OVERVIEW: In 2001 Hitachi, Ltd. and Babcock-Hitachi K.K. were contracted by EPCOR Power Development Corporation of Alberta, Canada to oversee the engineering and construction of Genesee Power Generating Station Phase 3, a 495-MW-capacity coal-fired power plant that is scheduled to become operational in the first quarter of 2005. This paper presents an overview of the Genesee Phase 3 project. Given the relative abundance and low cost of coal in the province of Alberta, it was decided early based on economic and environmental considerations that the new third unit would employ supercritical-pressure pulverized coal combustion technology. In addition to the high efficiency supercritical-pressure boiler and turbine, adverse impact on the environment is minimized through the use of low nitrogen oxides (NOx) burners, a dry FGD (flue gas desulphurization) unit, and a high-efficiency dust-collection system using a fabric filter baghouse. Based on a proven track record in building a number of supercritical coal fired plants, Hitachi, Ltd. and Babcock-Hitachi K.K. will execute all EPC (engineering, procurement, and construction) enabling seamless integration between the boiler and turbine. In addition, much of the design detail is based on a 500-MW reference plant, thus enabling the plant to be substantially completed in the first quarter of 2005.

INTRODUCTION
TO meet the demand for expanding energy requirements, Alberta has turned to coal-fired generation to reduce dependence on high-cost natural gas and to supercritical-pressure coal combustion to mitigate environmental impact by reducing greenhouse gas emissions.

The trend in power plant construction in North America from the 1970s through the 1990s has been toward nuclear and combined cycle plants with little emphasis on coal fired technology. Over the same timeframe, Hitachi continued to gain experience in the development and deployment of supercritical-pressure coal fired technology to meet the demand for high efficiency coal fired power plants growing out of special circumstances in Japan: high fuel prices, exacting plant siting requirements, and very strict environmental requirements.

Based on its accumulated expertise and practical experience, Hitachi was awarded the contract to build 495-MW Genesee Power Generating Station Phase 3, the first supercritical-pressure coal fired plant to be built in Canada. This is also the first time Canada has awarded a complete EPC (engineering, procurement, and construction) package contract to execute all engineering, procurement and construction, an
approach that ensures tight integration between the boiler and turbine and the shortest possible construction schedule.

After taking over from Hitachi, EPCOR Power Development Corporation and TransAlta Energy Corporation will own Genesee Phase 3 in a 50/50 joint venture.

PLANT OVERVIEW AND TECHNICAL FEATURES

Main Specifications

Drawing on Hitachi’s expertise in advanced combustion technologies and adopting the latest most efficient turbine, Genesee Phase 3 uses supercritical-pressure pulverized coal combustion, the first unit of its kind in Canada. The new unit is 10% more efficient than the existing Genesee units while also being much friendlier to the environment by reducing emissions of CO₂, sulphur dioxide (SO₂), nitrogen oxides (NOₓ), and particulate and associated mercury emissions. In addition, design of the third unit was optimized to share facilities with the existing units as much as possible including the coal handling facilities, demineralized water supply system, waste water treatment facilities, and circulating water canal. Table 1 summarizes the main specifications.

Scope of Work

The boiler and turbine were provided as a complete package in accordance with the EPC contract (some tasks and facilities were excluded from the contract because they were provided directly by the client, EPCOR), an approach that not only reduced the construction schedule but also minimized the interface adjustment and modification work.

The scope of work is summarized as follows:

(1) Boiler Island
   (a) Boiler proper (burner, super heater, etc.)
   (b) Induced draft / primarily air / forced draft fan
   (c) Coal handling system (branch conveyor added to existing conveyor)
   (d) Ash handling system
   (e) Flue gas desulphurization unit and fabric filter (stack provided by EPCOR)

(2) Turbine Island
   (a) Turbine-generator set
   (b) Condensate system (condenser, extraction pumps, vacuum pumps, polisher, etc.)
   (c) Circulating water system (pump, screen, and auxiliary equipment)
   (d) Feedwater heating system (pumps, feedwater heaters, deaerator, etc.)
   (e) Auxiliary systems (instrument air compressor, chemical dosing equipment, etc.)

(3) Electrical Instrument and Control
   (a) 600-V motor control center (6.9-kV and upper switchgear to be provided by EPCOR)
   (b) Distributed control system [HMI (human-machine interface) to be provided by EPCOR]

(4) Civil Engineering and Architecture
   (a) Boiler-turbine building (ground level foundation provided by EPCOR)
   (b) Turbine-generator pedestal
   (c) Heating and ventilation system
   (d) Elevator and lift devices
   (e) Lighting and services

<table>
<thead>
<tr>
<th>Boiler Island</th>
<th>Turbine Island</th>
<th>Generator</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Boiler proper (burner, super heater, etc.)</td>
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</tr>
<tr>
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<td>(e) Lighting and services</td>
</tr>
</tbody>
</table>

Table 1. Plant Specifications

<table>
<thead>
<tr>
<th>Boiler Type</th>
<th>Turbine Type</th>
<th>Generator Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal fired supercritical once-through</td>
<td>Hitachi impulse type tandem compound double flow exhaust</td>
<td>Totally enclosed, self-ventilated, forced lubricated, hydrogen cooled, cylindrical rotor type, synchronous alternator</td>
</tr>
<tr>
<td>BHK (Babcock-Hitachi K.K.)-type Benson boiler with sliding pressure operation</td>
<td>40-inch last stage blade, reheat condensing turbine two-casing indoor use</td>
<td>Capacity 586 MVA</td>
</tr>
<tr>
<td>Sliding pressure range: 35-95% load</td>
<td>Rated output 495,000 kW (gross)</td>
<td>Terminal voltage 22 kV</td>
</tr>
<tr>
<td>NOₓ: 115 ng/J at BMCR</td>
<td>Steam conditions 24.1 MPa (G) / 566°C / 566°C</td>
<td>Power factor 0.85 lagging</td>
</tr>
<tr>
<td>90 ng/J at 100% Load for S-% 0.32 coal</td>
<td>Speed 3,600 rpm</td>
<td>Short circuit ratio N.L.T. 0.50 at rated output</td>
</tr>
<tr>
<td>Particulate: 13 ng/J at BMCR</td>
<td>Exhaust pressure 5.0 kPa (A)</td>
<td>Excitation system Static-thyristor excitation system</td>
</tr>
<tr>
<td>Manufacture Babcock-Hitachi K.K.</td>
<td>Governor type Digital electro-hydraulic governor</td>
<td>Manufacturer Hitachi, Ltd.</td>
</tr>
<tr>
<td>Manufacture Babcock-Hitachi K.K.</td>
<td></td>
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</tr>
</tbody>
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combustion is achieved at minimum load operation, and all environment limits and regulations are satisfied even without a NO\textsubscript{x} removal system.

**Technical Features of Steam Turbine**

Hitachi has delivered more than 30 supercritical pressure condition steam turbines.

For the Genesee Phase 3 a double flow tandem compound/combined type high and intermediate pressure turbine was adopted; for the low pressure turbine, 40-inch last stage long blades with substantial practical operating experience were applied, and a very compact two-casing design was achieved (see Fig. 3).

**Technical Features of Boiler Plant**

A supercritical sliding-pressure BHK-type Benson boiler was adopted for the Genesee Phase 3 project, the first time this type of boiler has been used in North America. Combining high efficiency, flexible operation, and excellent reliability with an advanced low NO\textsubscript{x} combustion technology, this type of boiler is relatively environmentally friendly (see Fig. 2).

A very high standard of reliability is achieved thanks to uniform heat absorption and stable fluid flow and reduction of boiler plant pressure loss by using a spiral wall applying internally ribbed tube, together with proven high strength materials for the boiler pressure parts.

In addition, operability has been markedly simplified compared to conventional constant pressure once through boiler by eliminating the need for main system valve switching, and start-up time has also been dramatically shortened.

Moreover, the newest MPS-type system has been applied for the pulverizer that ensures longer life grinding and wear sections while featuring low vibration and low power consumption that prevents capacity from diminishing.

Achieving lower emissions is critically important for upgrading and enhancing combustion technology. By using the Hitachi’s latest pulverized-coal burner (NR3) and 2-stage combustion, the already low NO\textsubscript{x} combustion is reduced even further while unburned carbon in the ash is reduced. In addition, stable combustion is achieved at minimum load operation, and all environment limits and regulations are satisfied even without a NO\textsubscript{x} removal system.

**Technical Features of Steam Turbine**

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used to optimize the dimensions and shape of the low-pressure exhaust hood to match the plant’s steam conditions, as shown in Fig. 6. This greatly reduced pressure losses between the low-pressure turbine outlet and the condenser inlet, which further improved the turbine performance.

**PROJECT SCHEDULE**

**Schedule Outline**

Fig. 7 shows the project timeline and key milestone. The major installation work is now completed and the project has entered the commissioning phase.

**PDM, PDS, and Advanced Boiler Plant Design Accelerate Construction Process**

PDM (product data management) is a system for effectively managing the voluminous product data that flows back and forth during the lifecycle development of a plant from development and design to the actual fabrication and maintenance of the product. To strengthen the company’s competitiveness by streamlining engineering, holding down costs, and shortening the project schedule, Babcock-Hitachi K.K. adopted PDM and a sophisticated PDS (plant design system) at an early stage in the project. The Genesee Phase 3 project was the first time this approach had been applied at the facility and has proved very effective in customizing the boiler plant to the client’s needs (see Fig. 8).

All information regarding the boiler, boiler pressure parts and equipment, piping, support, structural steel, etc. was entered into the plant design system, and the
data has been enormously useful at every step of the project including configuration management, production design, tracking design changes, managing blueprints and plans, interference checking, tracking materials, site preparation, and installation work.

The design and deployment of the Genesee Phase 3 was based on the 500-MW-class supercritical-pressure Benson boiler that has been operating flawlessly at Nanao-Ohta Thermal Power Station Unit No. 1 (Ishikawa Prefecture) by Hokuriku Electric Power Co., Inc. By adopting this proven design, we could quickly present the boiler design data to the client and regulatory agencies, start actual work on the boiler sooner, and substantially reduce the time needed to construct the plant. Having a number of supercritical-pressure Benson boilers in the 500-MW to 1,000-MW capacity range to draw upon as reference plants, Babcock-Hitachi K.K. was able to deliver and startup the boiler for the Genesee Phase 3 in record time.

Reduced Boiler Fabrication Time through Synchronized Construction

Due to recent increase in the clients’ demands for a compressed schedule, plant installation work has led to fundamental rethinking of practices that can reduce plant construction and delivery time while maintaining the highest standards of safety. For the first time in the North American market, we adopted the simultaneous construction method that Hitachi has been refining and perfecting since the early 1990s, and this enabled us to complete the project — from NTP (notice to proceed) to S/C (substantial completion) — in a shorter period of time frame.

As illustrated in Fig. 9, simultaneous construction involves delivering and installing boiler pressure parts, ductwork, the coal silo, piping, support, valve station, and other ancillary equipment and systems in parallel as the structural steel is being erected. Obviously to pursue this kind of synchronized approach one must make arrangements and take delivery of various equipment and systems while the structural steel is being erected, and this approach really only works for

LOI: letter of intent
NTP: notice to proceed
S/C: substantial completion

Fig. 7—Project Schedule.

Fig. 8—Boiler PDS Model.
Entering structural steel, the boiler, piping, support, and equipment in the 3D model is useful for developing the manufacturing design and for studying installation methods.

Fig. 9—Boiler Simultaneous Construction.
The large-scale single coal silo that is fabricated at the factory is hoisted into position by a large crane.
large diversified companies like Hitachi that can design and install all the components of the plant — boilers, equipment, structural steel, etc. — and can execute EPC contracts.

The primary advantages of simultaneous construction are that:
(1) Temporary scaffolding and temporary equipment can be simplified and reduced thus reducing the amount of work in high places and improving safety.
(2) Installation can proceed in parallel with excavation and earth work, and congested work is reduced. This not only improves work efficiency but also reduces the overall construction process by reducing the number of times that a crane has to be brought in.

Let us briefly consider the floor unit construction, which is relatively important in simultaneous construction. Lugs to accommodate different equipment in the plant are welded to steel beams in advance and the beams are assembled into flat assembled floor units. Handrails, gratings, ducts, piping are all laid out on the floor units and then hoisted into position as a single piece. This enables most of the work to be done at ground level, and also permits 20 to 30 pieces — a combination of beams and equipment — to be lifted into place all at the same time.

CONCLUSIONS
Based on extensive experience with supercritical-pressure pulverized coal combustion technology, Hitachi, Ltd. and Babcock-Hitachi K.K. were awarded an EPC contract to build Genesee Phase 3, a 495-MW-capacity coal-fired power plant in Edmonton, Canada. This is the first supercritical-pressure power station to be built in Canada. Adhering closely to the planned construction timeframe and featuring high efficiency and low emission technologies, the major installation work is now completed. Working in close cooperation with EPCOR Power Development Corporation, the commissioning phase is now in progress, and the plant will be substantially completed in the first quarter of 2005.

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