Integrated Supervisory and Control System HIACS-MULTI for H-25 Gas Turbine

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OVERVIEW: Now serving as the core control system in numerous hydroelectric, thermal, and nuclear power plants, Hitachi's supervisory and control system HIACS has earned a reputation for robustness and reliability. Continuing this high standard of HIACS dependability, HIACS-MULTI was developed as a cost-effective, easily maintainable control console for application to gas turbines, optimized especially for Hitachi's H-25 gas turbines. The HIACS-MULTI provides a flexible control solution for the great diversity of gas turbine power plants that are in service and being built today.

INTRODUCTION

BESIDES providing a stable supply of electric power, modern power plants must meet a range of other performance criteria including high efficiency, high operability, and increasingly today, design to mitigate environmental impact. This calls for supervision and operation of power plants that is not only more advanced but also easier and more operator friendly. Although we are seeing a growing number of simple-cycle projects reflecting the deregulation of the power market, bringing down construction costs and reducing construction schedules are also very important in terms of economic costs. Building on its accumulated knowledge and expertise in developing supervisory and control systems that are highly reliable and cost-effective while also reducing the work load on operations and maintenance personnel, Hitachi, Ltd. is now offering HIACS (Hitachi integrated autonomic control system)-MULTI, an integrated supervisory and control system tailored specifically for H-25 gas turbine-powered plants. The HIACS-MULTI system is based on the HIACS series that has an extensive history and record of dependability and high performance. Here we will provide a summary overview of the HIACS-MULTI control system designed for H-25 gas turbines, and describe the actual installation in Fig. 1.

Fig. 1—Control System of the Hitachi Rinkai Power Station Unit-2.
Very high standard of reliability is achieved with HIACS (Hitachi integrated autonomic control system)-MULTI, Hitachi's cutting-edge digital control system used here to control a multi-shaft combined-cycle power plant consisting of two H-25 gas turbines, a waste heat recovery boiler, and a steam turbine.

HIACS-MULTI OVERVIEW

The HIACS-MULTI system is the beneficiary of countless technical refinements made to the HIACS series, whose robustness and reliability are attested by long years of service at many different power plants.

HIACS Milestones

Hitachi developed and deployed HIACS-2000, the world's first digital control system for power plants, in the 1970s, and followed with the HIACS-3000, a single module controller covering the entire gamut of required control functions, in the 1980s. Hitachi's current cutting-edge supervision and control system for power plants is the HIACS-5000M, and HIACS-MULTI incorporates all the wisdom and technology
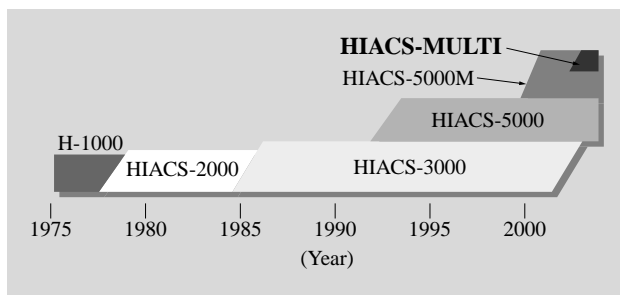
accumulated over decades of HIACS development and refinement: it features robust reliability, maintainability, and operability, along with excellent cost efficiency (see Fig. 2).

Specifically, the HIACS-MULTI features:
(1) Compact design with four cabinets of functional controls now easily accommodated on just two cabinets,
(2) A very high standard of reliability based on triple modular redundancy, and
(3) Enhanced maintainability based on a maintenance tool HMI (human-machine interface).

System Configuration

HIACS-MULTI controls and protects plant turbines through control processing of a multiplexed controller. The plant network is Hitachi's high-speed, large-capacity $\mu\Sigma$ network-100 system based on the FDDI (fiber distributed data interface) standard. Control and monitoring data passes at very high speed between the various equipment and the HMI connected to the plant network without having to pass through a gateway. As one can see in Fig. 3, local or remote HMI workstations are capable of interconnecting multiple systems and equipment over the plant network.

Failure Rate Reduced Through In-house Manufacture

All printed circuit boards going into the HIACS-MULTI are manufactured in house, and we take extraordinary efforts to eliminate initial defects and reduce the failure rate through strict acceptance inspections and by implementing rigorous coding and aging tests. Thanks to these painstaking procedures,

Fig. 2—HIACS Milestones.
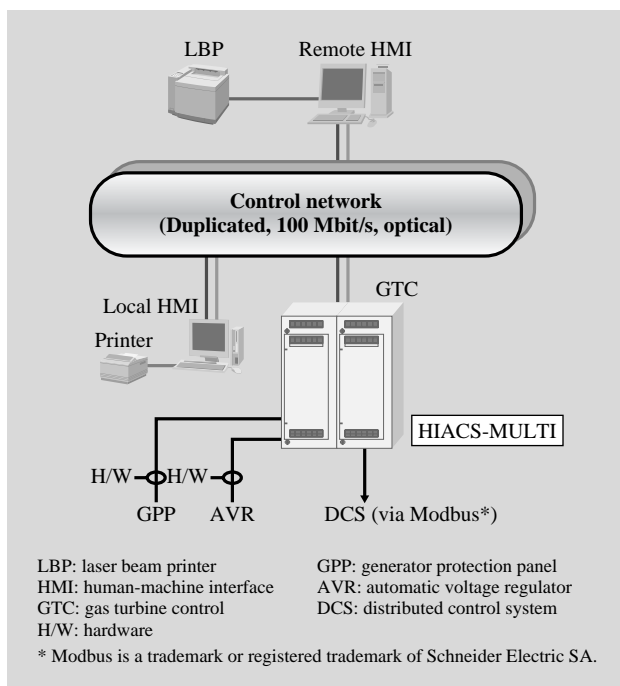*The HIACS series has continued to evolve to meet the demands of state-of-the-art power plants.*

LBP: laser beam printer
HMI: human-machine interface
GTC: gas turbine control
H/W: hardware
GPP: generator protection panel
AVR: automatic voltage regulator
DCS: distributed control system
* Modbus is a trademark or registered trademark of Schneider Electric SA.

Fig. 3—System Configuration.
Figure shows basic HIACS-MULTI configuration.

• **Improved controller performance**	
CPU	32-bit RISC SH4 (160 MHz) × 2
Processing speed	50-500 ms
Memory capacity	32 Mbyte of ECC

• **Improved response rate**	
Transmission rate	100 Mbit/s (dual ring topology)

CPU: central processing unit
RISC: reduced instruction set computer
ECC: error correction code

Fig. 4—Photo and Specifications of Hitachi CPU LPU610A.
Pains are taken to minimize the failure rate through strict acceptance inspections and in-house measures.

we have drastically reduced failure rates during trial and commercial operation and achieve highest operating ratios in the industry (see Fig. 4).

HIACS-MULTI FUNCTIONS AND FEATURES

Along with recent advances in system component technologies, HIACS-MULTI has been continually upgraded and enhanced with state-of-the-art technologies — all-digital high-speed circuitry, open-interface-based connectivity to systems and equipment, a repertoire of diverse multiplexed systems — to meet the diverse needs of independent power producers and other operators.

Exceptional Robustness and Reliability

HIACS-MULTI is configured so that the gas turbines are controlled and protected by a multiplexed controller, while the servo valve control, that requires realtime performance, is run from a PCM (programmable control module). This arrangement improves reliability while providing more flexible control capabilities by distributing the operation load and distributing the risk of loss of protection in the event that the controller fails.

Outstanding Maintainability

The HIACS-MULTI operator interface (HMI) is via LCD (liquid crystal display) console, and by incorporating HMI capability in the maintenance tool used to maintain controller programs, all supervision, operation, and maintenance tasks can be carried out from a single EWS (engineering workstation). The HMI provides an intuitive graphical operating environment, and a diverse range of menu options for running various plant operations and procedures, monitoring plant data, displaying alarms, adjusting servo valves, performing overspeed tests, and many other capabilities. And as one can see from the screen shots in Fig. 5, extending HMI to the maintenance tool makes this version much more powerful than past versions of the system by supporting visualization of online logic monitoring and trend data.

(1) Centralized maintenance tool with built-in CAD capability

The HIACS series centralized maintenance tool with built-in CAD (computer aided design) permits centralized management of software logic diagrams (production plans) and software. By expanding and hierarchically arranging the macro library used to develop software logic, control logic flow diagrams are easier to grasp and visualize, and this enhances
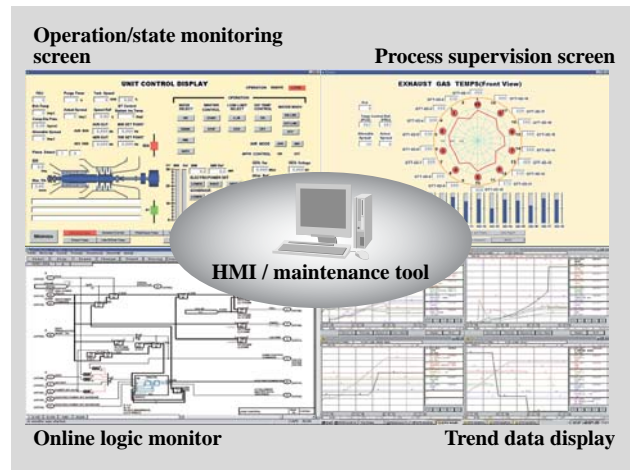

Fig. 5—Integrated Supervision, Operation, and Maintenance. HIACS-MULTI permits supervision, operation, and maintenance to be carried out from a single workstation.

the system's maintainability. In addition, the system allows online monitors to be added to CAD drawings, and displays engineering values next to process values that reflect the control state in real time. Moreover, because all the control data needed by the digital control equipment — address management data, operating sequence management data, and so on — are automatically tracked and maintained within the maintenance tool, the reliability of the software is markedly improved and the number of operation maintenance management plans is substantially reduced.

(2) HMI system

Supported by PC/AT (personal computer/advanced technology)-compatible hardware, the HMI consists of an intuitive, easy-to-use multi-window environment that makes it very easy for operators to perform all their operational and supervisory tasks. The HMI includes screens for running and operating the equipment (e.g. starting up and shutting down equipment), for monitoring processes (exhaust gas temperature, vibration monitoring, and other variables), for managing operating history (number of start-ups, and so on), for trip tests (overspeed test), for maintenance (servo valve adjustment), and for displaying alarms and warnings. The HMI system also supports the addition of customized screens tailored to the particular needs of the plant.

Full Repertoire of System Features and Options

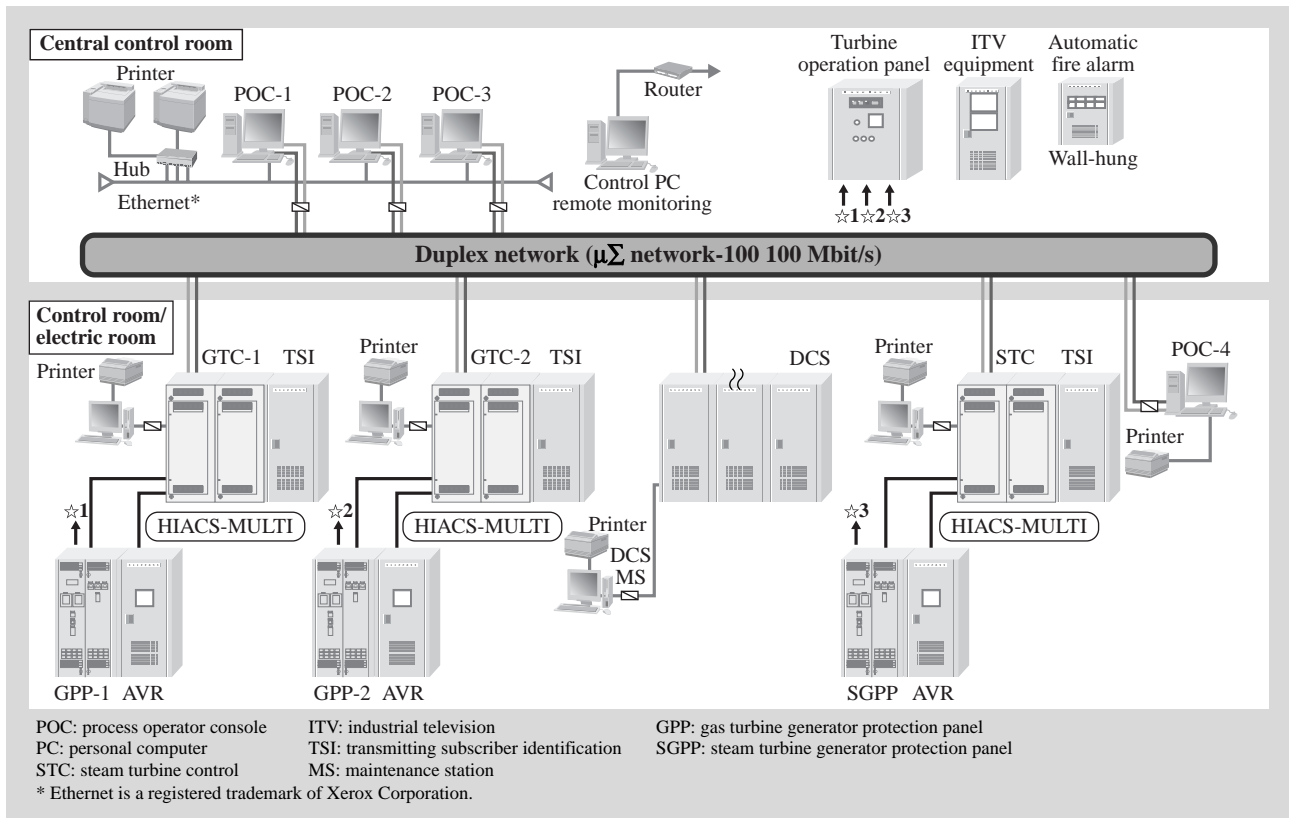Based on feedback and requests from many power producers and suppliers representing different types

Fig. 6—Typical HIACS-MULTI Deployment.
Application of HIACS-MULTI to the Hitachi Rinkai Power Station Unit-2 combined-cycle power plant is shown.

of power plants, HIACS-MULTI control systems are available with a wide range of configurations supporting different:

(1) Degrees of controller redundancy (single, dual, triple modular redundancy),

(2) Start-up modes (motor, diesel engine),

(3) Fuels (gas, oil, dual fuel),

(4) NO_x (nitrogen oxide) reduction methods (low NO_x burner, water injection, steam injection),

(5) Operating options, droop, isochrones, island operation, dead bus close etc., and

(6) Operating systems (Windows[*1] or open source Linux[*2]).

The control panel module is very compactly implemented (1,330 mm wide × 810 mm deep × 2,300 mm high), and HIACS-MULTI has been extensively deployed not only in newly commissioned power plants but in numerous retrofits of just the control system.

Open Interface Interconnection

HIACS-MULTI can be readily interconnected to other equipment over RS232, TCP/IP (transmission control protocol/Internet protocol), or other general-purpose open interfaces.

Available as a Control Package

In response to feedback and popular demand from power producers and suppliers, HIACS-MULTI has been implemented as a complete self-contained control package that can be delivered and installed at plant sites very quickly, thus greatly reducing the construction and installation time.

A TYPICAL DEPLOYMENT

Since the system was made available, HIACS-MULTI has been installed at numerous power plants in Japan and around the world, and has received high marks from plant operators for its robust availability (reliability), maintainability, and operability. Fig. 6 shows a plant schematic for Hitachi Rinkai Power Station Unit-2, a combined-cycle power plant with gas turbines and one steam turbine that are controlled by the HIACS-MULTI system.

CONCLUSIONS

This paper described Hitachi's HIACS-MULTI system, a powerful supervision and control system for power plants that is cost-effective, reduces the work load on plant operations and maintenance personnel, while maintaining a very high standard of reliability and robustness. The demands for even greater cost efficiencies, operability, and environmental safeguards will increase in the years ahead. Hitachi, Ltd. is certainly up to this challenge, and is committed to offering the highest standard supervision and control systems for the safe, efficient, and flexible operation of power plants ranging from the most complex systems to simple-cycle systems.

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