SABIC Innovative Plastics
Steam Turbine Generator
Final Report

Prepared For

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NOTICE

Table of Contents

1) Executive Summary

a) Description of STG Project

The installed Steam Turbine Generator system consists of one (1) 1 MW unit with a total peak power production of 1 MW. The unit was provided on a pre-wired, pre-piped, skid. The skid is located in a new STG building.

Fig 1: New Steam Turbine Generator

The Steam Turbine Generator building was fabricated on site to house the unit. The inlet and outlet steam piping was also fabricated and installed on site by contract construction firms. Instrumentation for pressure, temperature, and steam flow was also installed.

Fig 2: New Steam Turbine Generator Building

The new Steam Turbine Generator unit utilizes a pre-existing steam flow that supplies heat to a heat exchanger in the chemical plant. The STG is used to regulate the flow rate of that steam to the heat exchanger (instead of using a control valve), and creates electricity, which is utilized by the plant.

b) Summary of STG Operating Results

Operating results of the Sabic Innovative Plastics STG plant were analyzed based on actual computer recorded unit data. Site electric utility usage data was also examined to determine overall benefit to the site. In general the Sabic Innovative Plastics STG plant has run well once the initial commissioning was completed.

Following is a summary of the measured STG output. The STG electrical output is a function of how much steam is used to heat the heat exchanger in the chemical plant. This steam flow is a function of production rates. As production rates rise, the steam flow, and subsequent electric generation from the STG, also rise.

The estimated Project Cost and Electrical Output of the STG was:

Estimated STG Totals	
Est. kW/hr Generated	= 784 kWh
Est. Run Hours	= 7,536 hours
Est. kWh Generated	= 5,900,688 kWh
Est. Cost Savings	= $502,199 / yr
Est. Project Cost	= $2,400,000
Est. Simple Payback	= 4.8 yrs

For 2010, run-data from the STG shows actual STG Output of:

Actual STG Totals (2010)	
Avg. kW/hr Generated	= 749 kWh
*Est. Run Hours	= 7,536 hours
*Est. kWh Generated	= 5,644,464 kWh
*Est. Cost Savings	= $479,779 / yr
Actual Project Cost	= $2,373,079
*Est. Simple Payback	= 4.9 yrs

*The STG system has not run a full year (project commissioning was in 2010). Therefore, actual yearly run hours not yet available. However, run hours for future years are anticipated to be higher than those utilized for the project estimates.

c) Lessons Learned

Importance of Control Scheme Integration

The STG system at Sabic Innovative Plastics controls the steam turbine on flow control instead of pressure control. This is because the steam flow to the heat exchanger is a critical variable that must meet set point at all times. This makes the Sabic system unique to other steam turbine installations that normally control to pressure. A close working relationship, and multiple face to face discussions with the vendor supplying the STG skid and PLC controls was vital in ensuring our plant DCS and the skid PLC worked properly to maintain adequate steam flow to our systems.

Integrating Multiple Contract Engineering Documentation

The project required the use of engineering support for three different phases of the project – STG skid wiring and fabrication, site structural / mechanical / electrical fabrication, and site high voltage tie-in wiring. All three engineering groups utilized different standards for drawings (particularly wiring drawings), which caused some confusion during implementation of the project. For future installs, we would consider tasking one engineering team to compile all drawings into one format.

Construction Challenges

The largest challenge for installation was the use of torch and welding equipment (or “hot work”) in the chemical plant. Much care was taken in ensuring a safe working area for performing hot work near other chemical operations running at the time. These measures, though necessary, added cost and time to the implementation of the project.

Operator training

The chemical operations where the STG is installed run 24 hours per day, 7 days per week. There are 4 shifts of operators that rotate to run the facility. To train the operators for the new STG system, we walked through the start-up and shutdown of the unit with each shift. We also utilized their input for Standard Operating Procedure development of the system. The training and interaction with operations went very well.

2) Site and STG Plant Description

a) Site and STG System Description

Sabic Innovative Plastics is a chemical operations and finishing plant located in Selkirk, NY producing specialty plastics. The facility uses electric power year round to run equipment, lighting and general power for building utilities. Many systems onsite utilize steam for transferring heat through heat exchangers.

The installed steam turbine generator utilizes a pre-existing steam flow to generate electricity for site use. The steam flow is used to heat a heat exchanger in one of the chemical units. Instead of using a control valve to maintain flow, the STG is used to modulate steam flow to the desired set point while producing up to 1MW of electricity.

Fig 3: New Steam Turbine

Fig 4: New 1 MW Generator

Fig 5: New Circuit Breaker

b) Actual Project Construction Costs

Actual project costs are summarized below. Values are based on purchase orders to Turbosteam for the steam turbine generator, as well as construction contracts from the various contractors.

Total Project Costs:

STG Unit	= $959,754
Engineering	= $214,458
Equipment	= $210,208
Structural	= $442,679
Mechanical	= $335,400
Electrical	= $172,072
Controls	= $ 26,400

Total Project Cost = $ 2,360,971

NYSERDA Incentive = $ 816,000

Cost per kW = $ 2,361 (1 MW Generator installed)

c) Construction Process and Schedule

A purchase order was issued for the new Steam Turbine Generator in January 2009. Through the course of the year, the Selkirk team and the STG vendor (Turbosteam) met to discuss design drawings and control philosophy for the new system. During the summer of 2009, the steam piping and electrical tie-ins were installed to receive the future equipment. The STG was delivered to the plant in December 2009.

The Steam Turbine Generator construction documents were produced in November 2009 to provide competitive bidding for 5 main contracts: Electrical, Mechanical, Civil, and Structural construction, and the Steam Turbine Generator. Initial bids were received and were in line with the initial estimates for the project. Purchase orders were issued to contracting firms starting in November 2009 to begin installation.

Construction of STG building and piping began in November 2009. Electrical work followed in early 2010. Steam Blows were performed in May 2010. The system was fully installed and final checkout and startup began in early August 2010.

During the initial testing and startup phase of the project, the system controls were tuned and refined. During this phase, extensive time was given to operator training and development of the standard operating procedures.

System testing was completed and brought online in September 2010. The system runs continuously during normal operations of the facility.

Fig 6: STG Foundation

Fig 7: STG Foundation

Fig 8: STG Building

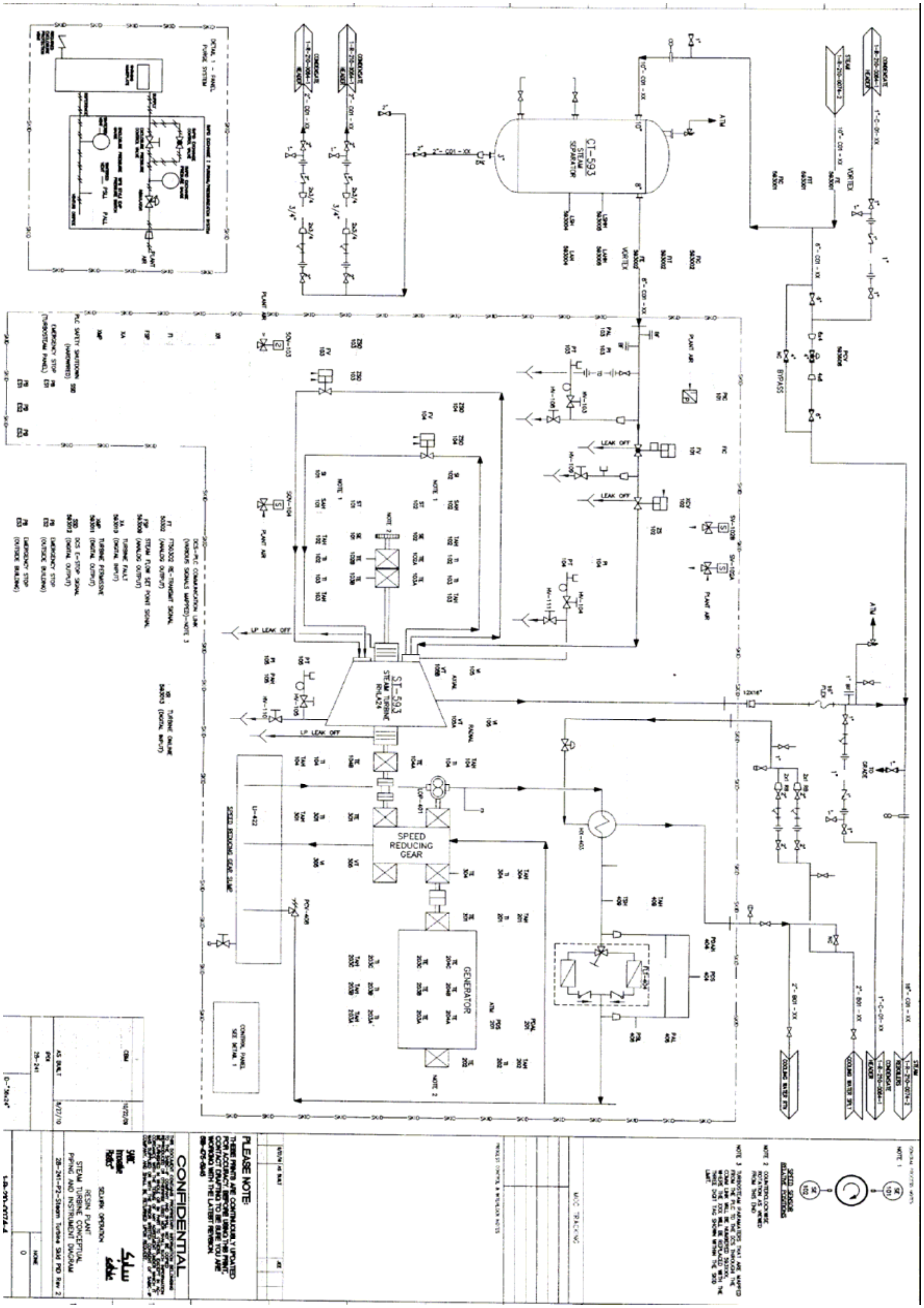
Fig 9: STG Fabrication

Fig 10: STG Installation

Fig 11: STG Finalization


Fig 12: New Steam Turbine Generator

d) System Schematic – Steam Turbine Generator



3) STG Measured Performance

a) Predicted STG Electrical Performance

The original study for the cogeneration plant was conducted in April 2008. At that time it was determined that a 1 MW plant best fit the existing electrical and steam flow profiles at Selkirk.

Preliminary analysis consisted of a simultaneous energy and financial analysis using the CHP calculation spreadsheet developed internally at the Selkirk site. The analysis utilizes transfer functions for the selected STG system to convert steam flow to calculated electrical production. Steam flow data was compiled for one full year and input into the analysis to generate an estimate for yearly electrical generation. This information, along with estimates for equipment and installation, were used to define the payback, and ultimately the feasibility of the system.

The initial analysis for the Selkirk STG utilized steam flows and process data for the full year of 2008. Because steam flow is a function of production rates, as production rates increase, steam flow (and electrical generation) increase as well.

From the initial analysis it was estimated the plant would operate as follows:

Estimated STG Totals	
Est. kW/hr Generated	= 784 kWh
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Est. kWh Generated	= 5,900,688 kWh
Est. Cost Savings	= $502,199 / yr
Est. Project Cost	= $2,400,000
Est. Simple Payback	= 4.8 yrs

b) Measured STG Electrical Performance

The Selkirk DCS system logs plant data into a data historian for future reference. Many data points were added to the data historian for the new STG system. These include temperatures, pressures, steam flow rates, and electrical generation.

For the STG run time in 2010, the electrical generation data was compiled and annualized to give an actual yearly cost savings analysis for the system.

For 2010, run-data from the STG shows actual STG Output of:

Actual STG Totals (2010)

Avg. kW/hr Generated	= 749 kWh
*Est. Run Hours	= 7,536 hours
*Est. kWh Generated	= 5,644,464 kWh
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Actual Project Cost	= $2,373,079
*Est. Simple Payback	= 4.9 yrs

NYSERDA Incentive = $ 816,000
Est. Simple Payback (with NYSERDA incentive)= 3.25 yrs

*The STG system has not run a full year (project commissioning was in 2010). Therefore, actual yearly run hours not yet available. However, run hours for future years are anticipated to be higher than those utilized for the project estimates.