Maintenance Support Device and Web Camera for Yanagawa Hydropower Plant of Iwate Prefectural Enterprise Bureau

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Abstract

There are concerns that due to the decrease in the number of hydropower plant maintenance personnel and the increase in the number of new hydropower plants, the burden on each maintenance worker will increase.

To add to this burden, hydropower plants are scattered along mountain areas, so long travel times are an issue when it comes to maintenance and on-site inspections. Efforts to resolve these issues (such as saving labor on maintenance and reducing the frequency of movement) are critical.

We recently delivered and installed equipment such as a hydro turbine generator, panels, main transformer, control panel, and auxiliary equipment to Iwate Prefectural Enterprise Bureau's Yanagawa Hydropower Plant. This plant originally began operation in July 2021. During this construction work, in addition to conventional hydropower equipment, we installed maintenance support device for power generation facility and web camera units in order to save on maintenance labor.

1 Preface

Many hydropower plants are in mountain areas, and it takes a lot of time to travel from maintenance bases, so it is important to reduce the time and frequency of travel. Additionally, as maintenance workers age and the number of them decreases, the transfer of technology to younger generations and the burden placed on each maintenance worker are becoming major issues.

A remote monitoring and control system is used to operate the hydropower plant, but in order to prioritize monitoring and control responsiveness in an emergency, detailed information about the hydropower equipment is not transmitted. This makes it difficult to accurately grasp the situation without going to the site. There are many things about a situation that are not able to be grasped remotely.

If more detailed information about a failure and measurement value information can be checked remotely, it is possible to understand the status of a power plant in advance. This would make it more efficient to make the necessary preparations and go to the site to reduce maintenance time and travel. There is a growing demand for smarter maintenance by utilizing such detailed data.

To solve the aforementioned problems, we have developed a maintenance support device that allows for checking detailed information about the hydropower plant from a remote location, and a maintenance support device equipped with a web camera. This latter system assures visual checks of the plant conditions of Yanagawa Hydropower Plant, owned by Iwate Prefectural Enterprise Bureau. This plant originally commenced operation in July 2021. In this paper, we will introduce a maintenance support device equipped with a web camera that enables the visual confirmation of the hydropower plant.

2 Outline of Hydro Turbine Generator

The Yanagawa Hydropower Plant was built in the Kawame district of Morioka City for the Iwate Prefectural Enterprise Bureau. It takes water at the Yanagawa Dam point, a dam type hydropower plant with a rated output of 1900 kW, utilizing river main-

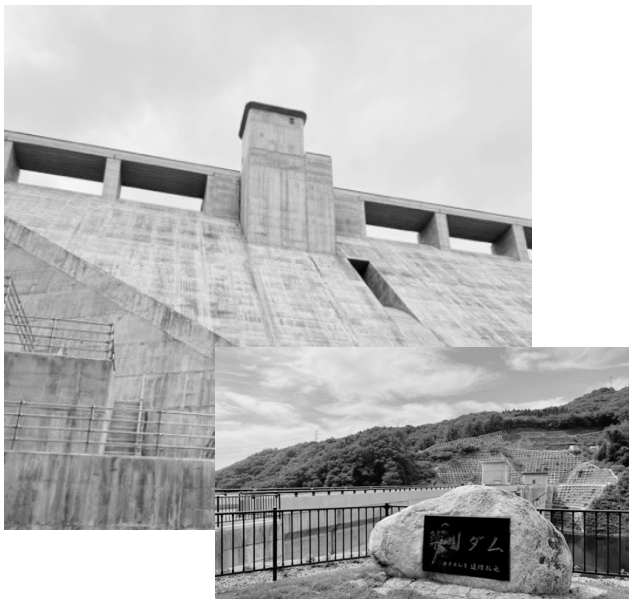

Fig. 1 Yanagawa Dam

An external view of the Yanagawa Dam is shown.

Fig. 2 Yanagawa Hydropower Plant

An external view of Yanagawa Hydropower Plant is shown.

tenance flow of up to 4.80 m³/s and a standard effective head of 50.65 m.

We supplied the hydro turbine, generator, main transformer, medium voltage panels, and control panels in 2021, and the hydropower plant initially began operation in July of the same year.

Fig. 1 shows the external view of Yanagawa Dam. Fig. 2 shows the external view of Yanagawa Hydropower Plant. Fig. 3 shows the hydro turbine generator. The hydropower plant equipment specifications are as follows.

(1) Water intake method: Dam type

(2) Turbine type: Horizontal shaft Francis turbine

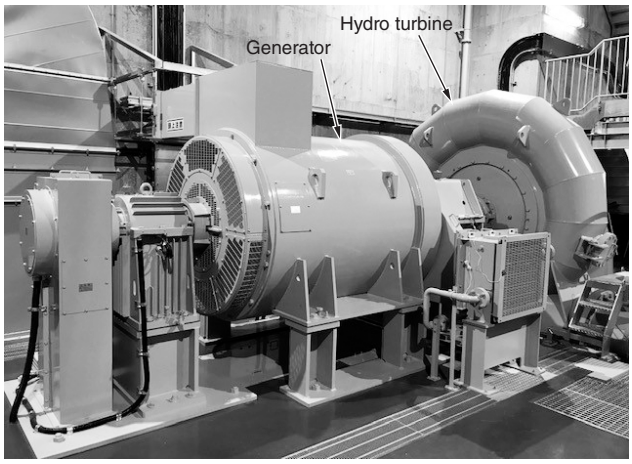

Fig. 3 Hydro Turbine Generator at Yanagawa Hydropower Plant

An external appearance of the hydro turbine generator at Yanagawa Hydropower Plant is shown.

(3) Turbine rating: Maximum water usage 4.80 m³/s, effective head 50.65 m

(4) Generator type: Horizontal shaft three-phase synchronous generator

(5) Generator rating: 2400 kVA-6600 V-10 P (600 min⁻¹)-50 Hz-0.95 pf

3 Introduction of Maintenance Support Device

Conventional remote monitoring systems have the following issues.

(1) Except for typical failure items, many cases are treated as collective failures, and detailed failures cannot be grasped.

(2) The measured values are only representative values, and the sampling frequency is not sufficient for accident analysis.

(3) When adding a hydropower plant to a centralized monitoring and control system that handles multiple power plants, major system modifications are required, which incurs a large amount of cost.

On the other hand, there is a large amount of information about status change, failure, and measurement data in the hydropower plant's Programmable Logic Controller (PLC), so if PLC data can be checked remotely, it will be possible to understand the hydropower plant's status in detail.

Our maintenance support device connects to the PLC via Local Area Network (LAN) and can acquire all the data used for control and measurement within the PLC. Additionally, data can be checked remotely via the network. A remote moni-

toring system can, therefore, be easily constructed. Fig. 4 shows a next-generation control panel with built-in maintenance support device and a large display.

The maintenance support device not only displays status changes, failures, and measured values on the screen, but can also save data daily in one-minute intervals as files. In addition, the status change history has the same function as a PLC sequence monitor and can handle up to 500 cases saved as one file. Fig. 5 shows the display screens of the maintenance support device.

Furthermore, the failure analysis graph display time is 100 ms for the 60 seconds immediately before the failure and the 10 seconds immediately after the failure. Data for the 10 minutes before and after this period is saved in a file at 1-second intervals. This file contains not only measured values but also status changes and failure information, making it possible to identify the context of each operation and phenomenon when a failure occurs and useful for investigating causes. Additionally, this data can be stored for a certain time timeframe in maintenance support device.

To save data for a longer period of time, it is necessary to periodically manually download it from a remote location. We, therefore, have connected a Network Attached Storage (NAS) so that files can be automatically transferred from the maintenance support device. This reduces long-term data storage and the burden on maintenance personnel.

Fig. 4 Next-Generation Control Panel and Large Display

The next-generation control panel and large display equipped with the maintenance support device are shown.

4 Installation of Web Cameras

Although detailed data such as control information for hydropower plant equipment can be checked from a remote location using maintenance support device, it is not possible to check the status of generators, rivers, and the surrounding area of the hydropower plant.

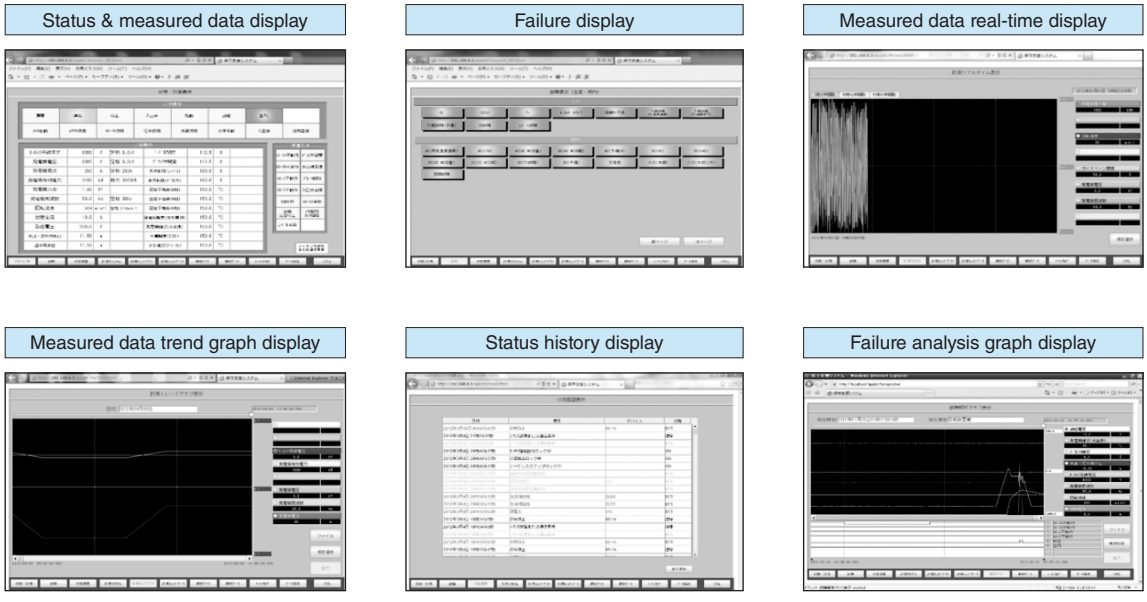

Fig. 5 Display Screens of Maintenance Support Device

An example of screens displayed on the maintenance support device is shown.

We installed web cameras that allow us to visually check the conditions of the equipment and the rivers and slopes surrounding the hydropower plant. The configuration of the web camera is as follows.

4.1 Web Camera

River conditions, hydropower plant entrance roads, switchgear rooms, and hydro turbine generator room conditions can be monitored remotely and stored for a certain timeframe using a video recorder.

We selected web cameras that can pan, tilt, and zoom, and installed a total of four cameras: two for outdoors (for rivers/roads, maintenance roads/slopes), one inside the switchgear, and one inside the hydro turbine generator room.

4.1.1 Outdoor Cameras (2 units)

By making it possible to visually check river conditions rising water can be visually confirmed remotely. Additionally, by recording road conditions, it is possible to determine things such as the number of cars entering the plant premises. It is also now possible to check video records along with maintenance support device data at a later date, making it possible to go back in time and correlate river conditions with operational data, and take measures after abnormalities like flooding or backflow have occurred.

Since the access to the hydropower plant is the administrative road and the road is located on a mountain slope, precautions against landslides and other disasters are necessary. When maintenance work is being carried out inside the hydropower plant, it may be difficult to notice the slope conditions outside the hydropower plant. A camera was installed to allow remote monitoring of the road conditions.

To make it easier to check the external conditions during maintenance work, large displays were installed at the hydropower plant to create a safe working environment.

4.1.2 Indoor Cameras (2 units)

Cameras in the switchgear room can check the situation inside the switchgear room (presence of fire or smoke), intruders, and the lamp displays on the panel (depending on lighting and other conditions).

The generator room camera was also placed in a position that not only provides a panoramic view of the hydro turbine and generator, but also the drainage pit.

Fig. 6 Large Display

A large-scale display is shown.

4.2 Large Display

Fig. 6 shows the large display. Although this system is configured to allow viewing of web camera images from a remote location, a large display was installed so that images from the web camera can be viewed on-site. By installing the web cameras inside the hydropower plant, the following benefits were obtained.

(1) Conditions for safety such as external weather, rising river water, slope abnormalities, etc. during the operational work from one place can be checked.

(2) The maintenance support device data and generator status can be checked at the same time in the control room.

(3) From the control room, it is possible to check the work status of the hydro turbine generator room.

(4) To handle the inspection tour of visitors, data can be shown in the display about the hydro turbine generator, surrounding conditions, and maintenance support device data. Such information can be used to explain hydropower generation status.

The screen layout of the large display can be changed freely by the on-site PC. The data from maintenance support device and web camera video are used by multiple people (maintenance workers) for information sharing and for operational management.

5 Postscript

Using maintenance support device and web cameras, we built a maintenance support device that allows detailed data to be checked remotely using a simple system.

In the future, we would like to work on improving the functionality of the system. This is to contribute to making maintenance work more sophisticated and reducing the burden on operational workers.

We would lastly like to express our deep gratitude to the Iwate Prefectural Enterprise Bureau and the many people involved with this project for their valuable guidance and co-operation during the course of the production and supply of this system.