

# Gas Turbine



## Load Following with MeeFog™ Controlling Output to the Power Required by the Dispatcher

### THE BENEFITS OF MEEFOG™ TECHNOLOGY

- 5-6 MW output increase for each turbine
- Ability to control output in response to changing demand and ambient conditions
- Fogging system costs millions of dollars less than upgrading turbine internals to achieve more power

### CHALLENGE

The four 250 MW ABB GT24-B combined cycle units at the La Paloma Generating Station in McKittrick, California needed an efficient way to control output in response to calls from the dispatcher and fluctuating ambient temperature. The plant had also been gradually losing output since going commercial in March 2003. The units could be upgraded to restore the lost output, but at a cost of millions.

### SOLUTION

Using a MeeFog inlet cooling system gave the facility 11 stages of control to fine tune power output, one MW at a time, and also allowed the company to recover 5-6 MW of power at a fraction of the cost of upgrading the turbine internals.

### La Paloma Generating Company McKittrick, California USA

La Paloma has four 250 MW ABB GT24-B combustion turbines coupled with the KA24-1 ICS combined cycle equipment. Unlike most U.S. plants, all the major equipment came from Europe: the GT from Switzerland, the steam turbines from Sweden, the generators from Germany, the steam train gearbox from France and the SSS Clutches between the generator and steam turbine from England.

*"The footprint is very small considering that we produce 1000MW," says Cortes. "The single shaft design makes the power blocks very compact."*

Another major advantage of the GT24, he says, is the dual-combustor, sequential combustion design which produces a heat rate in the high 6000s or low 7000s, depending on operating conditions. In addition, this results in very low emissions. The NOx is controlled for 1.5 PPM, following California regulations. The CO is required to remain below 10 PPM throughout the operating range of 150 to 250MW,



The La Paloma Generating Company

but the GT24s produce a minute fraction of that amount, about 0.1 PPM. The units also inject some of the HP steam into the GT combustor. This is not to control NOx, as is done with GE units, but to increase output by about 15-19 MW net per unit, after taking into consideration the steam turbine losses.

### Installation Challenges/ Specifications

Many people wish they still had the strength and stamina they had in their twenties. With plant equipment the decline sets in much sooner.

*"After a few years, machines start deteriorating and become less efficient over time," says Pablo Cortes Oseguera, Engineering and Maintenance Manager for La Paloma Generating Company (LPGC) in McKittrick, California. "Even though you do major overhauls and replace the blades and combustors, after a while your machine just isn't performing as well as it used to."*

In 2010, La Paloma came under new ownership, which was interested in bringing the plant back up to its originally permitted output. One option was to upgrade the GT internals with new components from Alstom Power. This, however, would cost millions. So, while the company hasn't rejected that idea, it preferred to first take the less-expensive approach of improving inlet conditions. Although the plant already had evaporative inlet coolers which provided 10-12 MW of recovery, it decided to look into using MeeFog inlet cooling as well.

*"Usually MeeFog is used in lieu of evaporative coolers," says Cortes. "This is one of the first studies to see what the fogging system can do on top of the evaps."*

La Paloma provided Mee Industries with the technical information on how the plant runs and how efficient the turbines were in the summer with the evap coolers in use. Mee did some calculations and determined how much

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—Pablo Cortes Oseguera  
Engineer and Maintenance Manager



power a MeeFog system could recover. When Mee presented its data and gave a price for the system, the owners were interested.

*"I can do physical modifications to the machine which will give us more power, but they will pay millions of dollars for that," says Cortes. "Or we can skip doing the major changes on the GT internals, just improve the intake conditions and recover an extra 5 to 6 MW."*

## The Installation

In December 2012, LPGC submitted a request to the local environmental authority (San Joaquin Valley Air Pollution Control District), requesting authority to install the foggers, stating that: *"the purpose of the proposed foggers is to recover lost generating capacity on hot days when the combustion turbines are not able to operate at their full firing rate. By providing additional inlet air cooling and additional mass, beyond what the existing evaporative coolers can provide, the foggers will enable each combined-cycle turbine generator unit to achieve up to 8 megawatts (MW) of additional electrical generating capacity on hot days."* The following month it submitted a petition to the California Energy Commission, and upon approval, the MeeFog units were installed during the spring outage.

Each of the MeeFog systems at La Paloma includes a pump skid with six positive displacement pumps along with a weather station and programmable logic controller. A fogging array with 700 nozzles was installed just upstream from the inlet flange. The systems have eleven cooling stages, each providing close to 2°F of cooling.

The original plans called for the MeeFog systems to supplement the evaps when the temperatures exceeded 90° F. Once they were in use, however, this changed with the MeeFog system becoming the primary cooling source. To begin with, Cortes says, they realized that the MeeFog system uses considerably less water than the evaps, something which is especially important currently given California's drought conditions. But the main difference is the level of control that they provide.

*"With the evap, if I turn it on, I know I should gain 10-12 MW power output on top of what I*



The MeeFog system installed on-site.

*am making, but if turn it off I lose it all," says Cortes. "With the MeeFog system, I can turn it on stage by stage and dial in the power boost a MW at a time based on what I need to generate. If my dispatch says you have to give me 255 MW, and I am at 250 MW, I can just turn on the fogging stages I need instead of having to run the evaporative cooler all the time."*

When there is enough demand, or high enough temperature, to use the evap's full capacity, the MeeFog system would initially be shut down. Then, if dispatch calls for additional generation, or the ambient temperature rises, the appropriate number of fogging stages would be brought on line.

*"If I am in the middle of summer and power demand is very high, the gas turbine is maxed out, then I will turn on my evap coolers which will give me an average of 10-12 more MW per unit," says Cortes. "Then if more power is needed I can turn on the Mee system and it will give me 5 more MW. I probably can recover 20 more MW out of the gas turbines if run them together."*

## Cost/Benefit Analysis

While La Paloma is still running the numbers to determine the exact economics of how the MeeFog system performed in its first year, there was no doubt going into the project that it would be far more economical to use fogging rather than upgrading the turbine.

*"After doing a net present value analysis of the money we would have to invest and how much power we would recover, fogging turned to be really, really good in terms of dollars per kW," says Cortes. "It made a lot of sense to our owners."*



WATER AND POWER REQUIREMENTS							
GAS TURBINE MODEL	ISO OUTPUT (kW)	kW 100°F (38°C)	WATER FOG FLOW		kW 80°F (27°C) SATURATION	POWER INCREASE (kW)	POWER INCREASE (%)
			GPM	LPM			
Alstom GT 8C	52600	41061	12.1	45.8	45980	4919	12.0
Alstom GT 11N	83880	70013	21.7	82.3	74920	4907	7.0
GE 5341N	24750	20252	19.0	71.0	22143	1891	9.0
GE 6541B	39615	32707	21.0	79.0	35500	2793	8.5
GE 7111EA	84920	69533	20.0	76.47	75033	5500	7.9
GE 7221FA	161650	128621	29.0	110.0	139998	11377	8.8
GE 9171E	126206	102777	28.1	106.0	111446	8669	8.4
GE LM2500+PK	27017	19001	5.5	20.8	22917	3916	20.6
GE LM6000PA	41020	25310	8.0	30.3	33475	8165	32.3
Solar Mars	10685	8443	2.8	10.6	9526	1083	12.8
W501 D5	109307	88153	25.0	95.0	95998	7845	9.0
SW501 F	171790	139596	30.1	114.0	150812	11216	8.0
SW V94.2	159410	133185	82.0	302.0	145237	12052	9.0
SW701 F	252560	206463	44.6	169.0	223512	17049	8.3

Table showing water consumption for 11°C (20°F) of inlet cooling and gas turbine power increases attainable. Actual numbers are site specific. Mee Industries can provide a detailed analysis for your application.

## About Mee Industries Inc.

For over 45 years Mee Industries has led the world with innovative water fog technology. MeeFog systems are used to humidify and cool many industrial, commercial and agricultural processes and to create interesting and dynamic special effects. Today there are over ten thousand MeeFog systems in use around the world. The MeeFog team looks forward to helping you with your fogging project.

## The Mee Advantage: Experience, Innovation, Performance

In 1969, Thomas Mee Jr. a former Cornell University research scientist, founded Mee Industries. The company originally manufactured high-tech electro-optical, meteorological instrumentation, but by the early 1980's, high-pressure water fogging had become the main focus of the company. Today, Mee Industries provides innovative, highly effective, economical fog solutions for many industrial applications including gas turbine inlet-air fogging, commercial and industrial building humidification and cooling, data center humidification, outdoor air conditioning, greenhouse climate control, wine barrel storage humidification, as well as dynamic special effects for the entertainment industry and theme parks.

## Industry Leaders — Focused on Fog Technology

Mee specializes in providing custom-engineered, turn-key high-pressure fog solutions. We are committed to researching, developing, marketing and supporting the most innovative and reliable fog systems available anywhere in the world.

### MeeFog™ System Applications

#### RO WATER TREATMENT

##### HUMIDIFICATION

- Commercial HVAC
- Manufacturing

##### EVAPORATIVE COOLING

- Data Center Cooling
- Condenser Cooling
- Heat Exchanger Cooling

##### GAS TURBINE COOLING

- Power Generation
- Oil, Gas, Petrochemical
- Offshore Operations

##### SPECIAL EFFECTS

- Amusement Parks
- Themed Entertainment
- Zoos, Aquariums, Gardens
- Fountain Art
- Private Residence

##### AGRICULTURE/OTHER

- Greenhouses
- Conservatory
- Wine Barrel Storage
- Cold Storage
- Dust Suppression
- Odor Control
- Cement Curing

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