Guyana Sugar Corporation (GuySuCo) has embarked on expanding sugar production by modernizing Skeldon Sugar Estate. The new, 350 TCH, state of the art factory will commence VHP sugar production during the second half of 2008. In addition to sugar production, 12 MW of co generated power will be made available to the national grid. Equipments of major interest are:

(a) Heavy Duty Hammer Shredder
(b) 350 TCH, Cane Diffuser
(c) New Generation SRI Clarifier
(d) Evaporator Floor - Quintuple arrangement of Semi –Kestner & Roberts Evaporators.
(e) Pan stage - Continuous Vacuum Pans
(f) C – Massecuite Vertical Continuous Crystallizers with Reheater.
(g) Curing station – Batch & Continuous Centrifugals
(h) Rotary- Louver type sugar dryer with water injection for final moisture setting.
(i) Boilers - Two boilers – capacity, 125 tonnes of steam /unit @ 54 bar pressure.

Power plant – Two T/A sets of 15 MW/unit, Three generating sets with a total capacity of 10 MW.

This paper will focus on the benefits of the new plant as well as the challenges faced by GuySuCo in optimizing the above benefits.

INTRODUCTION

Sugar has been an integral part of Guyana’s history from the time of the earliest Dutch Settlers in the mid-seventeenth century to the present day. During the nineteenth century, there were approximately 400 small-scale sugar cane processing plants in operation, but by the 1970s, the industry has consolidated into two companies – Booker Estates Limited and Jessels Holdings. In 1976, both companies were nationalized and combined to form the Guyana Sugar Corporation Inc (GUYSUCO).

Although Government-owned, GUYSUCO operates as an independent commercial organization. Policy is determined by the Board of Directors appointed by the Minister of Agriculture. Since 1990, GUYSUCO has been managed on contract by Booker Tate Ltd.

The corporation operates five sugar estates and eight factories all sited along the coast, four in the Demerara region and four in the east of the country on the banks of the of the Berbice and Corentyne Rivers.
Sugar estates in Guyana

The eight factories are situated on the narrow, fertile coastal strip which lies between the Atlantic Ocean and the rain forest and the savannah of the interior. The area is low-lying and is protected from the ocean by a sea wall. Drainage is by a complex system of canals, sluices and pumps, which is essential to ensure effective cultivation. Guyana is unique in having most of is sugar cane transported on water ways rather than by road or rail.
Bird’s eye view of the new factory

**LEGEND**

1. Punt dumper
2. Cane leveler knives & HD shredder
3. 1st. Set of Aerobelt
4. Diffuser
5. Lime shaker
6. SRI clarifier
7. Tower Crystallizers
8. Process house
9. Sugar Dryer
10. Sugar
11. Sugar bins
12. De-watering mills
13. Aerobelt for bagasse
14. Boilers
15. Water treatment plant
16. Bagasse shed
17. Electro static precipitators
18. TA sets (housing)
19. DG sets (housing)
20. Raw water supply & cooling tower
21. Fuel oil storage
22. Punts
In the year 2002, a peak production of 331,052 metric tonnes of raw sugar was achieved by GUYSUCO. However, due to loss of income from EU sugar sales, GUYSUCO has taken action to secure its future in the following manner.

a. Expansion of cane cultivation and sugar production
b. Value addition to its products.
c. Cogeneration of electricity, ethanol and refined sugar production

**Expansion of Cane Cultivation and Sugar Production**

In 2004 an Agriculture Improvement Plan (AIP) was introduced to boost the cane production. In addition, the decision taken to embark on Skeldon Sugar Modernization Project (SSMP) in 2001, was aimed at reducing the production costs. The reduction in production costs will be achieved with the introduction of state of the art processing technology, increase in production and mechanization of the field operations.

The most significant milestones in the progress of the Skeldon Sugar Modernization Project was the successful conclusion of financing arrangements with GUYSUCO, the Caribbean Development Bank, Word Bank, IMF and Exim Bank of China. The implementation of the modernization project would cost some US $110 million. When completed this site would be the most modern in Latin America and the best in the Caribbean.

The Chinese contractor, CNTIC trading Co. Ltd., was selected by international tender was selected for the construction of the factory and the cogeneration plant on turn-key basis. Booker Tate Ltd. was appointed as the Project Manager.

The project agricultural expansion stated in 2000, when completed the cane production area for the new factory will cover 13,000 hectares of which approximately 25% will be with private farmers. This is a three fold expansion of the existing cane growing area.

In addition, the land preparation of the cane expansion area will be done in a manner to initiate introduction of large scale mechanical harvesting. The mechanical harvesting will be done by Combine harvesters, which have been modified to cope with harvesting under wet conditions. Similarly, the haulage equipment also has been modified to cope with wet conditions.

The project factory expansions started in 2005. The factory construction contacts were signed in Beijing between GUYSUCO and CNITC Co. Ltd. on 22nd June, 2004.
Skeldon Sugar Modernization Project - New Factory Statistics

- Sugar production: 116,000 ts/y
- Cane consumption: 1,115,000 tc/y
- Cane processing rate: 8,400 tc/d
- Hourly processing rate: 350 tch
- Sugar production: 35.5 tch
- Pol extracting: 97.00
- Overall recovery: 85.5%
- Boiling house recovery: 88.10%
- Sugar quality: pol – 99.30%
  Colour - <1,350 Icumsa
  Moisture - , 0.18%
  Grade – VHP

- Steam pressure: 54 bar
- Boiler capacity: 2X 125 ts/h
- Boiler efficiency: 86.0%
- Steam temperature: 485 deg C
- Power generation capacity (steam): 2x15 MW sets
- Power generation capacity (diesel): 2X2.5 MW & 1X5.0 MW sets
- Total generating capacity: 40 MW
- Export capability: 25 MW

With the completion of the new factory, GUY SuCO will become the owner of a modern, state-of-the-art sugar factory that contrasts significantly with the existing factories. The technologies and equipment new to Guyana that will be found in the factory are:

- An improved automated punt dumper for offloading cane.
- Heavy duty cane shredder to increase extraction.
- Air supported belt conveyers (Aerobels) throughout the factory.
- Cane diffusion targeting an extraction of 97.0% Elimination of mud filters by addition of mud to the diffuser.

- New generation SRI juice clarifier and usage of lime saccharate for pH control.
- Double magma system for VHP grade sugar production.
- Quintuple evaporator station.
- Broadbent C54 batch fugals in HG curing stations. Broadbent SP continuous fugal in LG curing station.
- Fletcher Smith continuous vacuum pans for boiling all grades of massecuites.
- Continuous vertical crystallizers.

- Single pass, self cleaning, high pressure and high efficiency boilers.
- Use of electrostatic precipitators for pollution control to meet World Bank standards.
- Condensing turbines for power generation during off season.
- All electric drives to reduce energy consumption.
- Independent power station with automatic load following capacity.

- Central control rooms with PLC based DCS control systems.

(The above equipment are describe in detail in appendix 1)
2. **Value addition**

GUYSUCO has traditionally been a raw sugar producer. The bulk of the product was sold to UK on preferential prices and the balance was sold in the Caribbean region and locally as direct consumption brown sugar.

In 2001, small amounts of large grain, golden brown sugar was produced on trial basis at Blairmont Estate. The product was packed and marketed in a range of pillow packs as Demerara Gold. During the succeeding two years there was no real growth in packaging volumes or marketing of the above product. However, the plans to enhance the product quality by installing new equipment and make process improvements such as hot liming, syrup clarification, sugar drying, introduction of scalping screens and inline magnets for the removal of rust specs in sugar was given priority.

By mid 2003, GUYSUCO was ready to expand packaged sugar operations. This resulted in the launch of “Genuine Demerara Gold”, a high quality product, which was presented in 1 kg, 2 kg, 5 kg and 10 kg of sugar in attractive and quality pillow packs. The product range was further expanded in 2006 with the addition of “Demerara Brown” sugar in 900grms and 1800 grams pillow packs.

Since 2003, the increase in packaging volumes was coupled with improvements to packaging efficiencies, quality control, product handling and transportation procedures. Production of value add products was further enhanced with the implementation of Standard Operating Procedures, auditing of factory operations and attainment of ISO 2000/9001 certification by Blairmont Estate in 2006.

GUYSUCO is now well poised to take advantage of the above mentioned achievements and embark on large scale expansion of the packaging operations. The plans to erect a state of the art packaging plant with a capacity of 60,000 tonnes/year at Enmore Sugar Estate have been initiated. The plant is expected to package all grades of sugar at the year 2009.

1 **Cogeneration of electricity, ethanol and refined sugar production**

The cogeneration facilities at Skeldon will supply 10MW of form power to the national grid. The 10 MW diesel power plant will be able to provide MW of additional power from heavy fuel oil.

The generation of electricity from bagasse, will reduce the emission of green house gases and the project has qualified for the carbon credits under the World Bank Community Development Carbon Fund. In addition to the environmental benefits gained from this venture, a firm power supply is guaranteed to Berbice area and will reduce Guyana’s dependency on fossil fuels to generate electricity.

With the successful completion of the SSMP, plans are in train to produce ethanol as well as refined sugar for which feasibility studies have been completed.
3. **The Challenges**

Modernization and expansion of the Skeldon Sugar Estate is faced with many challenges. They are listed below.

- Expansion of the cane cultivation under adverse weather conditions.
- Increase in demand for cane supply coupled with decrease in availability of cane cutters.
- Training of factory personnel to understand the new technology and to be competent to operate the fully automated plant.

Expansion of the cane cultivation at Skeldon was initiated in 2004, with the clearance and preparation of additional land. However, a change in rain fall patterns since 2004 has severely affected land development and planting.

<table>
<thead>
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<th>Year</th>
<th>Rainfall (mm)</th>
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<tr>
<td>2008 YTD</td>
<td>651</td>
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</tbody>
</table>

Based on the above statistics, the rain fall in the Skeldon area and the new cultivation has increased steadily since year 2005. This has put pressure on the installed drainage that has had to cope with the increased precipitation and also the drainage of water from what had previously been a swamp. This has resulted in planting targets not being achieved to sustain the rated capacity of the new factory.

In the past the Guyanese sugar industry has been very fortunate with abundance availability of labour for manual tasks. However, in the recent past, the diminishing pool of labour, mainly for cane cutting has drastically affected the cane supply for the factories. The introduction of “Bell Loaders” for gathering and loading punts of manually harvested cane has been fairly successful. During the 2008, 23 new bell loaders have been purchased bringing the total number of machines in operation across the Industry to 59 by the end of the year.

However, at Skeldon the mechanization efforts have been taken another step forward with the introduction of cane combine harvesters, which have been built to modified specification to suit the field conditions at Skeldon. The “billet” cane will be transported by punts with specially designed infield transport and transloading equipment. With the increase demand in cane haulage, GuySuCo has invested in a
fleet of haulage equipment with special features to cope with the wet weather and field conditions.

Introduction of state-of-the-art technology with Distributed Control Systems to GuySuCo factories has highlighted the specific training needs for the managers and the workforce.

For training purposes, DCS controls were introduced to the juice treatment operations of the Blairmont factory. Extensive training programmes were conducted to familiarize the operators with DCS controls.

In addition to above, tailor-made classroom type training courses have been undertaken at Skeldon to prepare the staff to manage the fully automated plant. The above training will continue until the end of the successful commissioning of the plant.

The Wartsila DG generator station at Skeldon was commissioned on the 23rd March, 2008. 4 to 5 MW of uninterrupted power has been made available to the national grid. Supply of cogeneratated power will commence with the onset of grinding operations at the new factory. However, the amount of co-generated power available for exporting will largely depend on meeting the grinding targets and the efficient operations of the factory.
Appendix 1 - Factory Equipment

**Item 1** - An improved automated punt dumper for offloading cane.

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**Item 2** - Heavy duty cane shredder for increased pol extraction.

The shredder is located between feed and discharge Aerobelt conveyors. The second belt commences below the outlet of the shredder housing. There are 235 hammers mounted; it is rotating in flow direction at 900 rpm. The motor operates at 13.8 kV and 3.000 kW.
Item 3 - Air supported belt conveyers (Aero belts) throughout the factory.

Aerobelts are rubber conveyer belts, where upper belt trunk travels on an air cushion, which is an air film provided by two blowers. The returning trunk travels on idlers. The two transition points are rollers, the upper (head) roller is equipped with a VFD motor with gearbox for operating a belt at a designated speed.

Item 4 - Cane Diffusion Plant
**Diffuser**

A 9.000 m wide trough with fixed perforated bottom, with drag chain and scrapers, the average speed of the chain is 0.9 m/min. underneath the perforated plate there are 12 collecting trays for collecting percolating juice for recirculation and an additional tray at the entry for collection of the draft juice. Unit is totally enclosed

**Inside view of the cane diffuser**
The SRI clarifier has evolved over several decades and is recognized as the leading system in the cane sugar industry providing high quality clarified juice. The clarifier has been designed to provide optimum conditions for removing the maximum amount of impurities.

Clarifier has a diameter of 9.500 mm, with a height of 4.000 mm with double conical bottom (centre for mud collection and thickening). Vertical centered stirrer has a 0.55 kW motor.

The SRI clarifier at Skeldon is designed on the principles of quiet multipoint Juice entry and multipoint clarified juice take off.
**Item 6 - Evaporator station**

Evaporator station

**Evaporator station. Juice and Vapour Flow**

**Item 7 - First Effect & Second Semi-Kestner Evaporators**

**Description**
Two units with 2.500 m² heating surface each, body diameter 5.000 mm; calandria with 3’900 tubes, each diameter 51 mm, 4.000 mm long. Both units operating juice and steam side in parallel. Level controlled, control valve on outlet. Outlet juice fed to 3rd effect evaporators.
Third, Fourth & Final Set of Effects – Robert’s Evaporators

**Description - Third Evaporator**
A single unit with 2,800 m² heating surface, body diameter 6,400 mm; calandria with 7,077 tubes, each diameter 42 mm, 3,000 mm long. Level controlled, control valve on outlet. Outlet juice fed to 4th effect evaporator.

**Description - Fourth Evaporator**
A single unit with 1,800 m² heating surface, body diameter 5,200 mm; calandria with 4,550 tubes, each diameter 42 mm, 3,000 mm long.

**Description – Fifth Evaporator (Final)**
A single unit, identical to 4th effect unit. Outlet syrup fed to 5th effect evaporator. Unit is level controlled with control valve on outlet.

**Item 8** - Broadbent C54 batch fugal in HG curing stations. Broadbent SP continuous fugal in LG curing station.
A) Curing station has 3 Broadbent model C54MT, fully automatic vertical axis pendulum suspended batch centrifuges, rated capacity 1.850 kg A-massecuite (including spin off during filling), 20 to 25 cycles/h. Cyclic induction motor, 250 kW, 480 V, 6 pole winding with torque-speed characteristic to suit cyclic duty; rotor mounted directly on spindle, stator mounted directly on bearing housing.

Basket diameter 1.600 mm, height 1.220 mm, cake thickness 215 mm, maximum permitted speed 1.100 rpm.

Each machine is fully equipped with automatic butterfly feed valve, feed distributor (flinger), filling sensor, discharge valve, discharge plough, discharge chute, static vertical spray pipe with nozzles for washing the sugar cake and a vertical steam injection pipe for assisting drying the sugar layer. Complete with drive panel (inverter) and control panel (PLC).

B) Curing station has Broadbent model SPV1425 vertical axis conical basket self discharging continuous centrifuge, rated capacity 25 t/h B-massecuite, basket diameter 1.425 mm, inclination 30 °; 1.420 rpm, with 90 kW, 480 V motor including the following process and control equipment:

C) Curing station consist of Broadbent model SPV1425 vertical axis conical basket self discharging continuous centrifuges, rated capacity 20 t/h C-massecuite, basket diameter 1.425 mm, inclination 30 °; 1.680 rpm, with 90 kW, 480 V motor including the following process and control equipment.

Item 9 - Pan Stage - Fletcher Smith continuous vacuum pans

- Pan stage. CVPs for boiling all grades of massecuites.

Continuous Vacuum Pan for A, B & C Massecuites

Description
- A single unit with 115 m³ capacity, 1,150 m² heating surface and 10 cells. (6.911 mm x 14.670 mm.)
- Has a single steam inlet, choice of V1 or V2, manually set; condensate outlets at each cell.
- Has one seed entry point to the 1st cell from above. Feedstock addition to each cell from below, density (°Bx) controlled; display in %, for cell 10 as °Bx. Additionally hot water connections. All selection valves manually operated.
- Hot water addition controlled by recording flow meters to each chamber, with totalizers.
- Jigger steam to each cell manually set.

**Continuous Vacuum Pan for C Massecuites**

**Description**
- A single unit with 115 m³ capacity, 1.150 m² heating surface, with 10 cells; 6.911 mm x 14.670 mm.
- Has a single steam inlet, choice of V1 or V2, manually set; condensate outlets located at each cell.
- Has one seed entry point to the 1st cell from above. Feedstock addition to each cell from below, density (°Bx) controlled; display in %, for cell 10 as °Bx. Additionally hot water connections. All selection valves manually operated.
- Hot water addition controlled by recording flow meters to each chamber, with totalizers.
- Jigger steam to each cell manually set.
- Outflow is from cell 10, which has a weir controlling the massecuite level in the pan. With warming up and vacuum equalizing lines to each cell, sight glasses with steam and hot water cleaning options, steam-out lines, vacuum breakers and outlets for incondensable gases from top and bottom.

**Item 11 - Continuous vertical crystallizers.**
**C-Massecuite Vertical Continuous Crystallizers**

**Description**
Two vertical, cylindrical units (380 m³), diameter 5.750 mm, 19.870 mm high with cooling elements of 480 m² and VFD motor (15 kW) driving vertical shaft with attached mixing elements.

**Item 12 - Single pass, self cleaning, high pressure and high efficiency boilers.**

The plant has two boilers that are fuelled mainly by bagasse. They also have the capacity to burn “Heavy Fuel Oil” as an auxiliary fuel supply. Each boiler has a steam output capacity of 125 tch at 5400 kPa and 485 degrees. The boilers are fitted with economizers and air heaters as integral part of the heat recovery system. The boilers are also fitted with primary, secondary and induced air fans. The bagasse firing equipment consists of rotary drum feeders and an atomizing oil burning system capable of delivering 65% MCR.

The boiler is controlled by the Siemans PCS 7 and independent burner management system. Integral to PCS 7 is the control of all loops including pressure, temperature and level control for the boiler and its associated auxiliary plant. The PCS 7 also supervise the drive control and boiler plant interlocking systems. The boiler is further protected by a safety management system that supervises the Master Fuel Trip (MFT) and oil burner management system.
Item 13 - Electrostatic Precipitators (ESP)

The electrostatic precipitator (ESP) is fitted in the final stages of the flue gas path. The electrostatic precipitator electrically charges the ash particles in the flue gas to collect and remove them. The unit comprises of a series of parallel vertical plates through which the flue gases pass. Central between the plates are charging electrodes which provide the electric field.

The collecting plate are electrically grounded and are the + electrode. The discharge electrodes in the flue gas stream are connected to a high voltage source with a negative polarity. An electric field is thus established between the discharge electrodes and the collector surface, as the flue gases passes through the electrical field, the particles take on a negative charge. The negatively charged particles are attracted towards the grounded +ve charged collection plates and migrate cross the gas flow.

The ash particles form an ash layer as they accumulate on the collection plates. The ash layer can be removed periodically by rapping. The dislodged ash falls from the collection surface to the ash hoppers.

Item 14 - Condensing turbines for power generation during off season.
The turbine is of the extraction/condensing type with one controlled steam flow exit through a controlled extraction valve to the sugar factory Low Pressure (LP) process steam range. The steam upon leaving the last stage rows of blading combines to pass-through the exhaust branch to the water cooled condenser.

The steam turbines drives two 18.75 MVA generators through hardened and ground gearing.

**Item 14** - All electric drives to reduce energy consumption.

![De-watering mill and electric drive](image1)

**Item 15** - Independent power station with automatic load following capacity.

![Power House, Wartsila DG sets](image2)
The two 2.5 MW DG’s and single 5.0 MW DG, are directly controlled by Woodward 723 controllers which connect through digital and analog signals to Modicon Quantum Programmable Logic Controllers (PLC) located in the Watsila control panels.