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Toms Creek Integrated Gasification Combined Cycle Demonstration Project

Quarterly Report
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1 SUMMARY

The Quarterly Technical Progress Report for the period ending September 30, 1993, summarizes the work done by Tampella Power Corporation and Tampella's subsidiary, Enviropower Inc. Enviropower Inc.'s efforts were concentrated on the Toms Creek PDS (Preliminary Design and Studies). The scope of the PDS was expanded to include heat and material balances and selected equipments sizing designs, based on an IGCC plant size incorporating General Electric's new 6(FA) gas turbine. Tampella Power Corporation's efforts were concentrated on the Toms Creek heat and material balances, as well as, economic and technical evaluations, based on the same 6 (FA) gas turbine plant size.

2 PRELIMINARY DESIGN AND STUDIES

A meeting was held with Enviropower Inc., in Tampere, Finland, to discuss findings of the Preliminary Design and Studies. The meeting included a discussion of the technical risks associated with increasing the IGCC plant size from a nominal 55 MW to 105 MW electrical power output by replacing the original Frame 6(B) gas turbine with GE's larger more efficient Frame 6(FA) gas turbine.

2.1 GE's 6(FA) Gas Turbine

During the ASME Turbo Expo '93, May 24-27, 1993, in Cincinnati, Ohio, General Electric's Industrial and Power Systems division announced the introduction of the 6 (FA) gas turbine. This gas turbine was an evolution of GE's F technology for advanced gas turbines. The gas turbine performance characteristics are indicated in Table 1. GE also announced, that pending DOE approval, this gas turbine would be used on the Sierra Pacific project, another Clean Coal Technology IV IGCC Demonstration Plant.

TABLE 1

GE GAS TURBINE PERFORMANCE DATA

GE GAS TURBINE SIZE	6(FA)
Scale Factor Based on 7(FA)	0.69
Output (kW)	70,140
Heat Rate (BTU/kWh)LHV	9,980
Efficiency (%)	34.2
Pressure Ratio	14.6
Firing Temperature (°F)	2,350
Exhaust Flow (lb/hr)	1,591,000
Exhaust Temperature (°F)	1,107
Turbine Speed (rpm)	5,235
Basis: ISO, Dry, Natural Gas, Standard Inlet & Exhaust Pressure Drops	

2.2 Technical Risk for IGCC Plant Scale-Up

The IGCC specific plant cost ($/kW) is reduced when the design is based on a more efficient gas turbine and a larger overall plant size. Steam cycle improvements (i.e. higher superheated steam temperature) are also possible, due to a higher gas turbine exhaust gas temperature. Therefore, system design considerations are more favorable when the 6 (FA) gas turbine is compared to the 6(B) machine.

Technical risks for a larger gasifier island design were evaluated, based on feasibility of scale-up in the following areas:

a) Feed systems
b) Gasifier design and gasification process
c) Ash removal system
d) Gas cooling system
e) External sulfur removal system design
f) Hot gas filter system
g) Shop versus field fabrication of pressure vessels

The conclusion of the technical risk assessment was that the gasifier island scale-up was reasonable according to good engineering practice, and that the technical risks were within acceptable limits.

2.3 Preliminary Design Studies Review

The draft PDS (Preliminary Design and Studies) document was reviewed in detail with Enviropower Inc. A target date of September 30, 1993 was established for issuing the final draft of the PDS document.

Subsequent to the review, Tampella Power Corporation expanded the scope of the PDS to include heat and material balances for the Toms Creek IGCC Demonstration plant based on the 6(FA) gas turbine. In addition to generating revised heat and material balances, Enviropower Inc. was also given the task of re-sizing selected equipment. Based on this revised equipment sizing, Tampella will obtain vendor quotations for a more accurate IGCC system price estimate.

As part of the PDS review, Enviropower Inc. is also reviewing the preliminary P&IDs that Tampella Power Corporation generated previously, with comments being hand marked on each individual P&ID.

3. TOMS CREEK CONFIGURATION CHANGE

Using the original Toms Creek Plant configuration, the Power Sales Agreement could not be reached because, among other reasons, the utility felt that the cost of electricity produced and sold from this project was too high. The cost of electricity from the reconfigured project is lower due to the following reasons:

a) Economies of scale

- Specific plant cost, $/kW, is reduced with increasing plant size and power output.

b) Improved gas turbine efficiency

- The gas turbine efficiency is improved mainly due to a higher combustion temperature.

c) Improved steam cycle efficiency

- The gas turbine exhaust temperature is higher, thereby allowing for higher steam temperature design, and improved steam cycle efficiency.

A request for modification to the Cooperative Agreement will be sent to DOE requesting approval for a configuration change to the Toms Creek project. The IGCC plant configuration change would incorporate the following:

a) An increase in the gasifier island through-put to provide the quantities of coal gas required by the larger for the GE 6 (FA) gas turbine.

b) Deletion of the parallel pulverized coal boiler which was to have been used for additional power generation in the original configuration.

c) Deletion of the co-generation of process steam for sale to a near-by coal preparation plant.

4 IGCC PLANT COMPARISON

The use of an upgraded version of General Electric's Frame 6 gas turbine, which has been designated as Frame 6 (FA) will make a significant improvement to the thermal efficiency and overall economics of the Toms Creek Project. Replacing the smaller, less efficient Frame 6 (B) gas turbine with the new Frame 6 (FA) will increase the net power production from a nominal 55 MW to 105 MW. The coal feed rate will correspondingly increase from 430 tpd to 740 tpd. All process flows and equipment sizes will be increased accordingly.

Selected process parameters for the original and revised Toms Creek IGCC plant configurations are compared in Table 2. There is an approximately 10% increase in net plant efficiency for the revised configuration. Using this increased plant size, the pressure vessels become larger due to an increased through-put, but are still dimensioned for shop fabrication and over-the-road shipment.

The preliminary cost estimate for the enlarged demonstration plant was prepared by factoring the estimates for the original plant. Revised quotes for the larger equipment will be solicited and used to generate more accurate cost information for the revised plant.

TABLE 2

IGCC PLANT COMPARISON

Gas Turbine	Original GE Frame 6(B) (w/ PC Boiler)	Revised GE Frame 6(FA) (No PC Boiler)
Plant Elevation above Sea Level, ft	2,755	2,150
Power Production		
Gas Turbine, MW	34.8	65.1
Steam Turbine, MW	22.9 (IGCC Only)	45.5
Steam Turbine Conditions, psig/deg. F	1,800/1,005 (w/ PC Plant)	1,300/1,000
Gross Power, MW	57.7	110.6
Auxiliary Power, MW	3.6	5.2
Net Power, MW	54.1	105.4
Heat and Material Balances Data		
Coal Feed, lb/hr	35,800	61,800
Coal Heat Input, MM Btu/hr (HHV Basis)	469	821
Dolomite Feed, lb/hr	6,100	10,500
Total Ash Flow, lb/hr	7,500	13,100
Coal Gas Flow, lb/hr	164,500	294,000
H.R.S.G. Flue Gas Flow, lb/hr	1,020,000	1,520,000
Gas Turbine Exhaust Temp., deg. F	1,003	1,114
H.R.S.G. Stack Gas Temperature, deg. F	270	250
Superheated Steam Flow, lb/hr	169,000 (IGCC Only)	320,000
Gas Turbine Efficiency Data		
Heat Rate, BTU/kWh (Coal Gas LHV and Chemical Heat Only)	10,160	9,400
Efficiency, %	33.6	36.3
IGCC Plant Net Efficiency		
Net Plant Heat Rate, BTU/kWh (HHV Basis)	8,670	7,790
Net Plant Efficiency, % (HHV Basis)	39.4	43.8

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