Low NOx platform for small GT series
page 14

175MW China 6F cogeneration plant
page 22

Repowering coal site with SGT-800 plant
page 26
175MW Nanxun cogen plant to power industrial zone and grid

Utility in China is building a cogeneration plant powered by two 6F gas turbines to generate electricity and process steam for the Nanxun economic development zone.

General Electric and Nanjing Turbine & Electric Machinery Company (NTC) are supplying China Guodian with two Frame 6F gas turbines and balance-of-plant equipment for a 175MW gas turbine based cogeneration facility.

The facility is designed around two cogen power blocks each consisting of a 77.6MW gas turbine, unfired dual pressure HRSG and steam turbine. One cogen plant has an extraction steam turbine and the other a backpressure steam turbine, with a combined output of 20MW:

- **Electric Power.** Facility is rated at 175MW base load output generated by the gas turbine and steam turbine gensets.

- **Cogeneration.** Around 70% cogen efficiency for 205 ton/hr, 15 bar(a) and 330°C steam flow (230 psig and 625°F).

- **Emissions.** DLN emissions of 15 ppm or less NOx and 9 ppm CO from full load down to 50% part-load output.

The cogeneration facility is being built to supply electricity and process steam to companies in the Nanxun economic development zone near Huzhu city in Zhejiang province. Depending on grid demand, excess electricity generated will be fed to the grid during periods of reduced industrial load.

**GE partnership with Nanjing Turbine**

General Electric and Nanjing Turbine & Electric Machinery Compny (NTC) have been working together to supply 6B and 9E gas turbines to customers in China for nearly 30 years. Recently the two companies signed a technology transfer agreement for 6F gas turbines.

Compared to previous technology, the 6F power range, high efficiency and low emissions are said to be well suited for economic developments zones in China like the Nanxun plant being built to produce electricity and process steam.

"NTC was our earliest partner for gas turbine manufacturing in China," said Victor Abate, president and CEO, Power Generation Products for GE Power & Water; "and that relationship was key to winning this Nanxun contract award.

"It demonstrates long-term commitment and our local capabilities to provide products and technology that will produce the reliable power needed to support China’s continuing growth and progress."

In the past, the power and heat requirements of economic development zones like Nanxun were met by coal fired steam plants. Recently, however, many of the old, small and inefficient boiler plants are being replaced with gas turbine based cogeneration plants.

**Nanxun project**

The Nanxun cogen facility will be owned and operated by Guodian Di’anli, a subsidiary of the state-owned power generator, China Guodian Corp., which engages in power plant development, investment, construction, operation and management.

According to Steven Rahn, Executive Product Manager at GE Power & Water, the Nanxun plant is stereotypical of several projects that have been springing up over the past three or four years. "We sold ten 6F gas turbines last year, in groups of two, for economic development zones around China.

"Power companies primarily supply not only power for the industrial parks but also various levels of steam for process. These development zones are typically made up of small industries such as chemical plants, refineries, paper mills, etc."

**Scope of supply**

The turnkey contract for Nanxun will see GE supply key components of
the 6F gas turbines (flange-to-flange), installation services, spare parts, gas turbine training, distributed control system and steam turbine controls.

NTC will provide the steam turbines, generators and supervise installation of the cogeneration plants.

Rahm noted: "We will do the installation of the gas turbine as well as the control systems for the gas and steam turbines. We will also participate in commissioning of the plant."

The plants will have a cogeneration efficiency of around 70%, say company project engineers, which will enable Guodian Dianli to meet industry steam and electricity loads at relatively low costs with low emissions.

**Cogeneration efficiency**

That 70% efficiency level is based on 51 bar/16 bar steam from the HRSG, 120 ton/hr steam flow for backpressure steam turbine power generation, 85 ton/hr steam at 15 bar from the extraction steam turbine for process.

Guodian’s choice of the 6F gas turbines was based in part on its power rating and on the steam load available from the gas turbine exhaust flow and temperature, says Rahm.

"The fact that the 6F power blocks can be arranged in a 2-bay configuration to provide redundancy is critical. If there is an issue with one of the gas turbines, basic electricity and steam demands can still be met from a single gas turbine and steam turbine."

**GT design features**

The 6F gas turbine is a direct downscaling of the 7F 3 gas turbine design.

It has a single-shaft, bolted rotor with the generator connected to the gas turbine through a speed reduction gear at the compressor or ‘cold’ end. This feature allows for an axial exhaust, which helps enhance plant arrangements for combined cycle and waste heat recovery applications.

It has an 18-stage, axial flow compressor with a 15.7:1 pressure ratio and 213 kg/sec (469 lb/sec) air flow. The first eight stages are high
strength, corrosion resistant GTD-450 stainless steel, with the remaining airfoils made of 403-CS steel alloy.

The reverse flow, six-chamber, second generation Dry Low NOx (DLN) 2.6 combustion system has six fuel nozzles per chamber, includes two retractable spark plugs and four flame detectors as part of the system.

Crossfire tubes connect each combustion chamber to adjacent chambers on each side. For ease of maintenance, each chamber, liner and transition piece can be individually replaced.

The DLN combustion system limits NOx emissions to 15 ppm and CO emissions to 9 ppm, which can be sustained down to around 50 per cent load.

**Turbine**

The turbine section has three stages with air-cooling on each of the three nozzle stages, as well as on the first and second bucket stages.

The buckets are designed with long shanks to isolate the turbine wheel rim from the hot gas path, and integral tip shrouds are incorporated on the second and third stages to reduce bucket fatigue and improve heat rate.

The rotor is a single shaft, two-bearing design with high torque capability, incorporating internal air-cooling for the entire turbine section. The shaft rotates counter-clockwise when facing the gas turbine output flange and the load gear reverses the rotation as it drives the generator rotor.

To facilitate field change-out, the gas turbine rotor can be handled as one piece, and the turbine buckets (rotating blades) can be changed in sets or individually, without the need to field-balance the rotor.

The five turbine and compressor casings are horizontally split to facilitate inspection and maintenance. Borescope access holes, located in the compressor and turbine sections, also facilitate visual inspections.

Long-term service agreements for the turbines at Nantucket are under discussion. "We expect there will be the typical 24,000-hr hot gas path and combustion inspection intervals," said Rahm.

**Operation**

The cogeneration facility will run on natural gas supplied from China's West to East Pipeline II.

Inasmuch as the facility is designed to deliver power and steam, the units will operate primarily in base load service to meet industrial demand, probably operating in excess of 6,000 hours a year.

However, there may be times during the weekend when they don't operate, depending on electric grid and industrial steam demand. Excess power will be fed to the grid and steam supply vary according to industrial needs.

There is an extraction steam turbine on one of the gas turbines and a backpressure steam turbine on the other (used when high quality steam is required). Power production of the backpressure steam turbine is proportional to process steam demand.

**Timetable**

The first 6F gas turbine for the Nantucket project will be shipped from GE's factory in Belfort, France in October of 2013 while the second machine will be shipped in December 2013. Site construction is already under way.

Both should arrive on site within about one month of shipping. Installation is likely to be carried out during the first quarter of next year so that the new cogeneration plant can begin operation in the second quarter of 2014.

Based on the increase in sales over the last three years, Rahm believes there will continue to be further orders for 6F gas turbines for similar installations in the future.

"We see the demand continuing. In some cases it will not be for new installations; sometimes they will be replacing existing coal-fired steam boilers in some of these economic zones. We see a robust market for this machine going forward."

He summed up: "This is one of the reasons we reached an agreement with NTC last year to license the 6F gas turbine. As we move forward with them, eventually we will be just shipping the rotor and the hot gas path combustion and control components and NTC will begin to manufacture more of the gas turbine casing, etc. in the country."

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**6F gas turbine. Design features cold-end drive, 18-stage compressor (with a 15.7 to 1 pressure ratio and 469 lb/sec flow), six DLN 2.6 second generation combustors and a 3-stage turbine.**