

Control System for H-25 Combined-cycle Power Plants

Kazuyasu Asakura
Yotaro Kimura
Takashi Kamei
Kazuhiko Miura

OVERVIEW: These days, against a background of deregulation of the power-generation industry, more and more IPPs (independent power producers) and PPSs (power producers and suppliers) are entering the power-generation market. At the same time, the need for improved energy efficiency is growing. As a result of these circumstances, the number of combined-cycle power plants in the 20–100-MW class being constructed is continuing to increase. Accordingly, to meet these needs, Hitachi is proposing an H-25 combined-cycle power plant implemented with H-25 gas turbines (25-MW class)—which help to improve plant efficiency and shorten start-up and shutdown times. From such a background, Hitachi has developed a new plant control and monitoring system named “Hitachi Integrated Autonomic Control System—Multiplex for turbine control 1000 (HIACS-MULTI 1000)” for H-25 combined-cycle power plants. The HIACS-MULTI 1000 is the latest addition to the repertory of HIACS-MULTI systems. As well as attaining improved reliability and maintainability, the HIACS-MULTI 1000 control system is more compact and thus saves equipment space.

INTRODUCTION

ACCOMPANYING the deregulation of power generation, there has been an increase in the number of combined-cycle power plants in the 20–100-MW class being constructed by IPPs (independent power producers) and PPSs (power producers and suppliers). In response to these needs, Hitachi is providing an H-25 combined-cycle power plant applying H-25 gas turbines (25-MW class).

As regards the monitoring and control functions for overseeing these operations, systems that can maintain high reliability while saving power used in running and monitoring operations are being demanded. In accordance with that demand, Hitachi has developed a control and monitoring system called “Hitachi Integrated Autonomic Control System—Multiplex for turbine control 1000 (HIACS-MULTI 1000)”—based on our domestically and internationally proven HIACS-MULTI system—as the plant control and monitoring system for H-25 gas turbine for an H-25 combined-cycle power plant (see Fig. 1). In the rest of this paper, this system is briefly overviewed.

DEVELOPMENT CONCEPT AND CHARACTERISTICS

A control and monitoring system for a combined-cycle power plant is composed of a gas-turbine control system, a gas-turbine generator protection system, a gas-turbine generator excitation system, a steam-turbine control system, a steam-turbine generator protection system, a steam-turbine generator excitation system, a DCS (distributed control system: plant control system), an HMI (human-machine interface), and maintenance tools. In the case of the developed system, namely, the HIACS-MULTI 1000, the control system was made compact so as to save space at the installation location, and the control and monitoring systems were developed to save the work load of operation personnel in line with customer requirements.

Turbine Control System

In the case of a conventional monitoring and control system for a combined-cycle power plant, independent control systems are applied to the gas-turbine control and the steam-turbine control, respectively. With the

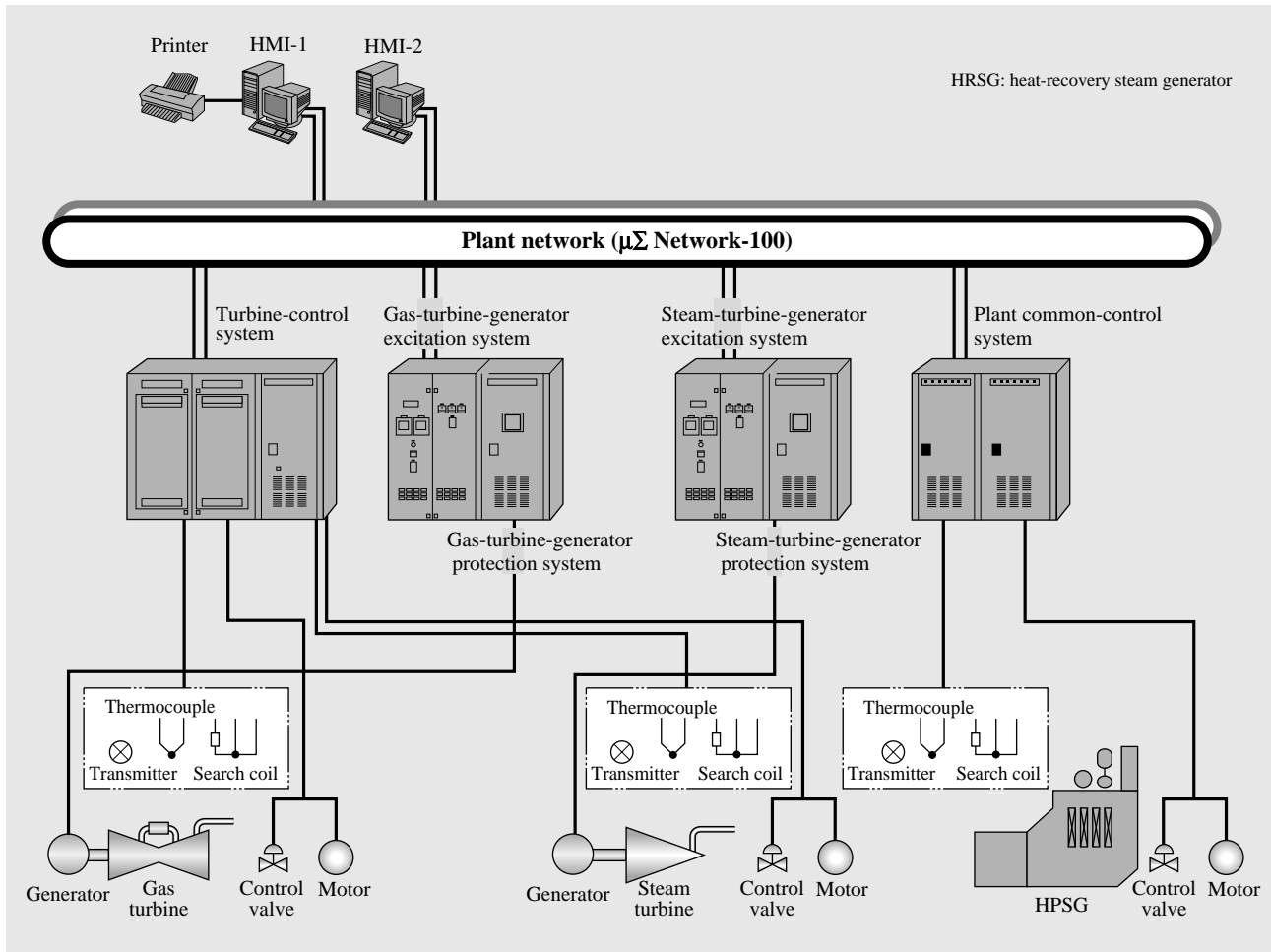


Fig. 1—Configuration of H-25 Combined-cycle-generation Plant Control System “HIACS-MULTI 1000.” This configuration shows an example of multi combined-cycle-generation plant control system “HIACS-MULTI 1000,” composed of one H-25 gas-turbine unit, one exhaust-heat recovery boiler, and one steam-turbine unit.



Fig. 2—External View of HIACS-MULTI 1000. By applying a turbine-control system that integrates the functions for controlling both the gas turbine and the steam turbine, it is possible to provide a compact monitoring and control system.

HIACS-MULTI 1000, both control systems are integrated as one controller in order to make the control system more compact than a conventional one. An external view of the HIACS-MULTI 1000 is shown in Fig. 2.

The turbine-control system functions as a triple-redundant controller for protection, and servo valve control of the gas turbine and steam turbine are executed by a hierarchically distributed PCM (programmable control module). As a result of this configuration, calculation loads can be dispersed so that the risk of losing protection caused by controller system down can be reduced, and reliability can be improved while expanding the flexibility of the control functions (see Fig. 3).

Plant Network ($\mu\Sigma$ Network-100)

The plant network utilized is Hitachi’s high-speed,

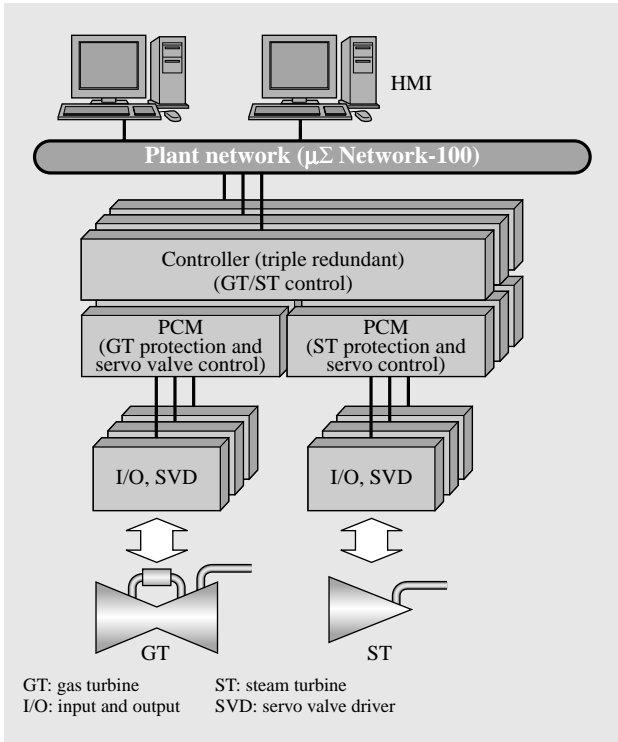


Fig. 3—Configuration of Turbine-control System. By distributing the calculation load by means of a hierarchical controller/PCM structure, it is possible to integrate the gas-turbine and the steam-turbine control functions.

large-capacity $\mu\Sigma$ Network-100. On this network, control and monitoring data can be transferred and received at high speed through a mutual gateway connecting by the turbine control system, the DCS,

the gas-turbine generator excitation system, the steam-turbine generator excitation system, and the HMI (human-machine interface) without using gateways.

DCS

As well as controlling the HRSG (heat-recovery steam generator) and plant local equipment, the DCS has a function for ATS (automatic turbine start-up and shutdown)—which aims to shorten the plant start-up time. Moreover, it can be appended with functions such as providing the constant-supply power control that is needed when users are connected to the grid of power generating companies.

Gas-turbine-generator Excitation System and Steam-turbine-generator Excitation System

The gas-turbine-generator excitation system and steam-turbine-generator excitation system apply Hitachi’s digital excitation system “VCS-6000”. This system can handle either brushless-excitation or thyristor-excitation methods. As for redundancy of the control systems, dual or single repertoires can be selected according to user requirements. The standard control functions are automatic voltage regulation and manual excitation regulation, and functions such as over excitation limiter, under excitation limiter, and reactive current compensator can be added to the system.

HMI

The HMI collects operation data from the gas turbine, steam turbine, generator, and the HRSG, and

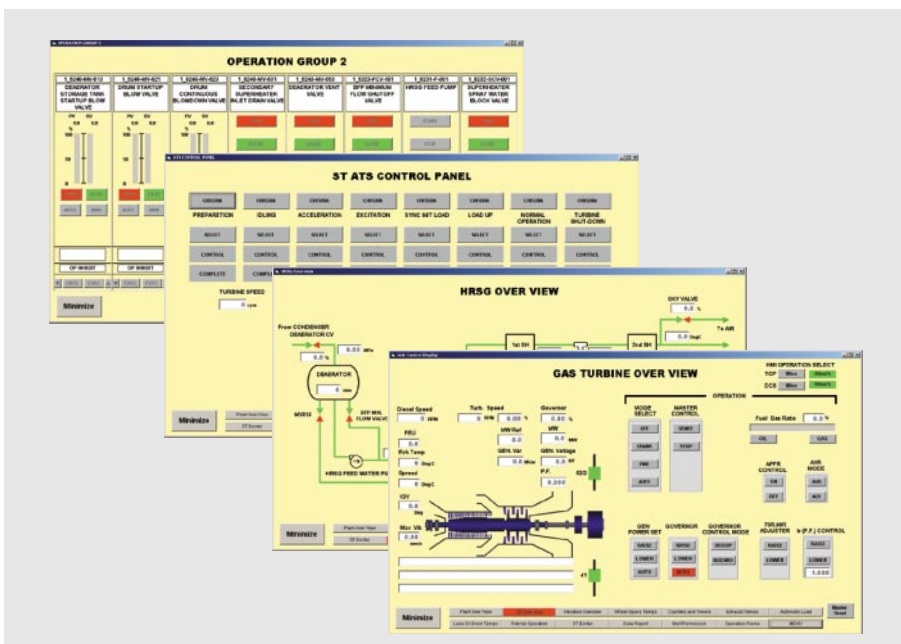


Fig. 4—Example of HMI Screen Shot. Centralizing of monitoring and control of the gas turbine, steam turbine, and exhaust-heat recovery boiler can be performed by the HMI.

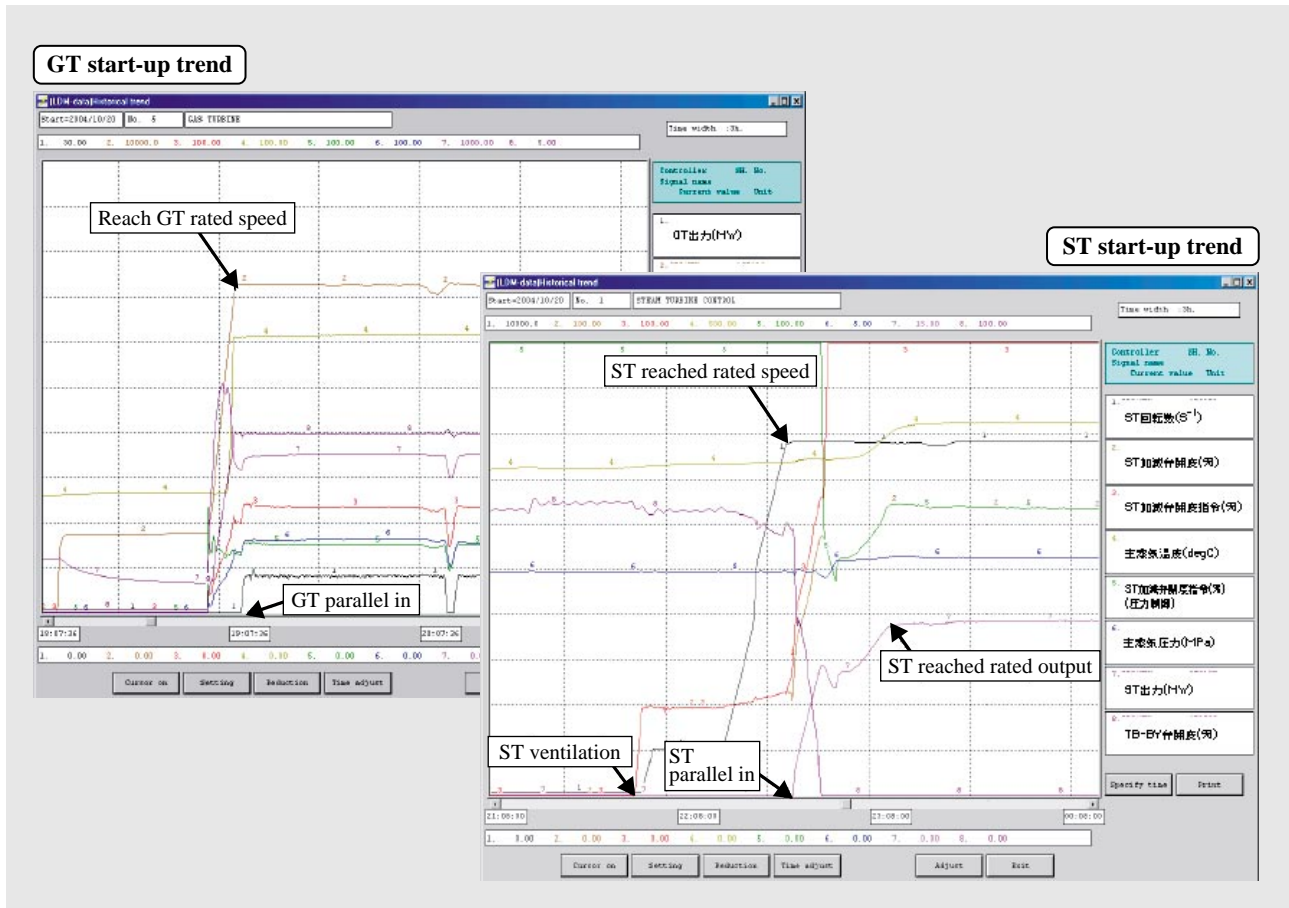


Fig. 5—Example of Trend Data from Commissioning Tests on H-25 Combined-cycle-generation Plant. Commissioning tests on an H-25 combined-cycle-generation plant fitted with the HIACS-MULTI 1000 control system have been completed, and the system is now running smoothly under fully commissioned operation.

it centralizes the monitoring and control operations for each piece of equipment (see Fig. 4). Furthermore, the maintenance tools for the turbine-control system and the plant common-control system are integrated into the HMI, thereby enabling centralized management of the software data for each system. And as regards the monitoring and control of external systems like BOP (balance of plant), communication links are provided via protocols such as Modbus*.

CASE STUDIES AND RESULTS

Implementing the developed system described here, i.e. the HIACS-MULTI 1000, in a power plant reduced the space needed for control systems by 65% compared to that needed for conventional systems. In addition,

the results of test runs performed on site confirmed that the system's operation and control characteristics, for example, during start-up and shutdown, in regards to a combined-cycle power plant are satisfactory (see Fig. 5).

CONCLUSIONS

This paper described Hitachi's control and monitoring system, the HIACS-MULTI 1000, for combined-cycle power plants. Against a background of deregulation of power generation and improvement of energy efficiency, it is considered that the demands for combined-cycle power plants in the 20–100-MW class will continue to grow in the years to come. In accordance with these demands, Hitachi will intensify our efforts to provide control and monitoring systems that ensure stable and safe plant operation, ease of use, and flexible system construction.

* Modbus is a registered trademark of Schneider Electric SA.

REFERENCES

- (1) T. Iijima et al., "Latest Supervisory and Control System for Advanced Combined Cycle Power Plants," *Hitachi Hyoron* **84**, pp.181–184 (Feb. 2002) in Japanese.
- (2) T. Kamei et al., "The Latest Power-plant Control Systems," *Hitachi Hyoron* **85**, pp.181-184 (Feb. 2003) in Japanese.

ABOUT THE AUTHORS

**Kazuyasu Asakura**

Joined Hitachi, Ltd. in 1991, and now works at the Power Plant Control Systems Engineering Department, the Information & Control Systems Division, the Information and Telecommunication Systems. He is currently engaged in the designing of power-plant control systems. Mr. Asakura can be reached by e-mail at kazuyasu_asakura@pis.hitachi.co.jp.

**Takashi Kamei**

Joined Hitachi, Ltd. in 1993, and now works at the Power Plant Control Systems Engineering Department, the Information & Control Systems Division, the Information and Telecommunication Systems. He is currently engaged in the designing of power-plant control systems. Mr. Kamei can be reached by e-mail at takashi_kamei@pis.hitachi.co.jp.

**Yotaro Kimura**

Joined Hitachi, Ltd. in 1992, and now works at the Turbine Plant Design Department, Hitachi Works, the Power Systems. He is currently engaged in the designing of gas-turbine plants. Mr. Kimura can be reached by e-mail at youtarou_kimura@pis.hitachi.co.jp.

**Kazuhiko Miura**

Joined Hitachi, Ltd. in 1992, and now works at the Power Plant Control Systems Engineering Department, the Information & Control Systems Division, the Information and Telecommunication Systems. He is currently engaged in the designing of power-plant control systems. Mr. Miura can be reached by e-mail at kazuhiko_miura@pis.hitachi.co.jp.