Hitachi's Latest Supervisory, Operation and Control System for Thermal Power Station

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OVERVIEW: Hitachi supplied Jiangxi Jiujiang Phase Ⅲ Power Generating Co., Ltd. in China with Hitachi Integrated Autonomous Control System 5000M (HIACS-5000M) as the supervisory, operation and control system for the company's plant equipment. Hitachi's expertise in plant control as a turbine, generator, and boiler supplier, are reflected in this system. The plant's reliability and maintainability have improved by this adoption. In addition, Hitachi has reduced the costs related to the cable using an RTB (remote terminal block), and has proposed the rationalization of equipment by using a digitalizing protection interlock panel. Both result in greater economical efficiency. Operability and maintainability have also improved by incorporating an HMI (human-machine interface) system, which features a 100-inch screen. The Plant Unit 1 began commercial operations in December, 2002, and so did the Plant Unit 2 in May, 2003.

INTRODUCTION

ON December 15, 2002, Plant Unit 1 and on May 29, 2003, Plant Unit 2 of Jiangxi Jiujiang Phase Ⅲ Power Generating Co., Ltd., China, started commercial operations. It has coal-fired thermal power generation equipment with a 350-MW × 2 capacity; Hitachi was in charge of the turbine, generator, and plant I&C (instrumentation and control) system.

In this paper, we introduce the DCS (distributed control system) component of the I&C system we supplied. The DCS that will monitor, operate, and control the power generation equipment, must greatly

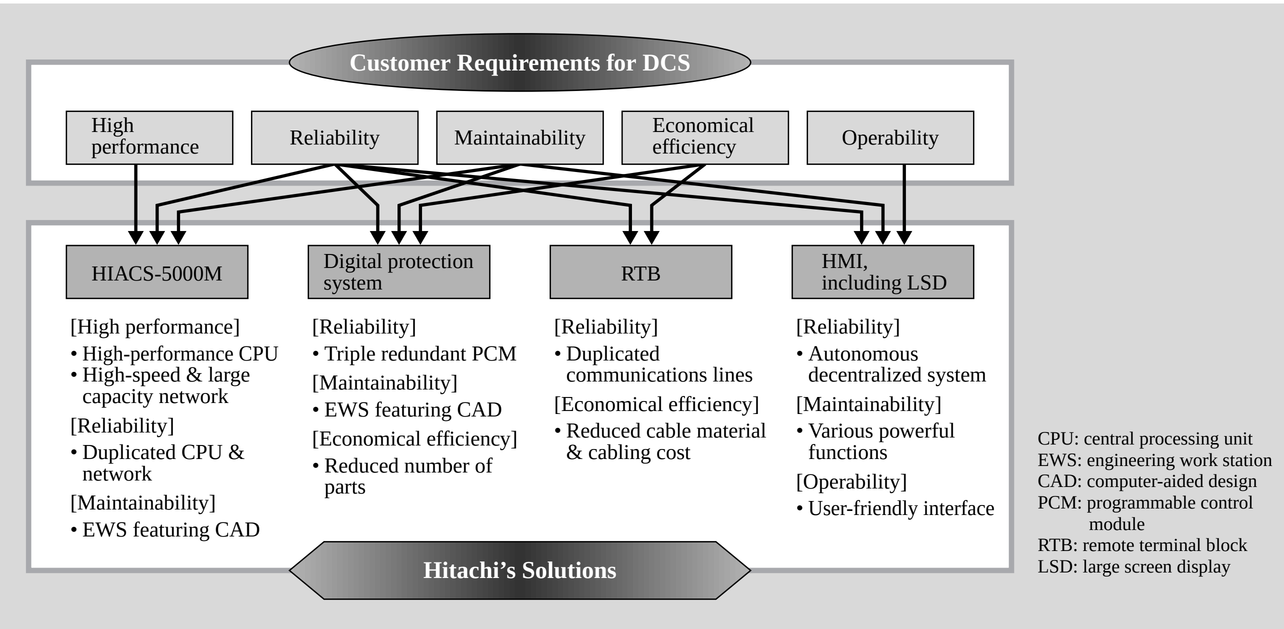

Fig. 1—Hitachi's Solutions for Plant Control of Jiangxi Jiujiang Phase Ⅲ Power Generating Co., Ltd.
The general requirements of an advanced DCS that supervises, operates, and controls power plant equipment are listed. For such customer needs, Hitachi supplies the best solutions.

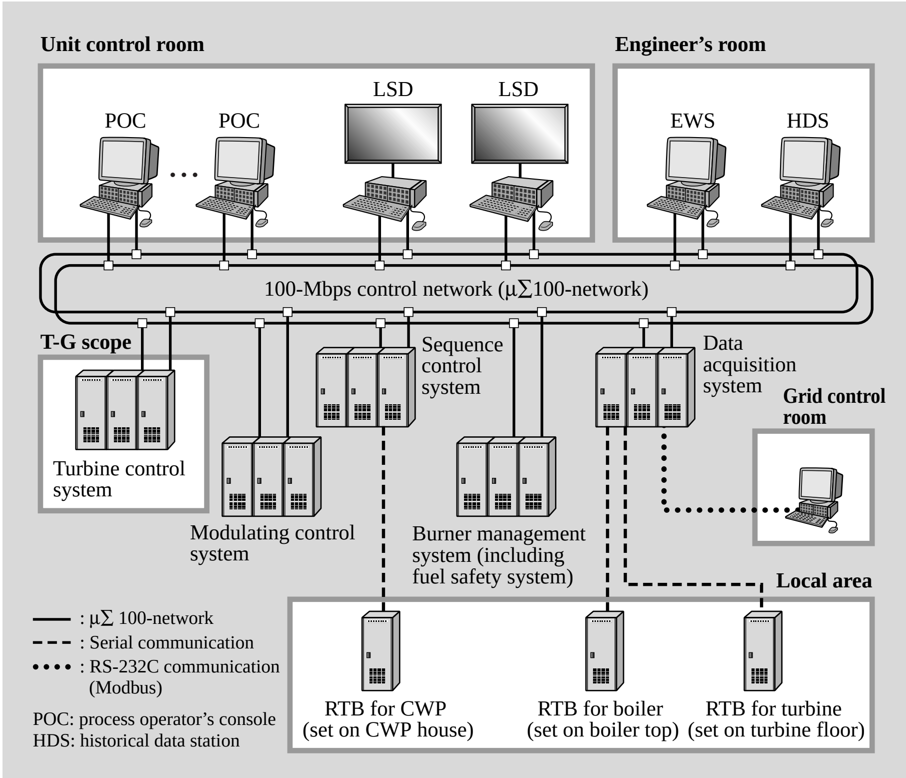

Fig. 2—Configuration of Main Control Equipment and Computers. The appropriate functional distribution for ideal plant control here is enabled by HIACS.

increase the client's economical efficiency, operability, reliability, and maintainability. To meet these requirements, Hitachi used its HIACS-5000M (see Fig. 1). Hitachi's experience and know-how in plant control, as a turbine, generator, and boiler supplier, are reflected in this system. Indeed, Hitachi can be the ideal plant control supplier regardless of who is supplying the turbine, generator, and boiler.

OUTLINE OF DCS AT JIANGXI JIUJIANG PHASE III POWER GENERATING CO., LTD'S POWER PLANT

The DCS is mainly composed of control systems including those for the boiler, sequence, electricity, and burners as well as DAS (data acquisition system) and an HMI (human-machine interface) system to monitor and operate the plant. The burner control includes a boiler protection system consisting of a digital protection interlock.

For the Jiangxi Jiujiang Phase III Power Generating Co., Ltd.'s power plant, Hitachi also supplied a turbine monitoring and control system as well as the DCS. Because the turbine monitoring and control system is incorporated in the control network of the DCS, no special interface is required for the system configuration. As a result, the entire operational system is unified in this power plant, making it possible to continuously monitor and control the entire plant efficiently (see Fig. 2).

SUPERVISORY CONTROL SYSTEM CONFIGURATION AND CHARACTERISTICS

Supervisory Control System

For the CPU, we used a high-performance and reliable controller equipped with 32-bit RISC (reduced instruction set computer); for the system configuration, we used duplicated CPUs to ensure safe and continuous operation of the plant. A state-of-the-art CAD system was installed on a Hitachi EWS, to provide exact one-to-one correspondence between the software logic and documents. For the control network to connect these CPUs, we used a high-speed and large-capacity optical network with a transmission rate of 100 Mbps. Because this network provides a loop-back function, when there is trouble due to cable breakage, breakdown of communication equipment, etc. during transmission, the areas of malfunction are avoided, so communication can continue without significant system disturbance. The I/O (input and output) interface is equipped with an SOE (sequence of event) function, in addition to the ordinary PI/O (process input and output). Because the SOE signal status can be detected at a resolution of 1 ms, it is very helpful for analyzing the cause of problems.

Fig. 3—Unit Control Room for Jiangxi Jiujiang Phase Ⅲ Power Generating Co., Ltd.
A user-friendly human interface is implemented through CRTs by having both individual screens and a large screen for common use.

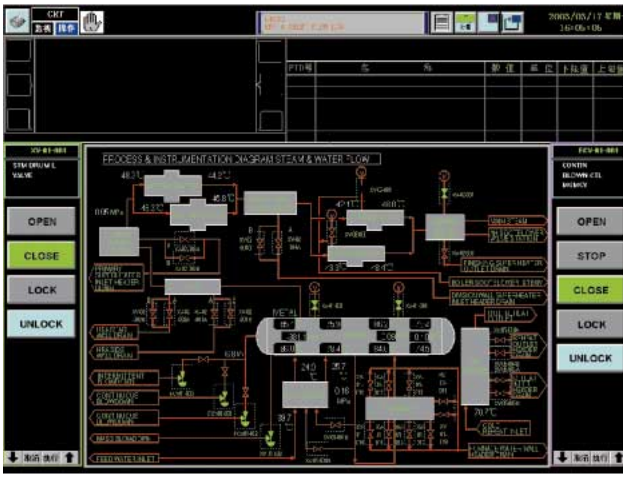

Fig. 4—Example of Mimic Diagram with CRT Operation.
By placing CRT operator functions on a mimic diagram, operators can execute optimum operations easily while monitoring the screen.

HMI System

The HMI system can be roughly divided into two systems: one for operation and monitoring by individual operators, and the other for common monitoring. For the common monitoring equipment, a large 100-inch screen was used to facilitate sharing information among all the operators. For the operator station hardware, we used HF-W, which is capable of 24-hour continuous operations with enhanced reliability due to the use of long-lasting parts and a stronger cooling system. In addition, HF-W supports various functions based on globally standardized PC (personal computer) technology. For the operator station software, we used HIACS-W based on an autonomous decentralized system, thus making possible a highly reliable HMI system (see Fig. 2). By using the autonomous decentralized system, many pieces of equipment are functionally distributed so that the entire control systems functions will not be affected by the failure of a single mode.

The HIACS-W can be implemented on various PC platforms. This system provides superior real-time performance as well as a variety of functions, such as a mimic diagram display, a historical trend display, an alarm display, and various logs. It also features powerful plant monitoring functions such as a trip log, a process record, and an SOE log. CRT (cathode-ray tube) operation is possible not only on the screen dedicated to eight control terminals, but also on the mimic diagram screen, thus enhancing operability (see Figs. 3 and 4).

Remote Terminal Block

The RTB enables easy front access wiring as well as the removal and installation of the wiring block. These features are especially useful for direct cable wiring, both in the workshop and the field. With each RTB, separation between high-voltage circuits and electronics circuits is enabled, and analog and digital I/O signals (for operation and monitoring) are communicated between the RTB and the controller through high-speed serial transmission. Because its line is duplicated, the reliability is high. Using the RTB reduced the amount of cable material and the cost of cabling. For this plant, we installed an RTB on the boiler top (to monitor temperature), in the turbine floor (to monitor temperature), and in the CWP (circulating water pump) house (to operate and monitor). In particular, for the RTB panel in the CWP house built on the side of a river, we used optical fiber cables because this CWP is about 2 km from the electrical room where the controllers are: This made it possible to greatly reduce the cables (by 90% or more) needed between the two sites (see Fig. 5). Because the boiler-top RTB panel is subject to severe ambient conditions, we adopted an outdoor-type panel (equivalent to NEMA 4) that does not need an additional enclosure to cover the RTB panel. Furthermore, it can withstand dust, water, high temperatures, and condensation.

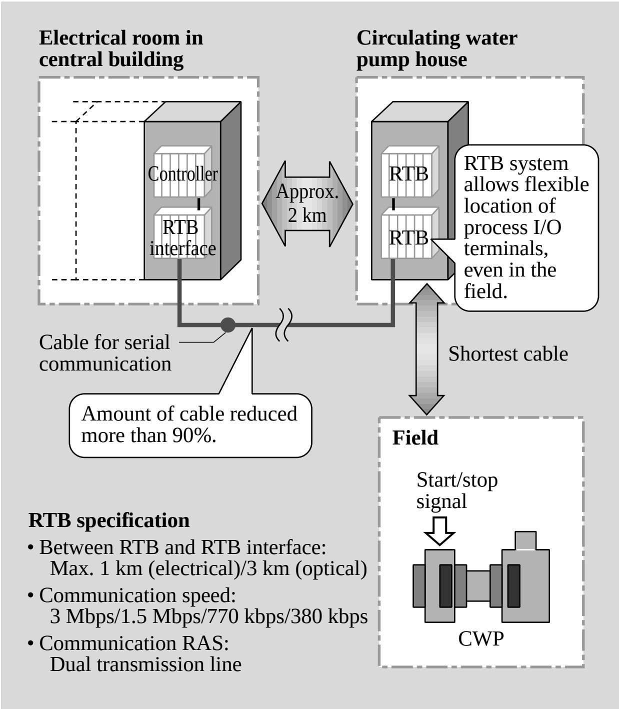

Fig. 5—Example of Remote Monitoring and Operating.
The RTB can monitor and operate distant equipment with the same reliability as operating from the electrical room. Moreover, the cable material and cabling costs were reduced by using serial communication.

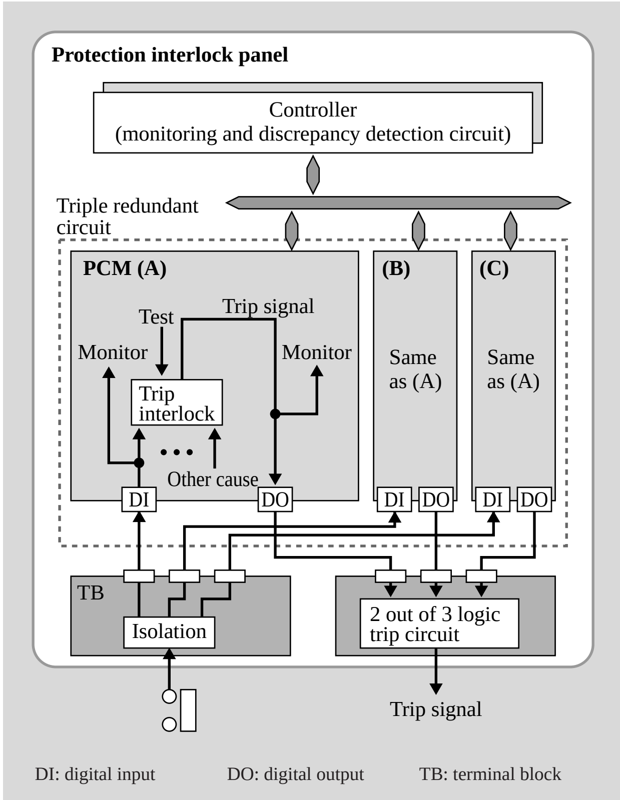

Fig. 6—Summary of the Protection Interlock Circuit Structure.
Reliability systems providing certainty of hardware and flexibility of software are implemented by the triple redundant structure of PCM.

APPLICATION OF DIGITAL PROTECTION SYSTEM TO FUEL SAFETY SYSTEM

We applied a digital protection system for the FSS (fuel safety system) to protect the boiler. The conventional protection interlock panel is entirely composed of hardware requiring a lot of fabrication work and modification. Hitachi adopted a PCM having a nonvolatile memory, which is regarded as reliable hardware. This made it possible to reduce the number of parts and to greatly improve the reliability, and it also resulted in a more reliable and cost-effective system than a conventional one.

The features of the digital protection system are as follows:

(1) Triple redundant PCM
(2) Circuitry visualized and rationalized by adopting PCM
(3) Test and alarm circuit functions

Triple Redundant PCM

The PCM is triple redundant, with each system separate and independent so that the protective functions will not be lost in the event of a single failure or single malfunction, thus ensuring high reliability and maintainability. The trip causes are input to trip interlock in each PCM through a terminal board, and the output trip signals from each PCM are initiated through 2 out of 3* logic trip circuits, thus guaranteeing its reliability.

Circuit Visualizing and Rationalizing by Adopting PCM

The PCM can work even when the controller (consisting of monitoring and discrepancy detection functions as shown in Fig. 6) fails, and it has an autonomous decentralized function that can perform protection functions independently. The logic circuit in the nonvolatile memory can be monitored through an EWS, and the logic can be loaded through the EWS when it needs to be changed. Because the functions enabled by the hardware are installed in the nonvolatile memory as software, the hardware components have been reduced, which has greatly improved the

* "2 out of 3" is a voting logic that produces an output by selecting the majority vote from 3 inputs.

maintainability, reliability, and the flexibility of the system for future functional enhancements.

Test and Alarm Circuit

Because the high reliability of the protection system is essential to being able to stop in an emergency caused by troubles during plant operation, a test and alarm circuit is equipped with functions to monitor and detect the operating status of the PCM as well as the discrepancy among systems. It also has a channel test function to check if the trip command from each system is normal, thus making it possible to ensure that the system will always be reliable.

CONCLUSIONS

We have explained the benefits that resulted from using our HIACS-5000M system at Jiangxi Jiujiang Phase III Power Generating Co., Ltd., China.

In the electric power industry, customers' needs are diversifying, and demands for a highly advanced distributed control system are increasing. For the supervisory and control system, we also paid careful attention to the safety and efficiency of the plant, and we will continue to work to satisfy these needs.

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