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...
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增加客户的经济效率，可操作性，可靠性和维护性。为了满足这些要求，Hitachi使用了HIACS-5000M（见图1）。Hitachi的经验和知识，在涡轮、发电机和锅炉供应商中的反映在这个系统中。事实上，Hitachi可以成为理想的植物控制系统供应商，无论谁是供应的涡轮、发电机和锅炉。

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

DCS主要包括控制系统的锅炉，顺序，电力和燃烧器，以及DAS（数据采集系统）和HMI（人机界面）系统来监控和操作植物。燃烧器控制包括一个锅炉保护系统。使用一种数字保护互锁。

对于Jiangxi Jiujiang Phase III Power Generating Co., Ltd.的发电厂，Hitachi也提供了涡轮监控和控制系统以及DCS。因为涡轮监控和控制系统被集成到DCS控制网络中，所以不需要特殊的接口来配置系统。因此，整个操作系统在电站中被统一，使得可以连续地监控和控制整个发电厂（见图2）。

SUPERVISORY CONTROL SYSTEM CONFIGURATION AND CHARACTERISTICS

Supervisory Control System

对于CPU，我们使用高性能和可靠的控制器配备了32位RISC（减少指令集计算机）；对于系统配置，我们使用了复制的CPU来确保安全和连续的植物操作。一种最新的CAD系统被安装在Hitachi EWS上，以提供精确的一对一对应软件逻辑和文档。对于连接这些CPU的控制网络，我们使用了高速和大容量的光网络，传输率为100 Mbps。因为这个网络提供了一个环回功能，当传输中有电缆断线，通信设备等故障时，故障区域被避免，所以通信可以继续在没有大系统干扰的情况下。

I/O（输入和输出）接口包括一个SOE（事件序列）功能，除了通常的PI/O。因为SOE信号状态可以在1毫秒的分辨率下被检测到，所以对于分析问题非常有帮助。
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.
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.

REFERENCES