Plant Maintenance Services and Application of ICT

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OVERVIEW: After a plant is constructed, the plant's owners need to manage not only production, but also the maintenance of equipment that requires specialist knowledge and experience. The obstacles to achieving this include a shortage of maintenance technicians, rising maintenance costs due to the aging of industrial equipment, and the difficultly of training maintenance staff. Hitachi is drawing on its plant construction activities to strengthen its plant maintenance management business and work together with its customers over all operations, from plant construction to after-sales service. Key factors in achieving this are the use of ICT and the service infrastructure that supports plant maintenance.

INTRODUCTION

THE maintenance of industrial equipment frequently requires specialist knowledge and experience. Currently, however, the obstacles to achieving this include a shortage of maintenance technicians, rising maintenance costs due to the aging of industrial equipment[(1)], a lack of maintenance and managerial know-how and experience among maintenance staff, and staff training issues such as problem solving skills.

Given this background, there is a growing international demand for strengthening after-sales services for the operation and maintenance of equipment after plant construction.

This article describes the challenges facing plant maintenance and after-sales services, the infrastructure for supplying services to plants, and the use of information and communication technology (ICT).

CHALLENGES FACING PLANT MAINTENANCE AND AFTER-SALES SERVICES

In broad terms, the operation and maintenance of equipment in order to keep up with production plans face two major challenges. These are the operational status monitoring of equipment, which is done to avoid disruption caused by faults, and facilities management, which is done to keep equipment working correctly.

Dealing with these two challenges requires not only that inspections be conducted in accordance with detailed schedules, but also the undertaking of preventive maintenance that draws on the sorts of experience and awareness that cannot be captured in a manual, and also improvement work for dealing with non-compliance or other problems. This in turn requires the involvement of staff, including dealing with new issues that arise due to the aging of equipment. Unfortunately, it is difficult to maintain and improve standards in this area merely through the education and training of inexperienced staff.

CHALLENGES FOR AFTER-SALES SERVICES

After-sales services provided by maintenance companies in developed economies involve service personnel proposing solutions, and performing repairs and upgrades based on the results of "patrol" inspections. Service personnel have a thorough understanding of the customer's equipment and undertake inspection, repairs, and upgrades with a sense of unity with the customer. However, with technical staff aging at both maintenance companies and their customers, and with growing price competition bringing down the costs of maintaining equipment, the task of ensuring the reliable operation and maintenance of production equipment currently faces a difficult environment.

At plants in emerging economies, meanwhile, factors such as traffic congestion make the performance of on-site patrol inspections difficult. In the case of businesses that deal only in mass production equipment, it is possible to establish service companies in each market and provide after-sales services for equipment in a similar way to developed economies. When handling maintenance for entire plants or for made-to-order equipment, on the other hand, this approach to after-sales services is not practical and also places a heavy burden on the plant owners.

These circumstances required the timely collection of the ever-changing information from the plant and advance planning of activities. The next section

describes the measures and activities being undertaken by Hitachi.

ESTABLISHMENT OF INFRASTRUCTURE FOR PLANT MAINTENANCE SERVICES

Because plant construction companies work with the customer throughout a construction project, they are in a position to understand such things as their operational philosophies and the thinking behind their business plans. During this time, they also have a thorough understanding of the equipment at the plant, such as details of piping and wiring layouts. In other words, a feature of plant construction companies is their ability to support the customer's operation and maintenance by utilizing this understanding and information.

To take advantage of this feature of the plant construction sector, it is necessary to establish a customer support infrastructure in the post-construction period that brings together, close to the customer's plant, all the companies involved with the equipment. Also required are the engineering capabilities for repairs and enhancements.

As a plant construction contractor, Hitachi seeks to strengthen not only customers' plant construction but also their after-sales services, so as to provide them with ongoing support after construction completes.

Establishment of Service Infrastructure through Formation of the Hitachi Subsidiary

When constructing a plant in a particular country, the Hitachi subsidiary in that country works with a wide range of local companies. By collaborating with companies involved in the construction who are familiar with the workings of the plant, Hitachi is able to ensure the reliability, shorten the work period, and minimize the cost of post-construction maintenance. It has set up subsidiaries in China, the Republic of Singapore, the Republic of Indonesia, the Socialist Republic of Viet Nam, the Kingdom of Thailand, Malaysia, and the Republic of the Philippines to establish the infrastructure for supporting customers throughout the lifecycle from construction to services. It has also set up service satellite operations located close to major industrial complexes in various countries that act as bases for enhancing customer services.

Use of ICT in Services

Remote monitoring has been in use for some time as a means of using ICT to monitor equipment operation, and other developments range from simple sensors through to technologies that incorporate graphics or acoustic information. However, because sensor data alone is insufficient for plant-wide monitoring, it remains standard practice to conduct on-site patrol inspections. An emerging technology for this purpose is the use of portable devices to eliminate the distance between the site and the monitoring room.

In the case of facilities management, activities include considering maintenance plans that cover all equipment; management of inspection, fault, and other records all the way back to the time of construction; coordination of inspection timings with production; and spare parts management. Recently, ICT has started to be adopted for purposes such as the introduction of common management practices across Japan and other countries, and integration with applications such as enterprise asset management (EAM) that deal with asset and personnel management.

The need to build a framework for supporting maintenance services that utilizes ICT is recognized as an urgent task for meeting the demand for plant after-sales services. Hitachi is commercializing the plant maintenance systems described below.

SUPPORT TECHNOLOGY FOR CLOUD SERVICES

Cloud computing is the general term for a computer technology for delivering software for use over the Internet without the user being aware of where the servers or other ICT hardware is located[(2), (3)]. In this article, the term "cloud services" is used to indicate services that operate via a support system for maintenance, after-sales services, and similar business activities that has been built on the use of cloud computing.

Fig. 1 shows an overview of cloud services for equipment maintenance.

Application to Operational Monitoring

In the past, activities such as product repairs and replacements or dealing with faults were performed in response to on-site patrol inspections by service personnel or reports from the customer. Meanwhile, the sort of remote monitoring undertaken in the past involved installing monitoring devices to collect operational data from the product to determine its condition and other information such as parts usage.

Cloud services are able to take advantage of the possession of high-capacity storage devices to record and utilize the stream of constantly changing control

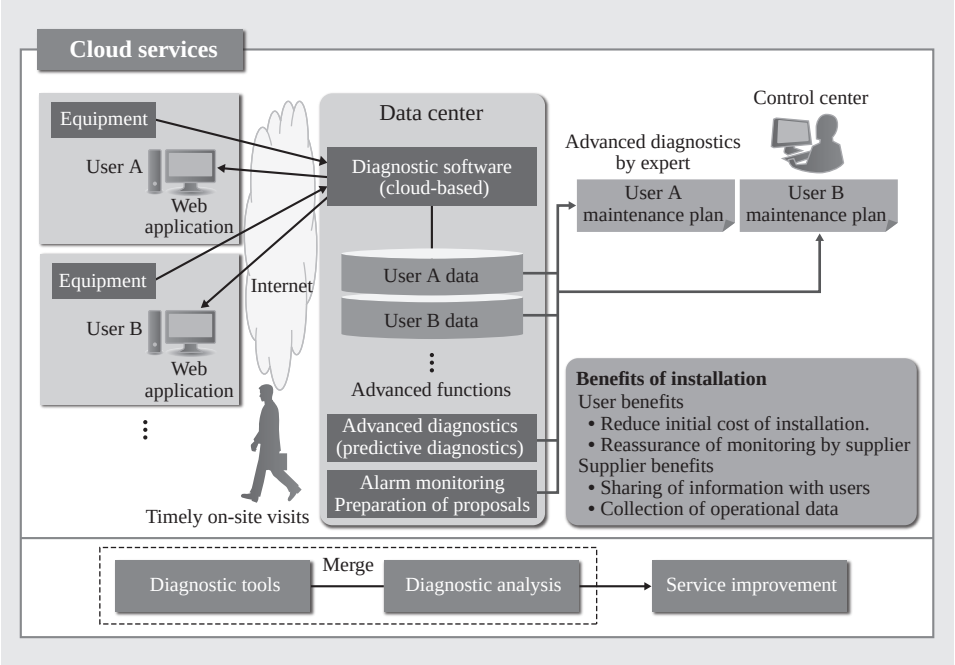

Fig. 1—Overview of Cloud Services.
This overview shows services delivered using cloud computing.

data. Use of this information makes it possible to reconstruct close to 100% of plant and equipment operating conditions. Using computing functions, this data can be analyzed based on the know-how and operating conditions assumed in the planning and design stages of the plant or equipment. The benefits of this include not only the ability to propose optimum operating practices or ways of boosting efficiency and saving energy, but also the identification of phenomena of which the customer is not aware.

The following describes the use of cloud services for operational monitoring of cranes for a waste treatment plant. Fig. 2 shows one of the cranes being monitored, and Fig. 3 shows an example reconstruction from collected data of crane operation at the time an alarm was triggered. When a crane alarm occurs, not only is the service alerted at the same time as the customer, its ability to reconstruct the circumstances around the fault means it is also able to respond promptly and minimize downtime, by quickly identifying the cause or ordering the necessary parts, for example.

Fig. 4 shows an example of collected control data and the results from an analysis of the crane's operation and use based on its design assumptions. The analysis in this example is of the bucket tipping operation (the bucket is the part that grips the waste material). It uses information such as crane position control data, data on the length of wire paid out to control the vertical position of the bucket, and data from the weight sensor installed on the crane to calculate when the bucket lands on the floor of the waste pit. This not only facilitates the sort of preventive maintenance that preempts failure of the bucket's hydraulic control cable based on the number of times the bucket tips over; it also enables genuine preventive maintenance measures involving specific investigations, such as reviewing operating procedures

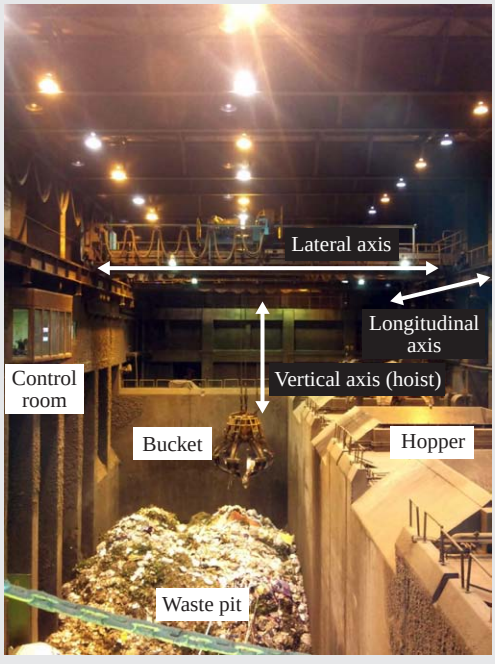

Fig. 2—Waste Treatment Plant Crane.
This waste treatment plant crane is monitored by a cloud-based operational monitoring service.

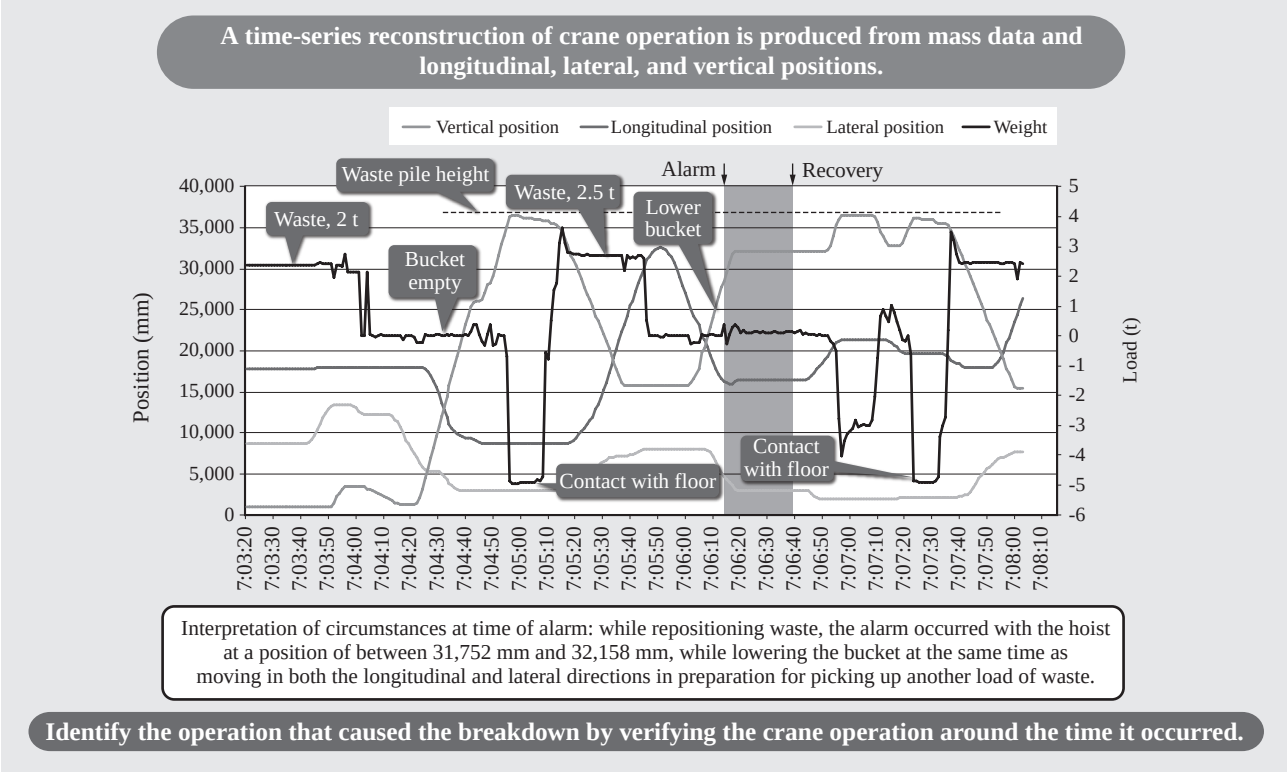

Fig. 3—Example Reconstruction of Fault.
Collected data can be used to reconstruct the circumstances at the time an alarm was triggered.

at the waste treatment plant to prevent tipping from occurring by analyzing trends such as locations where tipping occurs frequently.

Fig. 5 shows the height of the waste pile in the waste pit. It is possible to calculate the heights of the waste pile at different times from information on the weight of the waste and the crane's longitudinal, lateral, and vertical positions without needing to install any new imaging equipment or height measurement sensors. This ability to generate various types of information from existing data without installing new devices for information capture is one of the major attractions of cloud computing.

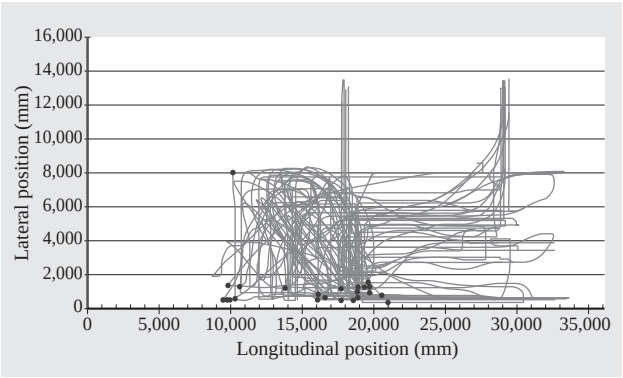

Fig. 4—Example Analysis of Crane Operation.
The graph plots the positions at which the crane bucket (the part that grips the waste material) lands on the floor. These positions are calculated from data on the crane's position in each axis. The information can be used to improve operating practices.

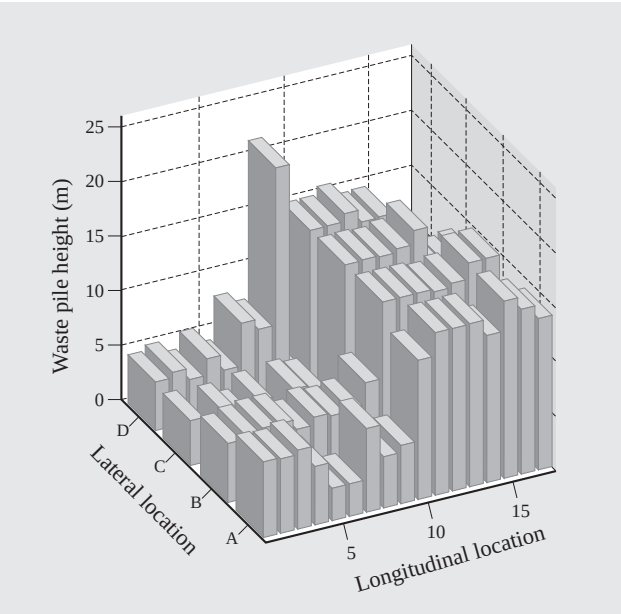

Fig. 5—Example Calculation of Waste Pile Height from Crane Position Data.
The height of waste piled in the waste pit can be calculated.

Application to Facilities Management

The tasks performed by the people responsible for plant facilities management include formulating equipment maintenance plans based on production plans, obtaining replacement parts, and finding ways to resolve problems identified in previous inspections. While they often utilize IT equipment to manage and perform these tasks in the plant, the information used for production systems and organizational activities is growing more diverse and increasing in quantity. This expansion in the scale of these information systems is causing an ongoing increase in costs that are not directly related to production, such as increases in personnel and other system maintenance costs. Shifting servers to the cloud is one way to respond to this trend.

In response, Hitachi has established the means to convert integrated management software for plant equipment to cloud-based operation. This involves linking to the monitoring system described above and automatically storing information in the facilities management systems so that it can be used when responding to future inspections. Examples of this information include abnormality monitoring histories or alarm logs for equipment. Use of systems such as these requires entry of equipment details. However, by taking advantage of being an equipment builder, data on the operation of each type of equipment can be input automatically when construction completes and the facilities management system is commissioned, without the troublesome task of data preparation and entry.

Also, the software's features include support for multiple languages and selectable functions, with functions that simplify management and are designed to be easy for staff to use.

Fig. 6 shows the Kakinoki Water Filtration Plant in Saitama Prefecture, an example site in Japan that uses the cloud-based facilities management service. The operation and maintenance function collects and records operational data from the Water Filtration Plant. The system also incorporates technologies such as portable devices and radio-frequency identification (RFID) to improve the efficiency of administration of inspections carried out on the on-site equipment.

In the past, the administration of equipment inspection was handled by separate systems for each site. Meanwhile, the scope of operation and maintenance at public facilities has been growing. While conditions such as water quality are different at each pump station, it is possible to standardize the tools and other resources that support operation and inspection work. Also, the collection of operating data from each plant increases operational know-how and makes possible qualitative improvements in the running of the plant. To this end, the Kakinoki Water Filtration Plant decided to standardize operating practices at each pump station (eliminate site-specific functions) and upgrade to centralized management using a cloud service.

The service includes functions for equipment ledger management, patrol inspection data management, and report and other document management, and progress is being made on its use as a common resource for the entire country.

FUTURE DEVELOPMENTS

As described above, growing challenges include the aging of equipment and the recruitment and training of maintenance personnel. To respond to these challenges, what is needed is to strengthen the provision of plant lifecycle support from construction through to after-sales services. Two aspects of this support are the strengthening of overseas operations and the use of cloud services that utilize ICT for maintenance and other forms of after-sales service.

At overseas operations, progress is being made on strengthening engineering, boosting training of local

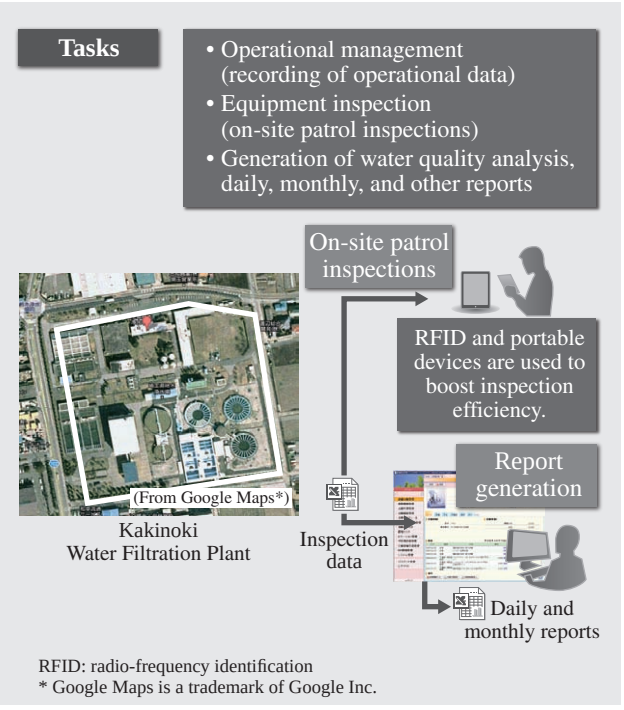

Fig. 6—Overview of Operation and Maintenance. Kakinoki Water Filtration Plant in Saitama Prefecture uses a system that incorporates technologies such as portable devices and RFID to improve inspection efficiency.

staff, and making greater use of ICT for achieving these objectives. In this context, engineering means working in conjunction with customers to identify issues with their plant equipment and propose solutions. This article has also described an example of the use of ICT in plant maintenance involving cranes and a water treatment plant. Expanding the use of new services like this will facilitate the embodiment in software of the know-how of customers and the Hitachi engineers involved in plant construction. This approach can be used for tasks such as comparing plant state transitions against construction and commissioning data to help identify the best operating conditions.

CONCLUSIONS

Equipment operation and maintenance is being made more difficult by factors such as the aging of maintenance engineers, the lower cost of maintaining equipment due to growing price competition, and the difficulties that maintenance companies face in providing "patrol" inspection services overseas. On the other hand, plant construction companies have a detailed understanding of plant piping and wiring that they can draw on to support customers' operation and maintenance.

This article has described what Hitachi is doing in response. To begin with, it is enhancing services for its corporate customers by establishing subsidiaries in countries where they have operations, particularly in Southeast Asia, and also service satellite operations at major industrial complexes. It is also achieving improvements in efficiency and performance by utilizing ICT to monitor the operational status of customer equipment, and offering maintenance solutions based on data analysis. The applications for these cloud services that utilize cloud computing include operational monitoring and facilities management.

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