CALIFORNIA ENERGY COMMISSION
Energy Facility Siting and
Environmental Protection Division

FILE: 93-AFC-2

EPORT OF CONVERSATION | PROJECT TITLE: Procter & Gamble

[X] Telephone [ ] Meeting/Location

NAME Jeff Canon DATE 4/29/94 TIME 11:00 pm

WITH Stewart & Stevenson Ops PHONE 904 523-0062
area code/number

ADDRESS Pasco County Cogeneration Facility, Dade City, FL

SUBJECT(s) Performance of LM6000s in new powerplant

DOCKET
93-AFC-2
DATE APR 2 9 1994
RECD. MAY 0 2 1994

COMMENTS:

Jeff Canon is the plant manager of the new cogeneration facility. He said the plant contains two 42 MW LM6000 combustion gas turbines and one 28 MW steam turbine. The facility and its identical sister facility 80 miles away have been on line since July 1993. The CTGs where guaranteed by GE to 40 ppm NO_x with water injection. Stewart and Stevenson determined that they could inject more water and achieve 25 ppm NO_x. The just completed source test reconfirmed that the Pasco plant is operating at approximately 23.5 ppm NO_x without any additional NO_x controls except water injection. Canon said that they have not experienced any noticeable degradation of combustor components or turbine blading at the water injection rates necessary to achieve 25 ppm. Canon said they are injecting 48 gpm of demineralized water (Procter proposes a maximum of approximately 30 gpm)

The phone and address of the sister facility is:

Stewart & Stevenson Operations
Lake Cogeneration Facility
Umatilla, FL
904 669-3288

These two projects are only the second and third to use the LM6000 that are in operation. Carson has proposed to use LM6000 at 40 ppm NO_x.

CEC ACTION:

Is this enough information to suggest to the District that 3 ppm (25 ppm with 90 percent SCR) is BACT for the LM6000? How should we use this information?

Attachment: Article

ms127\smudpg\jd042994.roc

cc: Chris Tooker
Keith Golden
Darrel Woo

Signed MH

Name Matt Layton

process include media and cartridge filters, reverse-osmosis units, vacuum degasifiers, and mixed-bed demineralizers.

Gas-turbine technology

The gas turbines are described as advanced-class machines with 146-MW net output and 2300F firing temperature. Some design features: 16-stage, axial-flow compressor with through-bolted design, compressor-blade locking mechanism, compressor-blade rings to ease alignment and optimize tip clearances, variable-inlet guide vanes, turbine blades that are individually removeable in the field, four-stage turbine with three cooled stages, and combustor with 16 burners. Vanes in the first row can be removed with cylinder covers in place.

Since commissioning, the four gas turbines have exhibited 97-99% availability. However, the gas-turbine's air separator required a "significant" design iteration. This component is a rotating cylinder which provides a sealed path for rotor cooling air to flow into the rotor. Cracking was observed at the interference fit between the air separator and the first-row turbine disc. Essentially, the component was underdesigned for the stresses it experiences.

The redesigned piece, with changes to the way it fits and seats into the turbine disk, has now operated for thousands of hours in all four machines with no incident. Lauderdale personnel describe the redesign as having achieved "excellent performance."

Other minor adjustments were made to the gas turbines. To illustrate: At the 3500-

RAM features, training

Paul Plotkin, unit manager, notes that the same people who operated the original Units 4 and 5 now operate the combined cycles. Thirty man-months of effort were spent in developing the appropriate train-

... RAM analyses are used to set preventive- and corrective-maintenance schedules and tasks and to stock spare parts.

Early experience suggests that the efforts in the RAM area will pay handsome dividends to the plant. ■

PASCO COUNTY COGENERATION FACILITY

First-of-a-kind aero turbines boost cogen-plant performance

LM6000 gas turbines with water injection for NO_x control make their US debut. Inlet-air chilling and zero-discharge water management round out the innovations at this Florida facility

Depending on the yardstick used, the two LM6000 aeroderivative gas turbines (POWER special report, "Gas Turbines," February 1992) installed at the Pasco County combined-cycle (CC) cogeneration facility (Fig 1), Dade City, Fla, were the first to see commercial service in the US. The pioneering unit began operation in 1992 at a site in Canada (POWER, February 1993, p 64). In simple cycle, this is regarded as the most efficient gas-turbine design in the world—nominally 41-42% when the machine fires natural gas and various site constraints are favorable. But as reflected at Pasco, the compact, powerful gas turbine is dwarfed by other plant systems necessary today to get the most out of a natural-gas-fired plant and meet environmental requirements.

To maximize output—and electric power sales—during the hot Florida weather, engi-

713-868-7700

slightly compared to steam injection, but causes a drop in efficiency of 2.4 percentage points compared to steam injection, and a drop of 1.1 points compared to a turbine equipped with a dry, low-NO_x combustor. Water injection also penalizes heat rate by reducing the temperature of the gas-turbine exhaust, reducing steam superheat temperatures.

To accommodate the lower exhaust temperature, the following features were included in the superheater design:

- Multistage superheater with interstage attemperation.
- Redundant thermocouples added to superheater tubes on outlet side to monitor metal temperatures.
- Seamless tubing materials for the headers and tubes.
- Extended surface used in all superheater sections, consisting of Type 409 stainless steel.

Zero discharge is forgiving

Plant designers describe the zero-discharge water system as simple—at least with respect to other zero-discharge systems—and forgiving. It is based on two separate and hydraulically isolated cooling loops. The first rejects 93% of the condenser heat, the second loop the balance. Among other things, this innovative design isolates high-mineral-content water to a small portion of the overall cooling loop.

Key suppliers

Turnkey contractor	Zurn/NEPCO
Gas-turbine supplier	General Electric Co
Gas-turbine packager	Stewart & Stevenson Co
Plant operator	Stewart & Stevenson Operations Inc
HRSGs	Zurn Industries Inc
Duct burners	Coen Co Inc
Zero-discharge water treatment system	EAU Tech Partners
Main cooling tower	Marley Cooling Tower Co
Wastewater tower	GEA Thermal Dynamic Towers Inc
Electric chillers	Trane Co
Absorption chiller	Mitsubishi Heavy Industries Americas
Steam turbine/generator	General Electric Co
Plant control system	Woodward Governor Co/The Foxboro Co
Cooling-water pumps	Goulds Pump Co
Condenser	Graham Manufacturing Co
Fuel-gas booster compressors	Ariel Corp/Tide-Air Inc
Water treatment system	Indeck Power Equipment Co
Water-treatment chemicals and O&M services	Nalco Chemical Co
Calandria crystallizer	Resources Conservation Co

Reportedly, 200 overall cycles of concentration are achieved in the system.

Softened blowdown from the first loop and regeneration wastes from the demineralizers provide makeup demand of the second wastewater-treatment loop. Blowdown from the second loop serves as makeup to a steam-fed calandria-type crystallizer, where it is reduced to a salt cake at an average rate of 110 lb/hr, peaking at 180 lb/hr.

A portion of the return cooling water from the steam-turbine condenser passes through a titanium-constructed plate-and-frame heat exchanger where it transfers heat to the second cooling loop. This secondary loop rejects about 7% of the condenser heat load.

Because of the relatively high fluctuation in demineralized water demand, a recirculating system is installed between the demineralized water tank and the demineralizer system. Solids from the water treatment system are trucked off site to a landfill. ■

PORT WASHINGTON POWERPLANT

neers installed two stages of inlet-air chilling on the front end of the plant. And, high-capacity duct burners are installed ahead of the heat-recovery steam generator (HRSG) to meet the fluctuating needs of the Lykes Bros citrus processing plant, the thermal host for the facility. Fuel-gas inlet requirements of the gas turbine dictated use of a plant-side compressor to boost the pressure from the supply value of 550 to 630 psig. Peoples Gas Co, a co-owner, supplies the fuel from its Dade City/Lakeland supply line.

Water injection into the gas-turbine combustor also helps to keep NO_x emissions in check. But space has been left inside the HRSG for future addition of a selective catalytic reduction (SCR) unit for more NO_x removal, or CO catalyst. In addition, the gas turbine has provisions for conversion to a dry low-NO_x combustor if considered cost-effective. Finally, to meet the strict demands on water usage in Florida, the facility employs an innovative zero-discharge water-management system.

Officials from the other co-owner, North Canadian Power Inc, Santa Ana, Calif, report that all the performance guarantees have been met. And gas-turbine operation has met the expectations of the owners, although problems with flutter of the fifth-stage low-pressure-turbine blades and thrust-bearing problems had to be worked out first. Heat rate for the facility ranges from 7160 Btu/kWh to 7926 Btu/kWh, depending on the amount of steam exported. NO_x emissions are below the permitted level of 25 ppm. The plant went commercial last July, 18 months after groundbreaking.

Another interesting note: Pasco has a twin. Its sister plant, the Lake cogen facility, is located around 80 miles away in Umatilla, Fla. Also owned by North Canadian Power Inc, Lake provides steam to the Golden Gem Growers citrus processing plant. Both plants were constructed simultaneously and went commercial the same day.

For pioneering the commercial application of an important gas-turbine technology and relevant subsystems, Pasco and Lake receive POWER'S 1994 Powerplant Award.

Basic design

Two gas-turbine/HRSG trains supply one steam turbine/generator. Output of each gas turbine/generator is 42.5 MW, of the steam turbine/generator 28 MW, for a total net plant capacity of 108 MW. No. 2 oil is the backup fuel and a two-day supply at full load is provided in on-site storage. Thermal output requirements vary considerably —from 15,000 to 200,000 lb/hr of 200-psig steam—and correspond to the harvesting and processing of citrus crops. The duct burners are sized to produce the maximum required steam flow with one gas turbine out of service.

Gas-turbine performance falls off at high inlet air temperatures. To maintain output in hot weather, the plant employs a 1500-ton absorption chiller and two 1250-ton electric centrifugal chillers to keep inlet air between 48 and 51F. The absorption unit operates when ambient temperature is between 51 and 73F; the electric chillers are staged into operation when temperatures climb to from 73 to 95F. Because the LM6000's optimum air-inlet temperature is 51F, steam coils are placed in the inlet duct for those periods when ambient temperatures fall below 51F.

HRSGs (Fig 2) include superheater, evaporator, and economizer sections. High-pressure 800-psig/835F superheated steam feeds the steam turbine/generator, 100-psig intermediate-pressure (i-p) steam is directed to a steam-turbine induction port, and low-pressure (l-p) steam is used for deaerating. An integral deaerating feedwater heater is mounted above the l-p steam drum, and discharges directly into the drum. Steam extracted from the turbine at 210 psig supplies the juice plant and the absorption chiller. A steam-bypass system is available to dump the full steam flow.

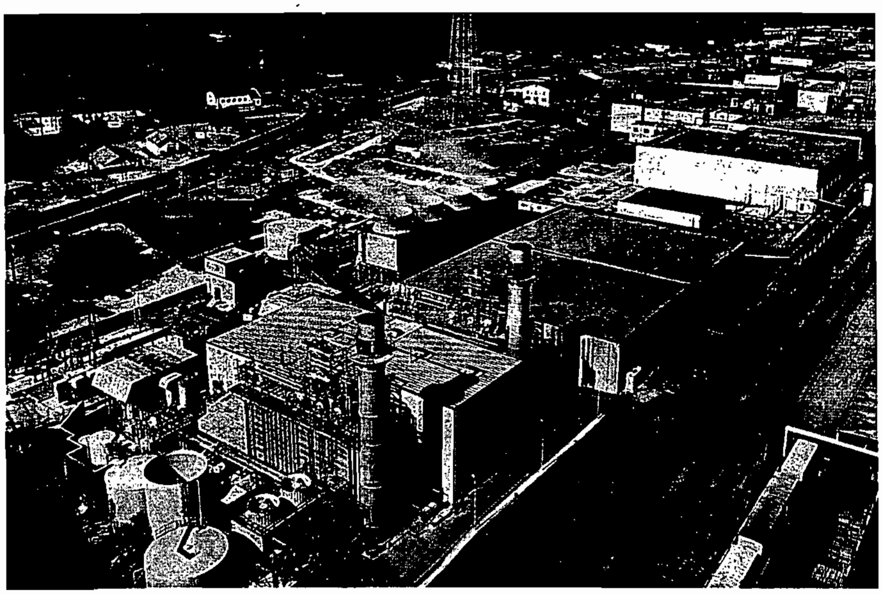
Sliding-pressure control is incorporated into the HRSG and the steam turbine/generator to accommodate the varying thermal output while maximizing electric sales. Sliding pressure control functions between 550 and 900 psig. Also, the condensing system is integrated with the zero-discharge water treatment system. In effect, a staged cooling loop, utilizing the main cooling tower, is optimized with a second smaller tower that accepts the recycle waste blowdown flows.

To further accommodate sliding-pressure operation, the HRSG was designed for 10:1 minimum turndown. This required that (1) the l-p evaporator be equipped with a backpressure control valve to create the necessary pressure drop and reduce the circulation ratio; (2) the evaporator steam drums be oversized, to 54 in. diameter for the i-p drum and 72 in. diameter for the h-p drum; and (3) low-water cutoffs for the evaporators be extended by 18 in. below normal water level to handle transients.

Noise, rain stay in. Noise attentuation and the requirement to collect all rainwater in an evaporation pond posed constraints on equipment siting. Utility inter-tie equipment is located over the storm-water retention basin, other intertie equipment is housed in the utility switchyard, and the dump condenser is placed outside the powerhouse building. Reverse-osmosis and demineralizing equipment is located on the second floor of the building. One side of the HRSG is baffled externally to maintain the required maximum sound level of 65 dB at the property line.

NO_x penalties

Water injection to the gas turbine for controlling NO_x emissions elevates output



1. The 108-MW, combined-cycle facility with first LM6000s in the US meets arduous demands of a Florida-based cogeneration facility (left)

2. HRSG design (above) includes special features to accommodate the thermal output fluctuations of the plant and the lower exhaust temperature from the gas turbine