of deterioration based on Yokogawa's original criteria.

Utilizing the results of these diagnoses, methods to maintain or improve the reliability are planned, which include judging the necessity of environmental improvement, planning life-prolonging methods, determining the timing of overhauls, and designing the times and contents of inspection.

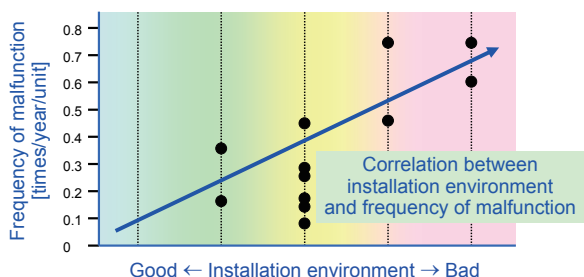


Figure 4 Correlation between the installation environment and the frequency of malfunction

■ Solution Implementation Services

The Solution Implementation Services conduct maintenance and improvement that are planned through the Opportunity Identification Services.

■ Lifecycle Effectiveness Services

The Lifecycle Effectiveness Services include the Patrol Inspection Service, a periodic visual inspection conducted by Yokogawa's service engineers to check the health of instrumentation devices and equipment under operating conditions, and the On-line Diagnostic Service that collects and analyzes the health information of systems utilizing remote communication infrastructure.

Service Model to Maintain and Ensure Security Properly

Current instrumentation systems generally consist of devices and equipment similar to those used in information systems, such as personal computers, servers, and networks. Additionally, such devices and equipment are often connected to a production control system or an enterprise system. In general, security measures for protecting confidentiality are taken for enterprise systems, but instrumentation devices and equipment are sometimes extremely vulnerable, particularly to virus infection. Protection of information for operation and production control and reduction of the risk of virus infection are important security measures for instrumentation devices and equipment. Figure 5 shows the areas and boundaries that require security measures in a control system.

There was one case in which a process data management system on a network was infected with a virus through a USB memory device and the virus spread throughout the systems. The virus infected the personal computers being used as human machine interfaces (HMI), consequently affecting the operation of the plant. It took considerable time and cost to eliminate the virus. Thus, security measures are becoming more important.

■ Opportunity Identification Services

The Security Risk Assessment, which is one of the Opportunity Identification Services, qualitatively or quantitatively evaluates the current awareness of and preparedness for external threats such as virus infection. Cost-effective security measures are proposed by utilizing the results of this evaluation and additional hearings.

■ Solution Implementation Services

The Solution Implementation Services include a service that conducts multiple protective measures including introduction of anti-virus measures, making network security settings stricter, and introducing a system to enable quick recovery from unexpected troubles.

If a PC is infected with a virus, initialization of the computer, re-installation of software, and restoration of data and configuration settings are required to restore it completely. Though the prevention of virus infections is the most important protective measure, it is also necessary to periodically make a backup of disc data to enable quick restoration in case of infection. Yokogawa also offers a service for this purpose.

■ Lifecycle Effectiveness Services

The Lifecycle Effectiveness Services offer services to maintain the effectiveness of the measures such as periodically updating the anti-virus measures.

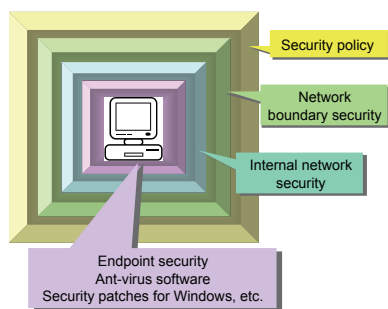


Figure 5 Areas and boundaries that require security measures in a control system

Services for Open Systems

It has been a long time since the Distributed Control System (DCS), a typical control system, was made open. Figure 6 shows an example of Yokogawa's DCS, CENTUM.

Maintaining and ensuring security and availability is important for open systems. Services for security are described above. As for the services for availability, the following characteristics specific to the devices and equipment used for open systems must be considered.

- Short product lifecycle and support period
- Interoperability

■ Response to short product lifecycle and support period

Since control systems are generally used for a long time and continuously unlike so-called office automation (OA) systems, the usage and maintenance of control devices and equipment are different from those of OA devices and equipment in many respects. Whereas the hardware and software developed by Yokogawa are continuously provided for a long time to maintain continuity, open resources such as PCs and network devices are remodeled in a short cycle, and their continuity is not maintained in some cases. In order to continue the maintenance of the entire system throughout its lifecycle, the maintenance must be planned considering the difference of cycle time mentioned above at the time of system installation.

Yokogawa makes maintenance plans as a service of the Opportunity Identification Services and offers replacement, updating, and migration as services of the Solution Implementation Services.

■ Response to the interoperability

In the area of devices and equipment for instrumentation or control, not only computer systems but also field instruments are being made open, such as digital field devices. For instance, several types of field instruments are linked with a fieldbus network. In a wireless field network, signals are transmitted from several types of field devices. Such transmission protocols are standardized, and interoperability between the devices to be connected is essential. However, since a variety of devices are actually connected to the same network, the operation of each device must be verified and troubles throughout the network are difficult to handle.

As services of the Solution Implementation Services, Yokogawa offers a service for validating the interoperability of field devices and a prompt troubleshooting service utilizing the diagnostic information of each device, diagnosis technology for networks and so forth, thus reducing the risk associated with open systems.

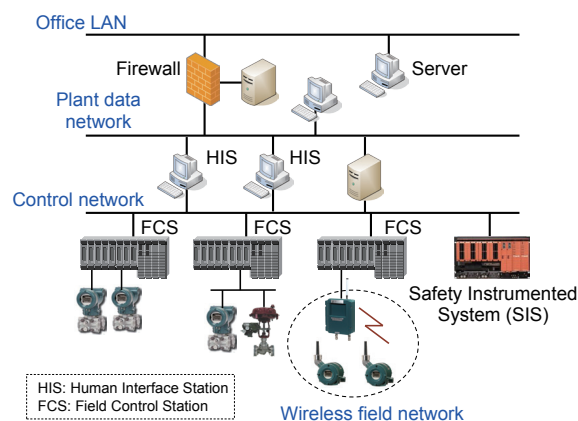


Figure 6 Open control system

Control systems are expected to become more open in the future. Yokogawa considers that maintaining and applying the LE Services properly is an important issue even in such circumstances. Consequently, Yokogawa is maintaining good partnerships with the vendors of the devices that constitute instrumentation devices, equipment and systems while validating the interoperability between them.

FRAMEWORK OF THE LE SERVICES

The style of maintenance of devices and equipment for instrumentation and control varies with the customer. Some customers outsource overall maintenance to Yokogawa and others conduct basic maintenance themselves while utilizing Yokogawa's services when necessary. However, maintenance services are comprehensively offered to customers mainly based on the maintenance agreement.

Previously, different models of maintenance agreements were offered depending on the culture of each country around the world, but they have been reorganized into the Japanese model and overseas model in line with the reorganization of the maintenance service system as a part of the VigilantPlant Services.

Japanese Model: Lifecycle Support Program

The Japanese model, which basically inherits the Lifecycle Support Program established in 2004, was upgraded with the launch of the VigilantPlant Services. Yokogawa offers comprehensive services which include not only conventional services mainly for maintenance but also those for productivity and safety to increase the benefits for customers in terms of both operation and maintenance of plants.

With the Lifecycle Support Program, when devices and equipment for instrumentation and control are introduced, an overall picture of necessary maintenance throughout the plant

lifecycle is drawn up as a “Lifecycle Plan” which defines an initial plan for the times and cost for maintenance. Figure 7 shows an example of the plan.

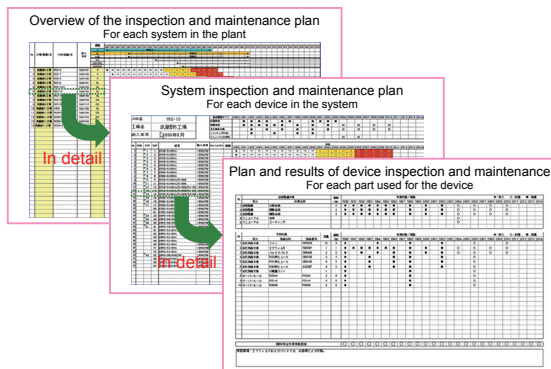


Figure 7 Lifecycle plan

Because the times for inspection and repair of devices and equipment depend on the usage environment and maintenance cycle of the entire plant, the Lifecycle Plan is reviewed every year accordingly. If the usage environment is judged to be good enough to maintain the reliability and availability, not only the maintenance cycle but also the time of replacement of parts to be replaced periodically can be extended or deferred as a matter of course, by referring to Yokogawa’s database. Although some customers optimize the maintenance cycle of their plants on their own based on past results, Yokogawa, which has a huge installed base of devices and equipment worldwide, can offer more appropriate Lifecycle Plans based on its enormous number of examples of operation.

Overseas Model: Lifecycle Agreement

Three types of support plans are prepared for overseas customers as items of the unified global menu framework.

Some customers, many of whom are major accounts (MA) having plants in several regions around the world, suggested that the conventional maintenance contracts were complicated and that the names and contents of the contracts varied from region to region. In response, Yokogawa has reorganized the maintenance procedure for systems for instrumentation and control into simple and unified support plans and added new operational improvement services to meet various requirements.

The name of the contract was changed from Annual Maintenance Contract (AMC) to Lifecycle Agreement (LCA) to show the objective of offering services to customers throughout the plant lifecycle.

Three support plans are introduced below.

1) Basic support plan

The basic support plan provides service eight hours per

business day and the target customers are those who conduct daily maintenance by themselves and those who request services within the warranty scope of products.

The Comparative Effectiveness Analysis and the Improvement Leader Development Program, which are services of the Opportunity Identification Services, are included in this plan to support operational improvement. Each customer identifies problems first, and then executes the PDCA cycle throughout the plant lifecycle while nurturing improvement leaders, and finally is impressed with the effectiveness of the improvement.

2) Enhanced support plan

The extended support includes 24-hour support and preventive maintenance in addition to the contents of the basic support plan, and targets customers who want quick recovery or preventive maintenance. Aiming to reduce alarms, which is a problem affecting many customers, the nuisance alarm reduction service is included to support operational improvement.

3) Custom support plan

The custom support plan is a service that is customized according to the condition of each customer’s plant and requirements in addition to the services of the extended support plan. Yokogawa cooperates with customers as a partner throughout the plant lifecycle. The services to be customized include environmental diagnosis and deterioration diagnosis, which quantitatively evaluate the extent of environmental improvement and deterioration of devices and equipment before and after a migration, and a security service that is intended to prevent today’s security problems.

CONCLUSION

The aim of Yokogawa’s LE Services is to offer a system that avoids risks and minimizes opportunity loss by providing appropriate maintenance throughout the plant lifecycle, thus enabling Yokogawa’s instrumentation systems to be utilized most effectively.

For this purpose, a scheme which can control the risk and opportunity loss quantitatively and maintain the operation at an appropriate cost is indispensable. Yokogawa will continue to improve and reinforce this scheme.

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