DOCKETED

Docket Number:	13-AFC-01
Project Title:	Alamitos Energy Center
TN #:	214856
Document Title:	Attachment - Gas Turbine World 550 MW El Segundo combined cycle provides 300 MW in 10 minutes-1 - 10-13-01
Description:	Attachment to Intervenor Los Cerritos Wetlands Land Trust Part 2 Opening Testimony, TN 214853
Filer:	ELIZABETH LAMBE
Organization:	Los Cerritos Wetlands Land Trust
Submitter Role:	Intervenor
Submission Date:	12/16/2016 1:37:48 PM
Docketed Date:	12/16/2016

Gas Turbine World, September-October 2013, Volume 43 No. 5, pp. 12-16:
http://www.gasturbineworld.com/el-segungo.html

El Segundo combined cycle offers 300 MW of peaking in 10 minutes

550MW Flex-Plant 10 combined cycle project represents a growing trend in the use of combined cycle technology that has the ability to provide peaking and base load power to complement intermittent renewables.

On September 12th, NRG Energy Inc. inaugurated what is only the second combined cycle plant in the US to use Siemens "Flex-Plant" technology. The new facility, in El Segundo, California, represents what is a growing trend among US operators to install plants that have the operating flexibility to back up the growing amount of renewable generation on the grid in markets like California.

The El Segundo Energy Center features two Siemens Flex-Plant 10 fast-start SCC6-5000F 1x1 combined cycle power blocks. Performance highlights include the ability to deliver 300MW in 10 minutes and limit transient NOx emissions during operation to 2 ppm. More specifically:

Rating. Each power block is rated at 275MW net output (at 85°F design point) for a total plant output of 550MW at 48.9% combined cycle efficiency.

Fast start. Each SGT6-5000F gas turbine can deliver 150MW of non-spinning reserve peaking power within 10 minutes of startup, for a total of 300MW.

Emissions. Entire combined cycle block can ramp up and down at 30-35MW per minute while maintaining 2 ppm NOx stack emissions and virtually no CO.

The El Segundo Energy Center is the latest move in NRG's ongoing drive to lower emissions from its thermal generating fleet while at the same time allowing greater use of renewables and the gradual replacement of aging steam units at the site.

The original plant at the El Segundo facility comprised four natural gas fired steam units – Units 1 and 2 which began operating in the 1950s and Units 3 and 4, which had been running since the 1960s.

Units 1 and 2 were retired in 2002 and demolished in 2010 to make way for the two new units. Unit 3 has also since been retired as part of the permitting of El Segundo Energy Center, while the 335MW Unit 4 is still operating.

In addition to helping the integration of renewables, the new plant will enable the site to reduce the consumption of potable water by nearly 90%; allow NRG to meet or exceed the State and South Coast's strict air quality standards; and require 30% less natural gas per MW produced than the original steam boilers.

Also, the removal of two large oil tanks at the south end of the property will lower the site's profile and reduce the overall visual impact.

Meeting demand

The repowering project has long been in the making. NRG first proposed the project in response to identified demand by California's Independent System Operator (ISO).

Population continues to expand to the eastern parts of the Los Angeles basin, where summer hot spells make air conditioning a necessity. Regional resources have not kept pace with this growth and the recent closure of the SONGS nuclear plant has resulted in the need to produce even more electricity than was previously thought.

The California Public Utilities Commission has determined that about 2000MW of locally produced power will be required to meet the region's energy demand by 2016. The repowering project is therefore essential for local energy reliability.

In terms of operation, each of the 1x1 combined cycle units is permitted to start 200 times per year to meet both California's base load and peak load demand. Although NRG has committed to a capacity factor of about 60%, which equates to a little over 5400 hours a year, the plant must be available 24/7.

Commenting on the new plant, Richard Loose, Siemens' Director of Marketing Energy Solutions, Americas, says: "When you look at the plant, you might think it looks like any other 1x1 combined cycle, but the unique thing is that it's actually a peaker. When you hit "start" each block delivers 150MW in 10 minutes; for a combined cycle that's game-changing technology."

Change of plan

Originally, the proposed plant was to be a 2x1 combined cycle plant designed to use ocean water for cooling. Accordingly, NRG was issued a licence in 2005 by the California Energy Commission for a 630MW ocean-cooled base load plant.

In 2007, however, the company moved to an air-cooled configuration as explained by George Piantka, Director of Environmental Business for NRG West Region, who has been part of the permitting effort since 2000, first as a consultant and then as an employee of NRG.

He recalls that the decision to switch to a configuration that used air cooling allowed the retirement of around 400 million gallons per day of ocean water cooling. This was in compliance with the objectives of the State Water Resources Control Board, ultimately approved in 2010.

Cooling is provided by low profile, air-cooled heat exchangers (ACHEs), which remove the energy and condense the steam, feeding condensate down a condensate receiver back into the cycle. Adopting this air cooling design allowed water usage to be reduced by about 90 percent.

Also, the old plant did not have its own sanitary discharge system. So, as part of the infrastructure improvements, the new plant is connected to the city's sanitary discharge. The facility is also designed for zero liquid discharge.

Fast start technology

The new plant features two power islands delivered by Siemens. Each unit comprises an SGT6-5000F gas turbine, an SST-800 steam turbine, an SGen6-100A-2P generator, a heat recovery steam generator and an air-cooled heat exchanger. Siemens also supplied the complete electrical equipment and the SPPA-T3000 power plant instrumentation and control system.

The SGT6-5000F at the heart of the plant is capable of reaching 150MW in 10 minutes, full gas turbine output in less than 15 minutes and full plant output (GT at base load, ST valves wide open) in less than 60 minutes.

The plant is also designed to ramp up or down at 30MW per minute between 100% and 55% gas turbine load, while maintaining emissions at the stack to less than air permit levels.

According to Siemens, the plant's fast start capability to deliver 200MW in 30 minutes or less can result in a 30% reduction in greenhouse gas emissions when compared to traditional F-class combined cycle plants.

Since first introduced in 1993, the 5000F engine has evolved over time, with improvements made to increase efficiency and power output, extend maintenance intervals and enhance operating flexibility.

Design features

According to Siemens, the engine is now designed for high reliability and frequent ramping without any service or increased maintenance penalty for fast startup and fast ramping.

It features a 13-stage compressor with four rows of variable compressor guide vanes enabling high efficiency at part load as well as at base load. The compressor is connected to the 4-stage turbine by a single tie-bolt.

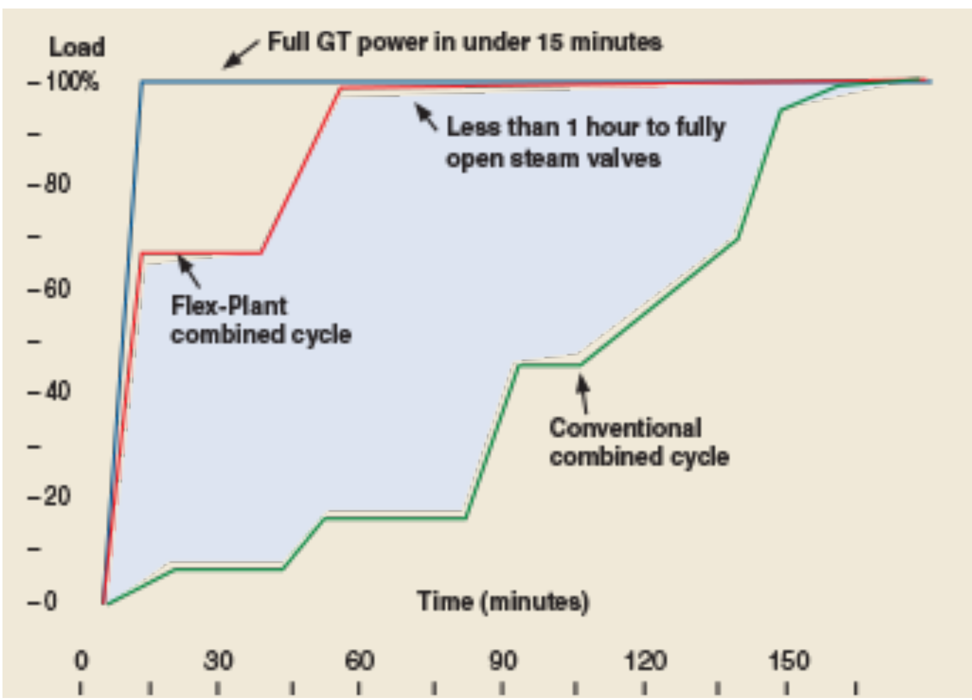
There are no nickel-based alloys used in the rotor construction. Instead, the rotor uses upgraded steel discs in the turbine section with a rotor air cooler to allow for greater flexibility in turbine blade cooling air temperature.

The engine is offered with an option of two combustion systems. The latest version of the turbine uses an ultra low NOx (ULN) combustion system that employs 16 can-annular combustors to reduce NOx levels to less than 9 ppm.

The ULN system uses five fuel stages to mix the natural gas with combustion air. The pilot and the main pre-mixers (on the combustor support housing) employ swirler fuel injection, where the fuel is injected off the swirler vanes. This provides more injection points and better mixing than the previous dry low NOx combustor.

In addition to reducing NOx, the ULN combustion system controls CO, volatile organic compounds (VOC) and particulate emissions. Reduced low load CO emissions are achieved by operational modifications and bypassing supplemental cooling air around the combustor.

Bypassing air around the combustor increases combustor flame temperature, which leads to reduced CO production. In this version, CO emissions are kept below 10 ppm down to at least 40% load, without alteration to the internal architecture of the combustion system. This allows greater flexibility during cyclic operation.



El Segundo performance. Each 5000F 1x1 Flex-Plant 10 is design rated (at 85°F) to deliver 150MW of gas turbine power in 10 minutes (non-spinning reserve) for peak backup of intermittent renewable generation and full 275MW plant output at 48.8% efficiency in less than 60 minutes.

First-of-a-kind

Exhaust gas leaving the gas turbines at a temperature of about 582°C (1079°F) is fed into an HRSG used to generate steam to drive the steam turbine. Interestingly, these combined cycle units feature first-of-a-kind HRSG technology developed by NEM.

Unlike Lodi, which is a Flex-Plant 30 design that incorporates a triple pressure boiler, the Flex-Plant 10 at El Segundo has a single pressure boiler, producing 78.3 kg/s of steam at a temperature of 502°C and a pressure of 99.6 bar.

Although double and triple pressure versions of the boiler are available, the single pressure version was used at El Segundo due to space constraints at the site.

Steam from the HRSG is fed to the backpressure non-reheat steam turbine for an additional 70MW per train and resulting in an overall plant electrical efficiency of about 49 per cent. This is around 9-10 percentage points higher than a traditional simple cycle gas turbine peaking plant.

The innovative heat recovery steam generator design allows the Flex-Plant 10 to not only meet the challenging emission regulations in California but also, according to NEM, is the most economically competitive solution for peak-to-intermediate duty cycles.

HRSG design

NEM worked with Siemens on the boiler design for the El Segundo units. According to project engineers, the key consideration in its design was that it should not restrict any operation of the gas turbine. The design of the DrumPlus boilers ensures that no hold points are imposed on the gas turbine during startup.

Instead of having a large high-pressure steam drum, the water/steam separators have been located outside of the drum. The drum also uses a thin-walled design to minimize stresses across the drums.

Whereas conventional drum-type HRSGs run a high risk of severely reduced lifetime due to cycling stresses, the significantly lower peak stress means the boiler can handle 10-minute start-ups while maintaining the same design life span of conventional drum-type HRSGs.

The boiler design also allows the use of a conventional selective catalytic reduction (SCR) and CO catalyst. The result is a plant that can operate like a peaker, with unrestricted startup, but with a conventional SCR at the back end.

Essentially, El Segundo has the operating profile of a peaker but the emission footprint of a combined cycle. According to Siemens, start-up CO emissions are reduced by 90% compared to conventional combined cycle gas turbine plants as a result of the shorter startup time.

Ramping operation

Another unique aspect of El Segundo is the use of what Siemens calls 'Clean Ramp' technology. It has been tested at several locations but this is the first time it is being fully implemented.

The technology allows the entire plant to ramp up and down at 30 to 35MW per minute while maintaining 2 ppm NOx out of the stack. There will be virtually no CO emissions from the new units.

Transient NOx emissions are seen during ramping. Normally, sensors in the stack detect a NOx excursion and send a signal to input more ammonia to reduce NOx. Basically, it is a reactive process.

Clean Ramp technology essentially links into the controls of the gas turbine and SCR. As soon as the gas turbine gets a signal to ramp up, the gas turbine and ammonia injection system operate in a proactive process to avoid NOx excursion at the stack.

The technology is hugely important in a state that has one of the strictest legislations in the country for NOx emissions. Piantka noted: "In this district, for Best Available Technology, there is a NOx limit of 2 ppm over an hour. So, when ramping up or down, we have to meet our limit over that hour period."

The plant has successfully demonstrated this during commissioning and operation.

Ready to meet demand

Despite having to be built on an existing site subject to space constraints, the new plant was completed in time to meet the growing demand in the region.

This can partly be attributed to a logistics plan developed by Siemens for special rail car usage and transit clearance to ensure that gas turbine and generator delivery to site went smoothly.

Effective implementation of the plan resulted in all equipment delivered ahead of schedule: steam turbines were delivered 63 days early; gas turbines three days early; HRSGs 42 days early, and air cooled heat exchangers (condensers) 21 days early.

With its second Flex Plant now in operation, Siemens believes this will be a growing trend in the US, where natural gas fuel is cheap, and especially in regions where there is an increasing amount of renewables.

A third Flex-Plant is scheduled to begin operation in Sherman, Texas by the end of 2014. This project, being built for Panda Power Funds, will be followed by another project in Temple, Texas, also for Panda Power, that is scheduled for completion a year later.