Maintaining Operational Availability of Thermal Power Plant through Long-Term Maintenance Planning of Control System: Latest Solutions of DIASYS Netmation

Service Engineering Department,
GTCC Business Division,
Energy Systems,
Mitsubishi Heavy Industries, Ltd.

In order for thermal power plants to operate stably in response to high demand for electricity and to ensure sustainable operation over the medium to long term, maintenance activities not only for the main facilities but also for the control system for their monitoring and control are extremely important. Maintenance work for control systems is required to be planned to cause as little disruption to the facility operations as possible. Maintenance of the control system includes periodic replacement and upgrade work for stable operation and dealing with the discontinuation of production of its electronic components. We have developed an FXtoLS adapter that enables efficient upgrade of only the input/output communication part of a control device so that maintenance work can be performed during an inspection shutdown period of the main facility side. In addition, this report presents the latest solution of DIASYS Netmation, a cybersecurity measure based on multi-layer defense, to prepare for the increased risk of cyber-attacks on control systems in operation due to the development of IoT technology.

1. Introduction

Renewable energy is increasingly being introduced across the globe. Power consumption in data centers is rapidly rising to support the enormous amount of calculations required for AI and other applications. For maintaining a stable power supply, thermal power generation, which can generate electricity on a large scale and with high efficiency as represented by gas turbines, is still indispensable. It also plays an important role as a complement to power generation from renewable energy sources, which is affected by rapid fluctuations in electricity demand and weather conditions. Under such circumstances, control systems support the stable operation of thermal power plants. Control systems are the plant operation infrastructure that controls, monitors, and optimizes the power generation process, and have been catering to customers' operational needs for optimal operation and operation support of their plants by utilizing and linking cloud infrastructure technologies, such as remote monitoring systems and predictive error detection. Therefore, planned maintenance and upgrade of the control system is the key to sustainable operation of thermal power plants, and it is important to plan maintenance of the control system together with establishing a long-term operation plan of the plant itself to realize stable plant operation. This report introduces the latest solution of DIASYS Netmation, a control system manufactured by Mitsubishi Heavy Industries, Ltd. (hereinafter referred to as MHI).

2. Life cycle of control systems

As shown in **Figure 1**, the control system is divided into two major components: control devices which perform plant control calculations and input and output process signals from various instruments, and Human Machine Interface (hereinafter referred to as HMI) which is operated by supervisors and engineers.

Control devices consist of electronic components such as capacitors and semiconductors, and their life cycle in consideration of the end-of-life (EOL) of each element and part and the availability of their successor products, is approximately 10 to 15 years.

HMI, with some exceptions, includes computers running Microsoft Windows OS, and the life cycle of the computers themselves is generally said to be about five years. In recent years, the generation cycle of the Windows OS has become shorter for enhanced security measures, etc., and the support period for the latest commercial OS license provided by Microsoft is generally five years (or ten years for OS licenses for embedded devices).

Assuming that the life of a thermal power plant is about 30 years, the control devices need to be upgraded once or twice during the plant operation period, and HMI three to five times. Therefore, as a manufacturer, we support the business operations of power producers, our customers, by offering solutions described below so that they can make long-term maintenance plans for their control systems in advance.

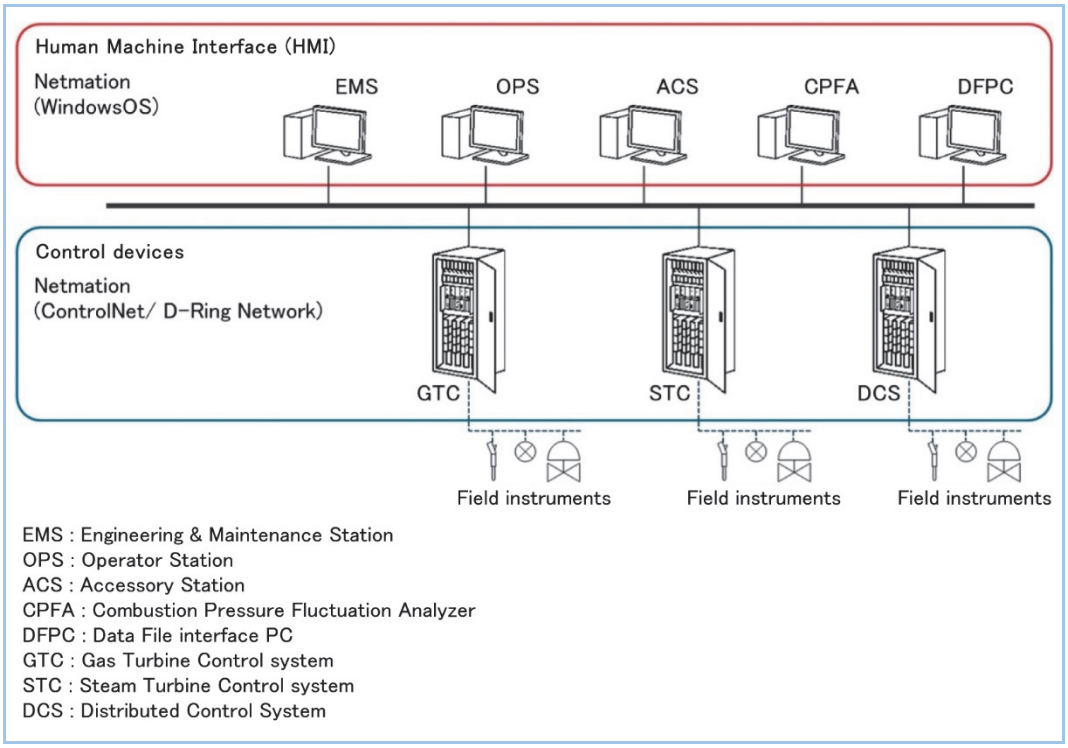

Figure 1 Control system configuration

3. Solutions for control system maintenance

This chapter presents solutions for maintenance and upgrade of DIASYS Netmation.

3.1 Periodic part replacement

Replacing parts periodically as preventive maintenance at the timing of periodic inspections for which the plant equipment is shut down can prevent plant operation from being affected by component failures due to age-related deterioration.

For this reason, we recommend periodic replacement of parts used in the control system. The recommended replacement cycles for major parts are shown in **Figure 2**.

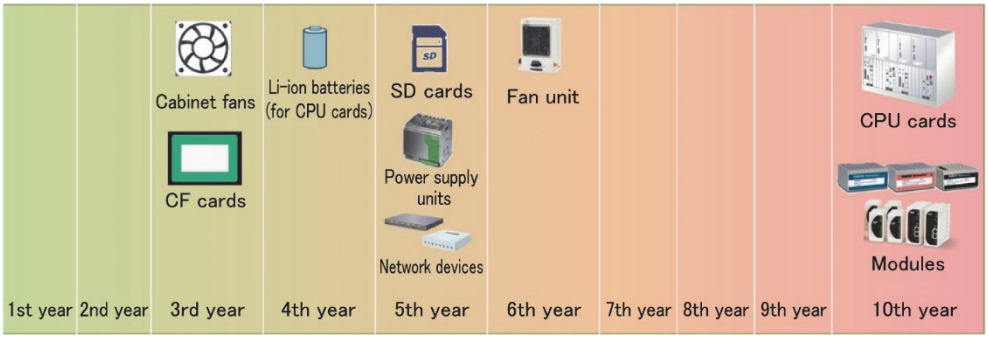

Figure 2 Recommended replacement cycles for major control system parts

3.2 I/O network upgrade

Control devices are divided into two major sections: a controller section, which consists of a CPU that performs control calculations, a communication card that communicates with HMI, and other components; and an I/O network section, which consists of an I/O module that input and output process signals to and from instruments on the field side, an adapter that communicates signals from the I/O module to the CPU, and other components.

The controller section is subjected to model changes due to the end of production of its electronic components, but successors with upward compatibility are available, and therefore we recommend upgrade to the latest model at the time of periodic replacement, I/O network upgrade as described below, and upgrade of HMI.

As for the I/O network section, there are two types of DIASYS Netmation I/O networks: ControlNet, which was released in 2000, and D-Ring Network, which was released in 2014 and is currently adopted for newly constructed power plants. We recommend I/O network upgrade from ControlNet to D-Ring, as shown in **Figure 3**, to make the aging I/O modules and adapters up to date.

The methods of I/O network upgrade include the upgrade of the entire control panel as well as the modification of only the I/O network section on-site without changing the control panel to meet the restrictions of the installation location and to reduce the scope of modification as much as possible. We offer the best method for each control device, taking into account the installation location and the control panel internal layout of the existing equipment. To efficiently modify only the I/O network section on-site, MHI has developed the FXtoLS adapter, a conversion adapter to mount a D-Ring Network I/O module on the existing module terminal block to which the external cable is connected (**Figure 4**). This adapter reduces the need to disconnect external cables from field instruments connected to the I/O module, thereby simplifying on-site modification work and post-modification verification work, which enables a shorter upgrade period.

In addition, one of the effective measures against aging of the CPU section of the control device is to perform the upgrade of its components such as the CPU card and CPU power supply in conjunction with the I/O network upgrade.

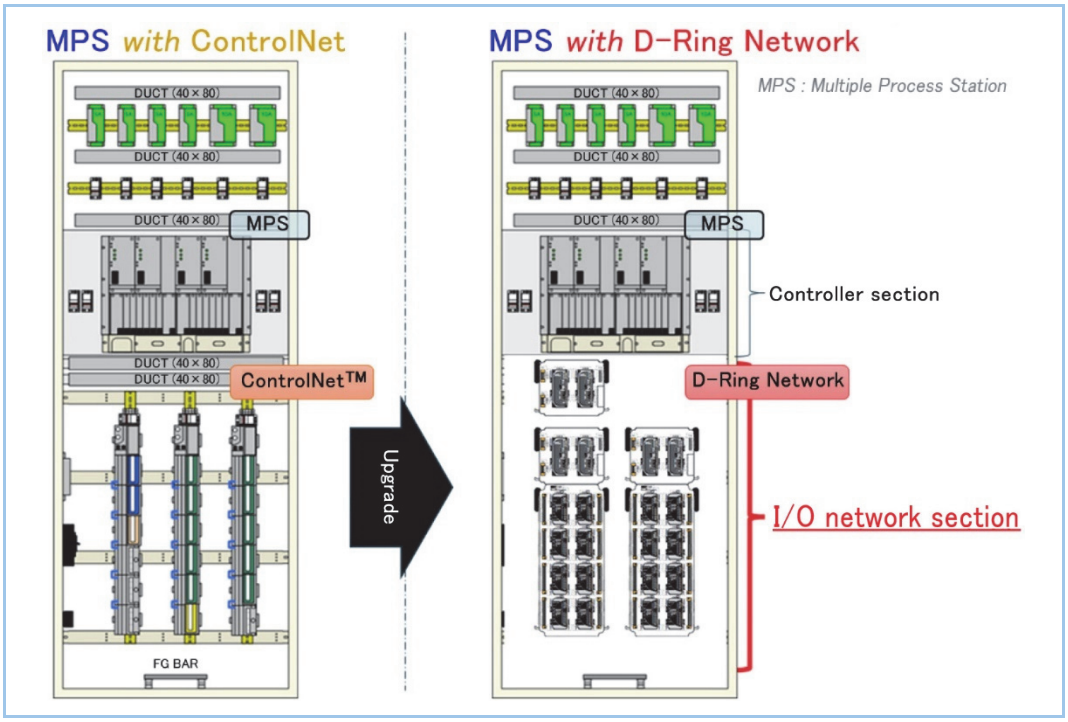

Figure 3 I/O network upgrade

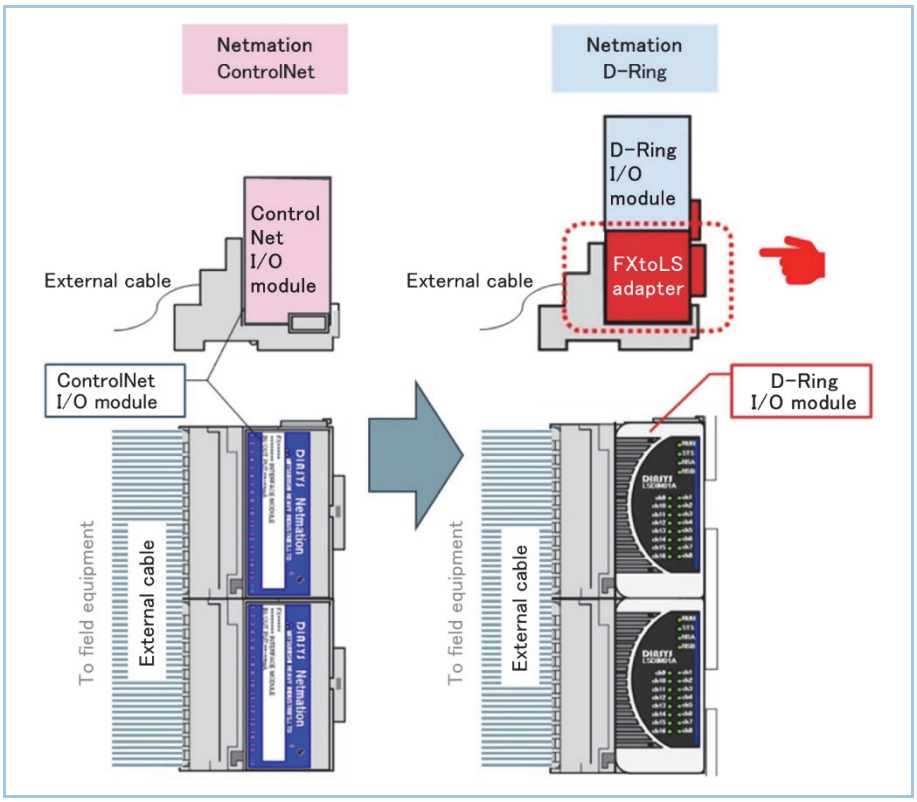

Figure 4 FXtoLS adapter

3.3 Step-by-step upgrade

The I/O network upgrade described in section 3.2 can be implemented on each control device basis. Specifically, in the case of some control systems consisting of multiple control devices as shown in **Figure 5**, the upgrade of the control devices can be carried out in stages according to the timing of long plant shutdowns such as periodic inspections, etc., thereby allowing the upgrade to be divided up and proceeded with in periodic inspections of multiple years in a planned manner.

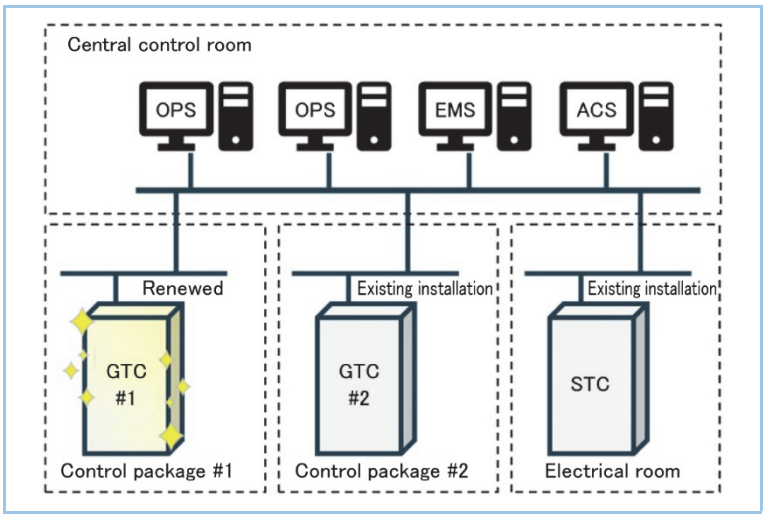

Figure 5 Illustration of step-by-step upgrade

3.4 Upgrade of HMI

The above description explained the upgrade of control devices. This section presents the upgrade of HMI. Since HMI uses general-purpose computers, problems such as slowdowns and freezes tend to increase with age. Furthermore, since HMI is based on Microsoft Windows OS as mentioned above, when computers that support the old Windows OS are discontinued due to generational changes in the hardware used in the computers, it becomes difficult to obtain spare parts or replacements in case of failure. The computer generation cycle is shortening year by year, and therefore, it can be said that the life cycle of computers is becoming shorter than before.

In addition, as mentioned above, Microsoft's support provision period is about five years.

When the support ends, Microsoft no longer provides security patches to correct vulnerabilities. Therefore, from a security perspective, there is a great need for the periodic upgrade of HMI.

In addition, since I/O network upgrade requires DIASYS Netmation software that is compatible with the D-Ring Network, MHI recommends that the upgrade of HMI be performed in a planned manner along with the I/O network.

4. Strengthening of cybersecurity measures

The above description presented maintenance solutions to keep control systems in a sound state. This chapter introduces the strengthening of cybersecurity measures, which have been in increasing demand in recent years.

In recent years, the threat of cyber-attacks has been increasing along with the development of IoT technology. Industrial plants, which are critical infrastructure of society, are also at risk of being targeted by such attacks, and therefore their security measures have become even more important.

Some countries and plants require their infrastructure facilities to be equipped with cybersecurity measures, and this trend is expected to spread worldwide in the near future.

MHI has released Netmation Protect Pack (hereinafter referred to as NPP) as a solution to strengthen the cybersecurity measures of DIASYS Netmation. NPP is a solution to reduce cybersecurity risks through multi-layered defense with multiple cybersecurity countermeasure functions as illustrated in **Figure 6.**

Figure 7 shows a part of the control system configuration diagram to indicate the area of the equipment and networks supported by the NPP (coverage area). The NPP is connected via the control system network. The introduction of NPP requires Windows OS supported by Microsoft Corporation, and HMI needs to be Windows 10 or later. To ensure that the NPP always maintains effective cybersecurity measures, it is important to perform ongoing maintenance and to update the licenses of the software that makes up the NPP.

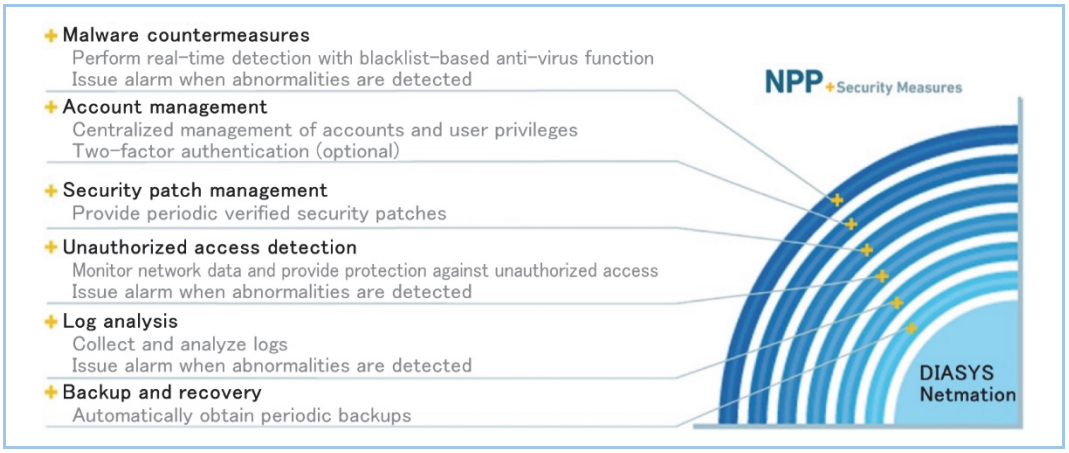

Figure 6 Multi-layered defense provided by NPP

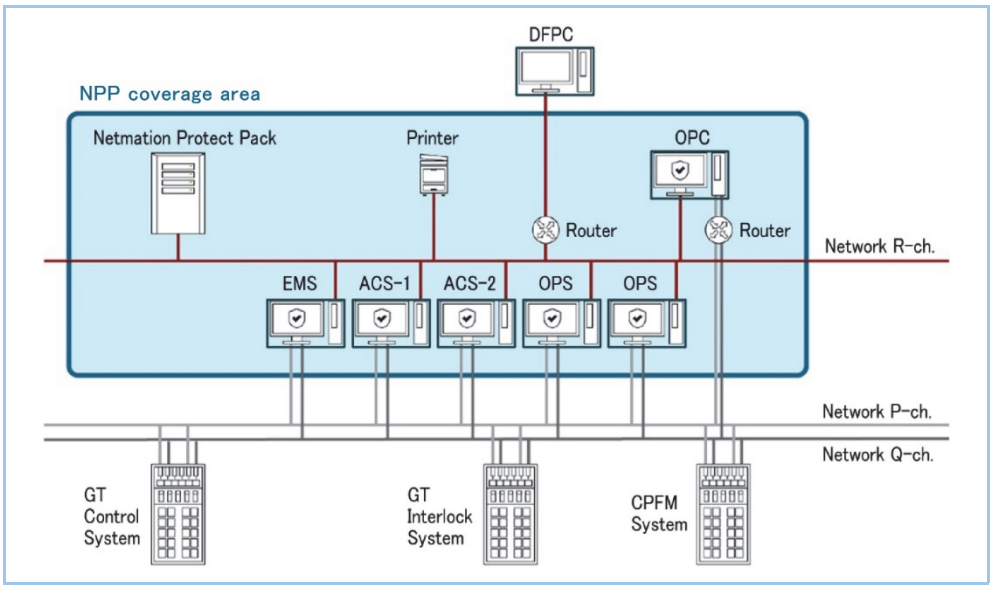

Figure 7 NPP coverage area in control system

5. Future prospects

To achieve stable operation of thermal power plants, it is essential to maintain and upgrade the control system. MHI provides appropriate solutions according to the lifecycle of the control system and supports the realization of maintenance plans that are linked to the long-term operation plan of the plant. This makes it possible to maintain safe and stable plant operation through preventive maintenance and efficient upgrade.

A key to sustainable plant operation is to take a long-term perspective and perform planned control system maintenance. MHI will continue to offer optimal solutions that meet our customers' needs to provide contributions as a partner in supporting the stable operation of their plants.