Completion of Hitachi Rinkai Power Station Unit-2

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OVERVIEW: In recent years, thanks to deregulation in the field of thermal power generation, power-generation facilities called IPP have been constructed in great numbers throughout Japan. Hitachi, Ltd. is actively involved in the power-generation business across all activities — ranging from plant engineering up to operational management after plants have been constructed and commissioned. At this time, as an IPP providing wholesale power to the Tokyo Electric Power Co., Inc., Hitachi Rinkai Power Station Unit-2 has been completed. Since this plant is located in Hitachi Works, Rinkai Factory (Hitachi City, Ibaraki Prefecture, Japan) surrounded by local residences, its equipment specifications must take particular account of the plant's influence on the surrounding environment (namely, noise pollution and waste-water discharge). In comparison to Unit-1, which is already in commercial operation, Unit-2 is a power plant that features improved start-up characteristics and high reliability while taking extra account of the surrounding environment.

INTRODUCTION

COMPOSED of two H-25 gas turbines, one heat recovery steam generator, and one steam turbine, Hitachi Rinkai Power Station Unit-2 is a multi-shaft combined cycle power plant that started operation in the wholesale power market (supplying the Tokyo Electric Power Co., Inc.) on June 20, 2006. Since rated-load operation after start-up is maintained and there is no operation at partial load, this facility adopts an operation method that synchronizes two gas-turbine units as if they were a single operating unit. Moreover, streamlining is achieved by cutting the number of machines in the form of a configuration that channels exhaust gas from two gas turbines into one heat recovery steam generator. As a result, the plant attains all-out economical efficiency — namely, suppressing power generation costs and capital expenditure in line with demands of IPP (independent power producer) power generation facilities.

Fig. 1—A View of the Hitachi Rinkai Power Station Unit-2.
This unit is a multi-shaft combined cycle power plant composed of two H-25 gas turbines, one heat recovery steam generator, and one steam turbine.

In this report, an overview of Hitachi Rinkai Power Station Unit-2 is presented, and its special technical features are described (see Fig. 1).

OVERVIEW OF HITACHI RINKAI POWER STATION UNIT-2

Design Overview

As a combined cycle power plant composed of two gas turbines, an heat recovery steam generator, and a steam turbine, this facility is configured as a multi-shaft type that channels exhaust gas from two gas turbines into the single heat recovery steam generator (see Fig. 2).

The main specifications of Unit-2 are listed in Table 1. The gross output is 89,680 kW. The two gas turbines are high-efficiency Hitachi H-25 types, using low sulfur A heavy oil. The heat recovery steam generator is a horizontal natural circulating double pressure type, the steam turbine is a double pressure condensing type. Cooling tower is installed for condenser cooling. Moreover, to prevent ground pollution due to leakage, the design of the discharge-water tank takes into account the regional environment; that is, instead of adopting the conventional concrete tank, it adopts an underground duplex system that allows six-side inspection access to the tank.

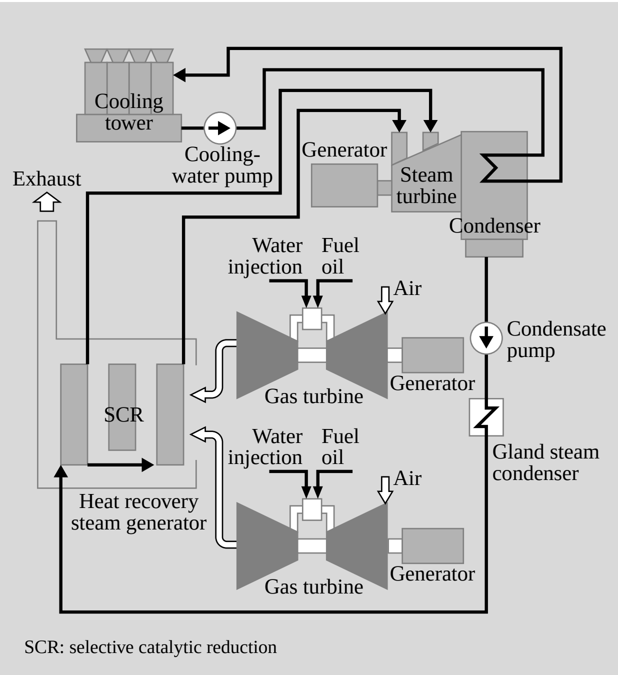

Fig. 2—Outline of System Configuration.
The special feature of the system is heat recovery by means of one heat recovery steam generator for collecting the exhaust heat from two gas turbines.

Operation

Under "middle operation," the operation system implements 12-hour operation excluding operation at weekends or during public holidays [DSS (daily start-up and shut-down) and WSS (weekly start-up and shut-down)]. The service factor is 30%.

FEATURES OF MAIN EQUIPMENT

Gas Turbines

As a gas turbine independently developed by Hitachi, Ltd., the H-25 was introduced in 1988, and since its introduction, it has been positively evaluated in terms of high reliability and high performance. Presently, operating both within Japan and overseas, the total number of delivered turbine units is over 100. Furthermore, the gas turbines can handle various applications, and while being applied to businesses and industries, they can cover a wide range of operation conformations (such as simple cycle, combined cycle, and co-generation systems).

The gas turbines are heavy-duty types for high reliability, and ease of maintenance is improved by configuring the turbine casing in a horizontal split type (see Fig. 3). In addition, the gas turbines are configured in such a way — namely, they are "packaged" — so as to shorten times for delivery and installation. In this plant, to clear the noise regulation concerning the regional environment (i.e. 80 dBA), the gas turbine, auxiliary equipment, and generator are housed in a large enclosure (see Fig. 4). The compressor achieves a pressure ratio of about 15 by means of 17-stage axial

TABLE 1. Main Specifications of Unit-2
The main specifications of Unit-2 are shown.

		89,680-kW multi-shaft combined cycle
H-25 gas turbine	Type Number Fuel DeNO_X method	Open-cycle single shaft 2 Low sulfur A heavy oil Water injection
Heat recovery steam generator	Type Number	Horizontal natural circulating double pressure 1
Steam turbine	Type Number	Double pressure condensing 1
Condenser	Type	Surface condensing
Cooling tower	Type	Forced draft
NO_X discharge	ppm	40 or less (16% O_2)
SO_X discharge	m^3N/h	11.2 or less

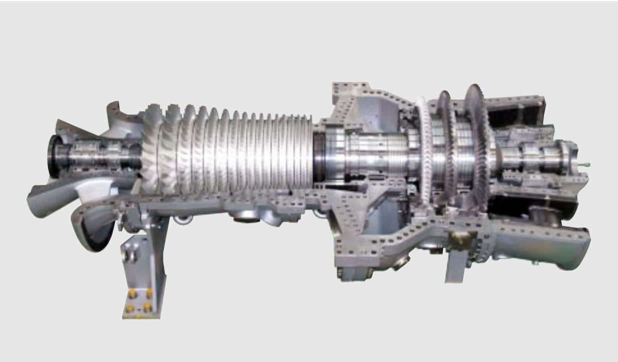

Fig. 3—Open State of H-25 Gas-turbine Casing.
The casing adopts a horizontal split type, so maintainability is improved.

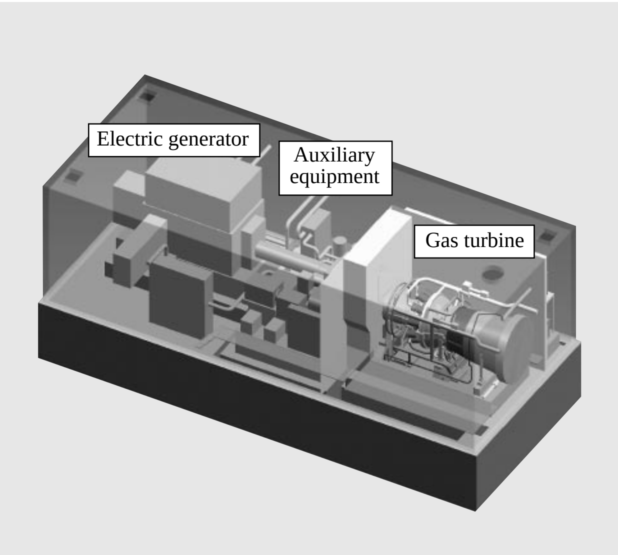

Fig. 4—Schematic View of H-25 Gas-turbine Package.
To clear the 80-dBA noise regulation, the gas turbine, auxiliary equipment, and generators are housed in a large enclosure.

flow, and the front-stage side has a high Mach number, so transonic aerofoil is adopted.

The gas turbine is constructed as a three-stage impulse type. The first-stage buckets are cooled types (multi-path return-flow cooling), and the interior of the buckets are fitted with a high-performance turbulence promoter. Moreover, the first-stage nozzles adopt film cooling, impingement cooling, and pin-fin cooling. As a result, while cooling efficiency is improved, the cooling-air flow mass is reduced, thereby improving cooling performance. The second- and third-stage buckets are fitted with a shroud cover, which improves the leak performance at the edges of the blades.

The combustor is a multi-can type, and H-25 has

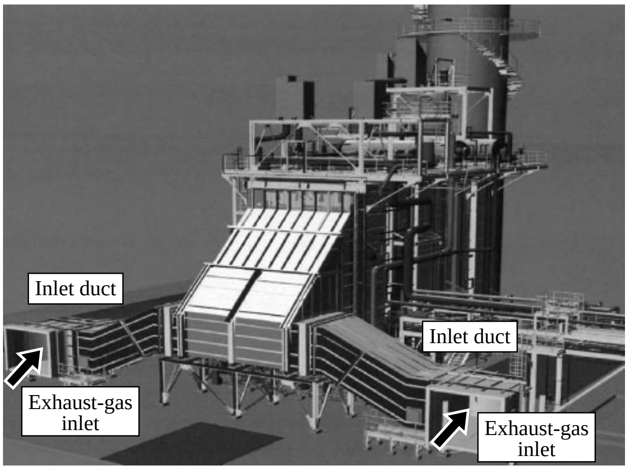

Fig. 5—Image of Heat Recovery Steam Generator.
The heat recovery steam generator recovers the heat from gas discharged from the two gas turbines and generates steam for supplying the steam turbine.

10 combustors. As for fuel, gas, liquid, or multiple fuels can be used. In particular, as well as natural gas, diesel oil, crude oil, and offgas, medium calorie gas (such as coke gas) can be used. For denitration (i.e. $DeNO_x$), as well as steam injection and water injection, a dry low-NO_x combustor is fitted. In this plant, low sulfur A heavy oil is used as the gas turbine fuel, and $DeNO_x$ is performed by a water-injection method in conjunction with the $DeNO_x$ by the equipment of the heat recovery steam generator. As a result, the environmental-control criterion of 40 ppm (16% O_2) is cleared.

Heat Recovery Steam Generator

An image of the HRSG (heat recovery steam generator) is shown in Fig. 5. The HRSG is a horizontal natural-circulation double pressure type installed outside, and its streamlining is accomplished by merging exhaust gas from the two gas turbines via an inlet duct and by performing heat recovery in a single unit. As a result of this configuration, initial costs and maintenance costs are both reduced; thus, economical efficiency is greatly improved.

The HRSG has three special features: (1) compactness and low cost are achieved by utilizing an integral deaerator (integrated with a low-pressure steam drum); (2) corrosion resistance is improved by adopting a steel alloy (corresponding to STBA22) for the low-temperature fin tubes; and (3) by setting up a work space inside the casing, access covering the overall height of the heat transfer tube is assured and maintainability is improved.

From the environmental viewpoint, the HRSG design takes three approaches: (1) a denitration system with a low-SO_3 conversion ratio is adopted; (2) NO_x is decomposed into non-toxic nitrogen and water by dry ammonia catalytic reduction; and (3) emissions are lowered by adopting 40-m height stack. Moreover, as a result of modularization of the HRSG, installation is simplified and its costs are significantly reduced. Compared to the Unit-1, the HRSG of Unit-2 is more environment friendly, easy to install, maintain and operate while achieving high efficiency.

PLANT CONTROL SYSTEM

Configuration of Monitoring and Control System

The monitoring and control system performs both DSS and WSS operation, and once the plant has started up, rated load operation is maintained. Since the format of the operator staff for the system provides two people on one shift (covering the Unit-1 as well), this monitoring and control system adequately considers reducing the load on the operators. The key features of the monitoring and control system for the plant are summarized below (see Fig. 6).

(1) The system assigns control requiring special or quick response to dedicated control devices, takes up that information by a DCS (distributed control system), and performs centralization of operation and monitoring, thereby making operational monitoring of the plant easy.

(2) The plant is a multi-shaft combined-cycle, so control equipment of each gas turbine, the heat recovery steam generator, and the steam turbine are independent. Therefore, even in the event of a breakdown, the reliability of the control system — which can prevent spreading and expanding to the other equipment — is improved.

(3) To flexibly handle future expansion of control and management functions, serial transmission is adopted, thereby reducing cable costs.

(4) A remote-monitoring system, which performs operational analysis by remote monitoring of operation status and abnormal status of the plant and that supports appropriate operation and maintenance in accordance with that monitoring, is installed.

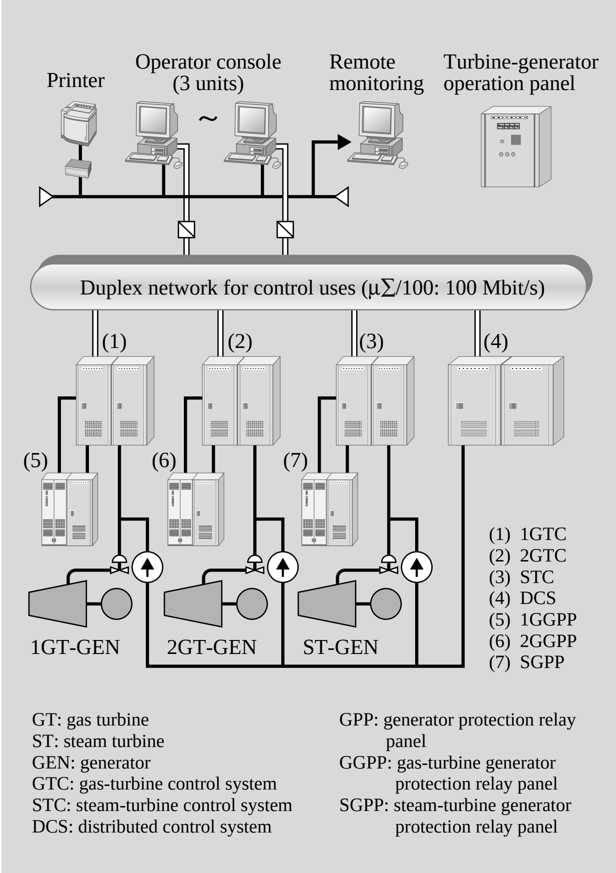

Fig. 6—Structural Overview of Monitoring and Control System.
A distributed control system composed of various kinds of software for sequence control, process control, and various monitoring functions is adopted.

Operation Control Method

This plant comprises one heat recovery steam generator for handling two gas turbines, which are based on integrated operation. The features of the main control method for operation of the two gas turbines are summarized as follows.

(1) As for the start-up process, the simultaneous completion of the purge operations on both gas turbines is confirmed, and ignition and speed-up are performed on both turbines simultaneously. Moreover, after both gas turbines are synchronized in this manner, completion of initial-load retention is confirmed, and load-up is performed simultaneously.

(2) During normal operation, to prevent unbalanced-load operation of the two gas turbines under target loads, equalizing-load distribution is executed.

(3) As for handling plant abnormalities, such as one gas turbine trip or run-back occurrence, the other gas turbine trips or run-back operation is initiated.

TRIAL-OPERATION PERFORMANCE

Construction of this plant was started in February 2005, and after about ten months of construction and installation work, the first ignition and synchronization were conducted in February 2006. The safety, reliability and operability of this plant were verified during the four months of trial operation, and finally, on June 20, 2006, this plant was put into commercial operation.

Plant Performance

The test result of the plant gross output and efficiency were higher than the design value at the performance test. What's more, NO_x and SO_x emissions concentrations lower than the design values were achieved, thereby confirming that this power plant takes adequate account of the environmental surroundings.

Plant Start-up Characteristics

As for testing the start-up characteristics of the plant during commissioning tests, in the case of "hot start," it was confirmed that the start-up process is completed approximately 60 min from gas turbine rolling to gas turbine full load. Compared with the start-up time of Unit-1, that of Unit-2 is reduced by approximately 30 min.

CONCLUSIONS

This report presented an overview of Hitachi Rinkai Power Station Unit-2 and described its main features. From now onwards, Hitachi, Ltd. will continue to accumulate experience in operating and maintaining this plant while pushing ahead positively in regard to the power-generation business.

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