Turbomachinery International
March/April 2000

Siemens on fast track to commission Santa Rita

Siemens on fast track to commission Santa Rita

A 1000 MW combined cycle with four single-shaft blocks is nearing completion in the Philippines. Through careful planning of the commissioning program on two fuels, Siemens are able to bring all four units into commercial operation within the space of a few days.

In the old days a steam plant with four 250 MW sets might at best have been brought into operation over the space of two years, with one unit being put into service every six months in accordance with the generation development plan of the utility concerned. Later, utilities faced with rapid growth in electricity demand were attracted to the combined cycle because a large multi-shaft block allowed the gas turbines to be commissioned quickly and run simple cycle for upwards of 12 months while the steam cycle was completed.

The trend to install large single-shaft combined cycle blocks with, for the 60 Hz market, gas turbines of about 180 MW has been accompanied by a move to reduce the construction time by having a greater degree of factory assembly for what is effectively a standardised plant design.

The electricity supply system in the Philippines is in a process of change. The National Power Corporation (NAPOCOR) is no longer in the business of building generating plant. That is left to IPP's either alone or in partnership with NAPOCOR, to build new plants or refurbish and repower existing stations. In effect the company, which is still in the public sector, will become the market place for electricity trade, with responsibility for the high-voltage grid and the HVDC links between the major island networks.

Another factor which has brought the Santa Rita and other combined cycles into being is the discovery of the Malampaya gas field offshore southwest Luzon in 1990. Shell, as developer of the field saw that in the absence of any gas market in Manila and the other large cities, the only way to exploit this field would be through power generation. 3000 MW was seen as the size of market that would enable the development to go ahead.

As development of the first combined cycle plants got under way, the country was seeing growth in demand of 7.5% per year, then at the beginning of 1998, growth slowed down and is now effectively at zero. In this situation new construction is for plant replacement to benefit from improved efficiency and environmental quality of power generation.

Figure 1. Santa Rita power station viewed from the fuel unloading jetty. Unit 10, the first to complete commissioning is at right of picture. The mobile crane at left is working on preparation of the San Lorenzo site

Basically three large combined cycle plants and a planned 300 MW CHP unit at the Caltex refinery in Batangas define the market that enables the development of the Malampaya field. The first of these, Santa Rita, with four single-shaft blocks of Siemens Model V84.3A, is nearing completion. A second plant, San Lorenzo, on the neighbouring site achieved financial closure February 15 It will have two of the same combined cycle units as Santa Rita and a number of shared facilities including the control room. These two plants account for half of the 3000 MW.

About 40 km north along the coast, at Ilijan, site preparation is in progress, pending financial closure, for a 1200 MW combined cycle to be built for a joint venture of NAPOCOR and KEPCO (Korea Electric Power Corp). Mitsubishi is reportedly the prime contractor. The plant is expected to be completed just as the first gas arrives.

It was because of the prospect of developing gas infrastructure in the Philippines that British Gas holds 40% of First Gas Power Corporation, the owners of Santa Rita. The other partners are First Philippine Holdings, with 51%, and the Meralco Pension Fund with 9%. For San Lorenzo, the owners are a joint venture of First Philippine Holdings and British Gas alone. But Meralco, as the electricity distributor in Manila will buy the net output of both stations which must be wheeled over the NAPOCOR 230 kV grid. Indeed, Siemens' turnkey contract for Santa Rita includes construction of a 35 km dual-circuit transmission line from the 230 kV switchyard on site to NAPOCOR's Calaca substation, the capacity of which is more than will be the combined output of both plants when San Lorenzo comes into operation in the second quarter of 2002.

Santa Rita

In December 1996, Siemens were awarded a turnkey contract by First Gas Power Corporation for the construction of a 1000 MW power plant. Preliminary access to site was granted in July 1997 and financial closure was achieved two months later on September 4. Official ground breaking to signify the start of works was performed two

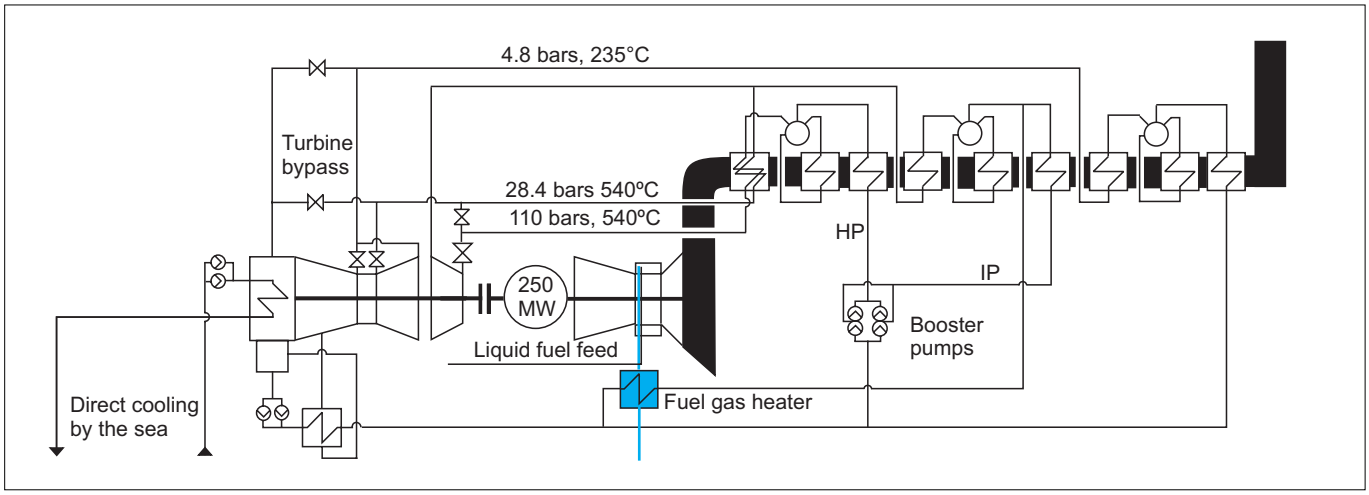

Figure 2: Steam cycle of Santa Rita and San Lorenzo combined cycles in their final configuration with gas firing, which is expected to start in 3rd quarter of 2002. Until then Santa Rita will run on either gas condensate, naphtha, or a mixture of both.

months later on November 17.

As originally planned the plant was to be two 500 MW blocks and this terminology has stuck even though the four units are considered separate and numbered 10, 20, 30 and 40. In any event the plan was to bring 10 and 20 to completion in 24 months and 30 and 40 after a further three months. Operational factors outside Siemens control have led to some delays so that the four units were due to be handed over in April, 2000.

Each unit is similar in its basic configuration of the power train, and the steam cycle is similar to that of the 50 Hz single shaft units with Model V94.3A, as for instance at Otahuhu, New Zealand, (Jan/Feb 2000, p.34). The two gas turbines were developed as a common scaled design so that although the mass flow is less, the temperatures are the same.

Operating examples of Model V84.3A in the United States exhibited the same humming at high loads that was observed on the larger Model V94.3A. This was due to a circumferential resonance being set up in the combustion chamber which, as in the larger 50 Hz machine was cured by fitting asymmetric collars to selected burners to dampen out any tendency to hum. The same modification has been applied to the 60 Hz machines in the field and subsequently on the production line. In the case of Model V84.3A sixteen of the 24 hybrid burners are fitted with these collars.

Siemens' standard steam cycle for both machines is tri-pressure reheat, with a 2-cylinder steam turbine exhausting to an axial condenser. Deaeration takes place in the condenser hot well so that the condensate extraction pump doubles as the LP boiler feed pump. There is a single preheater stage in which the condensate passes through a heat exchanger, which is supplied by a steam bleed from the LP turbine. The main conceptual difference between this and Otahuhu is that it is directly cooled by sea water instead of having a hybrid cooling tower; and that since the gas turbine will, for the first three years, burn liquid fuel, it has water injection for NOx control.

Figure 3: Units 1 and 2 of the first Block were simultaneously commissioned on diesel oil in mid February

The initial fuel contracts for naphtha and gas condensate have been placed with Enron and the first shipment of 50 000 m³ of gas condensate was on site when *Turbomachinery International* visited on February 14. In the station's tank farm there are five 26 000 m³ tanks for storage of naphtha and gas condensate. In addition there are two for storage of diesel fuel, and a further two day tanks for the diesel fuel used for start-up and shut-down.

The station will be operated on liquid fuel until Malampaya gas becomes available, which is expected to be in 2002. Shell are bringing it ashore at their Batangas refinery, from where First Gas Holdings will lay an 8 km pipe to the Santa Rita site. Meanwhile all four sets are being commissioned on diesel fuel, after which commissioning will be carried out on whichever of the other liquid fuels is available. In commercial operation the plant will be started on distillate and switched to either naphtha or gas condensate, or a mixture of both.

The original construction plan set a schedule to commission two 500 MW blocks three months apart. In practice the delays in the first block have brought the second block to the point that with careful planning commissioning of two units within the block can be performed at the same time.

Clutch aids testing

For this to be possible at all the generator has to be in the middle of the power train with an SSS clutch separating it from the steam turbine. Besides its normal uses to facilitate rapid start up, and to enable early access to the gas turbine at a maintenance outage, at Santa Rita it plays an important role in the commissioning of the combined cycle units. With the clutch open, the gas turbine can be run to clean the boiler which discharges steam through bypass valves to the condenser. The clutch has only to be closed to commission the steam turbine.

On February 14, three of the four gas turbines had been synchronised and boiler cleaning was about to start on unit 40. In the first block, work was focusing on the commissioning of unit GT10 to full load, and the commissioning of ST20.

For cleaning the boilers the gas turbines can be operated with their hybrid burners in diffusion mode. This is a high NOx mode of operation which is permissible during commissioning when the plant is exempt from prevailing environmental rules. In any case, in normal operation, premix mode would

Figure 4: Siemens standard single shaft combined cycle has centrally mounted generator and steam turbine exhausting to axial condenser as can be seen here in left background.

Figure 5: Centrifuge fuel treatment system by Westfalia Separator will handle diesel , naphtha and condensate fuels in the first two years of operation until natural gas arrives.

cut in at above the 80 MW output level needed to clean the boiler. With both boilers cleaned and the clutch of the Unit 20 closed its steam turbine can be tested up to full load and the control settings established with the gas turbine still firing in diffusion mode. While this is happening, the clutch of GT10 is open with the gas turbine commissioning, and the boiler dumping steam into the condenser.

Commissioning tests entail taking the gas turbine output up to full load in stages and checking out hardware and control software to establish operating settings and eliminate any design anomalies. For this, the Teleperm controller has a software editing display which allows the commissioning engineer to view, and if necessary amend the section of the control program code corresponding to the particular condition of loading under which the gas turbine is testing. Using this facility, alarm signals can be verified and settings confirmed. With commissioning completed, the finalised control software of unit GT10 can now be transferred to the controller of GT20. Similarly, control software for ST20 can then be transferred to ST10.

The file transfers can be carried out overnight after which a final check of GT20 and ST10 can proceed in parallel so that both units can be brought to completion of the entire block of two gas turbines, and a steam turbine in about four days. While this is going on the defined control software routines can be transferred to the other two units provided that cleaning of the boilers has been completed.

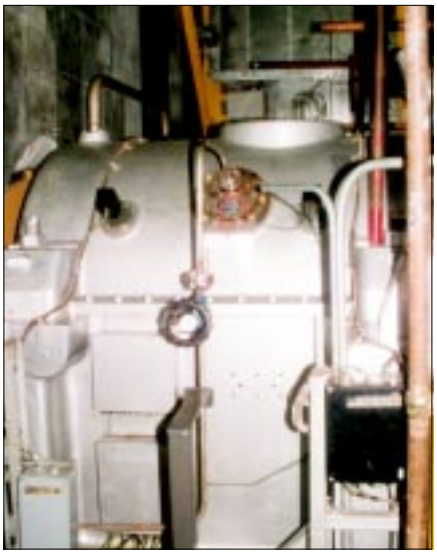

Figure 6. Without an SSS clutch in each unit simultaneous commissioning would not have been possible

Running on naphtha or gas condensate poses a problem of lubricity. This is not so severe in the Siemens fuel system with an annular combustor arrangement as in some units with cannular combustors but it still means that without purging the system at shutdown there is a risk of sludge collecting in fuel lines and pumps.

It is in India where naphtha firing has really taken off and Siemens have therefore carried out extensive tests on the Paguthan combined cycle with two Model V94.2 near Ahmedabad. With naphtha firing the gas turbine can be started on diesel fuel and switched to naphtha when full load has been reached. To shut down it is not necessary to switch back to diesel. The gas turbine is run down on naphtha and then the whole fuel system can be purged with demineralised water. This method has been found to be effective in Paguthan and will be applied also to the four units at Santa Rita.

Commissioning on either naphtha or gas condensate followed commissioning on distillate, and using the same methods to bring all four units up to commercial operation together. At the same time, work has started in earnest on the construction of the two single shaft blocks for San Lorenzo. By the time that this station is completed natural gas may be available, and then Santa Rita will have to be taken out of service for commissioning on this fuel.

SSS Gears Limited
Park Road, Sunbury-on-Thames
Middlesex, TW16 5BL, England
Telephone: +44 1932 780644
Fax: +44 1932 780018

SSS Clutch Company Inc
610 West Basin Road
New Castle, DE 19720, USA
Telephone: +1 302 322 8080
Fax: +1 302 322 8548

Printed in the United Kingdom