McBurney—Gaffney, South Carolina, USA

Calpine, Broad River Energy Center

Once Through Steam Generators (OTSGs) were chosen by Calpine for installation in their first Gas Turbine steam Injection (GTI)/(STIG) simple cycle peaking plant located in Gaffney, South Carolina. The first phase of the project included the GTI retrofit and installation of OTSGs on units 1 through 3. The second phase of the project included the GTI retrofit and installation of OTSGs on units 4 and 5.

Project Description

The Broad River Energy Facility was constructed in phases during the late 1990s and early 2000s. The plant's simple cycle phase included five GE Frame 7FA 190 MW gas turbines. The first three gas turbines were retrofitted in 2001 to permit steam injection, and three GTI OTSGs were installed in the turbine's exhaust path. The GTI cycle significantly increased the gas turbine's mass flow, which resulted in an increase in efficiency and power output plus a reduction in NOx emissions. The remaining two gas turbines were retrofitted with two more GTI OTSGs in 2004, which resulted in the same improvements as the previous units. GTI OTSG applications can reduce NOx emissions by 85% and increase the gas turbine output by more than 15%.

Each gas turbine was out of service for less than one week during the installation of the GTI OTSGs. The GTI OTSGs were designed, fabricated and ready for shipment within less than 6 months. The GTI OTSGs have a full dry run capability permitting operation of the gas turbines while the steam process is out of service.

GTI OTSG Process (STIG)

This process consists of injecting steam into the head end of the combustor (for NOx reduction) and into the compressor discharge, increasing mass flow, lowering fuel consumption and increasing power output. Gas turbines are typically designed to allow 5% steam injection of the compressor airflow with flows of as high as 10% allowed on some gas turbines. The injected steam must contain at least 50 °F (28 °C) superheat and be at a pressure comparable to the fuel gas pressure. A steam injection flow of 5% of total flow will increase power output by approximately 17.5% for all ambient conditions (independent of temperature, humidity etc.) and also reduce NOx levels.

The main advantages of the steam injection process are:

a) Increased power. The power augmentation process will increase power in all climates and at all times of the year.
b) Reduced NOx. The injected steam reduces the flame temperature thereby reducing thermal NOx.
c) Reduced fuel consumption. Current power levels can be maintained while reducing current fuel consumption.
d) No additional capital investment. Large utilities can upgrade their GT fleet with GTI and add 17.5% more power without adding any new bricks and mortar.

CONTRACT SUMMARY

Gas Turbine	Turbine Output (MW)	Exhaust Weight (lbs/hr)	Fuel	Exhaust Temp. (°F)	Firing Temp. (°F)	Feedwater Temp. (°F)
Frame 7FA	+190	3,381,000	Natural Gas	1122	NA	190

HP Steam Flow (lbs/hr)	HP System Pressure (psia)	HP Temp. (°F)	LP Steam Flow (lbs/hr)	LP Steam Pressure (psia)	LP Temp. (°F)	OTSG Total Heating Surface (sq ft)
136,000	490	700	NA	NA	NA	21,073