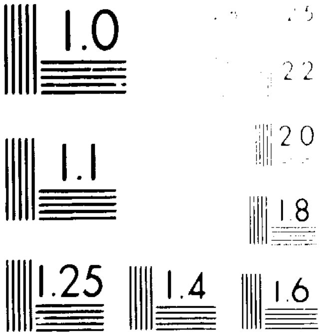
1.0
2.5
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ROCKWARE

Rockware International Limited

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FEASIBILITY STUDY ON THE COMMISSIONING AND OPERATION OF THE GUYANA GLASSWORKS LTD. GEORGETOWN, GUYANA.

DP/GUY/79/007

BY

ROCKWARE INTERNATIONAL LIMITED

on behalf of

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

ROCKWARE INTERNATIONAL

November, 1982.

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ACKNOWLEDGEMENTS

Rockware International wish to acknowledge with thanks the assistance and co-operation received from all GUYANA GLASSWORKS management and personnel in the compilation of this report.

Rockware International wish also to acknowledge with thanks the assistance received from the U.N.I.D.O. representatives in Guyana.

CONFIDENTIALITY

INTRODUCTION

Rockware International was contracted by the United Nations Industrial Development Organisation to complete a feasibility study at the Guyana Glassworks Ltd. Georgetown, Guyana, to determine the cost of commissioning the Glassworks and to assess the viability of producing glass containers for the local market. The glassworks for the purposes of this study is defined as the glasscontainer furnace and the bottle production and decorating line. The general terms of reference for the study are included after the Introduction. General comments on the Pressware line are included for information.

The feasibility study was completed in two parts:

a) on site technical assessment by the Rockware International Team

b) technical and financial review of team's findings in the United Kingdom with proposals for action

This report is compiled in three sections:

Part I – Technical appraisal of facilities of Guyan Glassworks Limited
– Appendices

Part II – Personnel, Technical Assistance, Technical Management and Training Requirements.
– Appendices

Part III – Operational Strategy and Financial projections
– Appendices

A substantial amount of technical and statistical data was supplied to the RI team. Where this is used as a basis for comment, copies are attached as appendices.

Technical assessment of the plant has been made on the basis that it is the intention of Guyana Glassworks to manufacture glass containers which conform to normal standards as regards capacity, dimensional accuracy and closure performance required by container users in the beer, soft drink and spirit trades as well as for pharmaceutical and food containers. Production of this nature would allow Guyana Glassworks the possibility of export and the ability to compete with other regional manufacturers.

Various market and demand assessments have been carried out indicating various consumption levels for containers in Guyana. The anticipated demand has a very great bearing on the operational aspects of plant in terms of raw materials, energy usage, furnace life, machine performance and so forth. The calculations made in this report are based on the assessment completed using material supplied locally. Further explanation of the importance of the assessed consumption is given in each relevant section.

It should be noted the Rockware International are not equipment manufacturers. Items of equipment designated as required for this project are given their technical description and not named by manufacturer except where the reason for this is explained.

ROCKWARE TERMS OF REFERENCE FOR A FEASIBILITY STUDY TO DETERMINE THE COST OF COMMISSIONING THE GUYANA GLASSWORKS PLANT AND THE VIABILITY OF PRODUCING GLASS CONTAINERS FOR THE LOCAL MARKET.

The study will cover the following:

1. Raw Materials

(a) Sand - suitability, treatment required, methods of quarrying and transport to and storage in glass plant.

(b) Soda ash and other imports - specifications, importing arrangements, dock facilities, transport and storage arrangements.

(c) Quality and value of raw materials in stock.

(d) Cullet crushing and storage arrangements.

2. Production Equipment - i.e. batch plant, furnace, production lines, decorating equipment.

(a) Condition - repairs and refurbishing needed.

(b) Comments on equipment designed and shortcomings.

(c) New equipment recommended.

(d) Detailed estimate of cost of refurbishing existing and purchasing new equipment.

3. Services

(a) Electricity - adequacy of standby equipment, variations in frequency and voltage, reliability of supply, power factor condensers, quantity of electricity consumed, cost of electricity.

(b) Water - availability, quantity needed, cost.

(c) Compressed air, state and adequacy of compressors. Operating Costs.

4. Moulds

(a) Number and condition

(b) Source of supply

(c) Design

(d) Mould repair, maintenance and storage arrangements.

5. Technical Assistance Agreement

Terms and Conditions

6. Warehouse, Inventory

(a) Storage of finished containers

(b) Inventory to be carried

(c) Value of inventory

7. Market

(a) Specifications of bottles to be produced, quantity, price, sales income.

(b) Production program, yield, effective operating days, colour changes.

(c) Furnace loading

(d) Machine loading

8. Labour

(a) Numbers required organisation

(b) Training arrangements

(c) Recruitment

(d) Rates of pay and labour cost

9. Costs

Raw materials, labour, electricity, water, oil, fuel, maintenance, moulds, management salaries, administration costs, depreciation, amortisation of initial expense service fee.

10. Profit and loss account for 10 years, cash flow statement, balance sheet, return on sales and equity. Debt service coverage, financial rate of return (discounted cash flow).

11. Suggested financial plan.

PART 1

TECHNICAL APPRAISAL OF FACILITIES OF GUYANA GLASSWORKS LIMITED.

PART 1 - CONTENTS

1. GENERAL

The Glass Plant is situated some 50 km south east of Georgetown, and has been virtually complete since 1978, although equipment continued to be installed up to 1980 and there were resident contractor's engineers on the site until March, 1982. A Status Report was submitted to Guyana Glassworks Limited dated 13th April, 1982 by Kurt Badelt of General Glass Equipment Company, the Contractors. Whilst this is a helpful summary, it requires reading with discretion in the light of the actual detailed inspection and findings.

Considering the length of time the equipment has been standing, it is in a good state of preservation and the comments refer not so much to the deterioration of the plant as to its design.
The site of 20 acres is large and more than adequate for the tonnage now contemplated or even when the Window Glass project was contemplated.

The plant layout is scattered and has given rise to technical problems in that the oil storage and batch house are an excessive distance from the furnace, namely 900 feet and 400 feet respectively, whereas the expected position in a new layout is immediately outside the furnace building. These problems can be overcome.

There is inadequate provision for warehousing, carton storage and assembly, resorting of Q.C. rejected ware and ancilliary processes for decorating ACL or machine maintainance. However, as long as the Window Glass section is not in use the space so freed could be used to fulfil these several functions.

It must be said at the outset that the plant is capable of making glass containers, at a cost and with operating difficulties, without major modification. However in order that the plant can function to the required standards certain minimum requirements are necessary such as secure power supply, sound fuel lines, instrumentation, effective forehearth and feeder operation, furnace performance and good sand treatment. In some areas of the plant these requirements are not met and therefore certain additions in terms of equipment and plant are necessary. These are specified under their separate sub-headings.

2. SERVICES

2.1 Power Supply - Electricity

It is absolutely vital that the plant has a completely reliable power supply, even a surge can cause chaos particularly in the early stages of production, causing not only loss of production but possibilities of serious damage. During the two weeks of the BI teams visit, there were six power failures varying from a few minutes to several hours. This is completely unacceptable for container manufacture.

It was stated that the reliability of the power supply was improving and that within two years the station supplying the plant would have additional equipment. However, the container manufacturing process is particularly sensitive in this area and cannot tolerate interruptions. In keeping with many other industries in Georgetown, e.g. The Corrugated Paper and Carton Factory, Guyana Liquor Corporation, Banks, D.K.H. Brewery and the Guyana Sugar Corporation, the Glass plant must have its own power supply.

At present, there are two emergency stand-by motor generators, a ½ mega-watt caterpillar set and a 1 mega-watt I.D.E. set. The latter is so connected that should the mains power fail it is automatically self-starting but at the time of the visit the automatic switch was inoperative.

When the I.S. bottle production line alone is running and taking no allowance for the decorating lehr, over 650 kw will be required. This figure will rise to over 900 kw approximately should the press line be included, and some allowance made for the maintainence of the temperature of the decorating lehr. The connected load on the heating elements of the lehr is 700 kw so that at starting up this would place a great demand on the power supply. This equipment could however be fed from the G.E.C. mains.

To allow for reliable supply it is recommended that a second motor generator be installed to twin the existing one and that these two are run in parallel, thus each could carry the full normal load of the I.S line and should one fail or require maintainance the other could take the load. A ½ kw Caterpillar generator would be stand-by equipment The most satisfactory arrangement would be to purchase a second generator from International Diesel Electrics to reduce the spares requirement and retain a consistency of performance a[illegible]ge. New switch gear would be required to make this parallel arrangement possible. With such an installation an uninterrupted power supply could be guaranteed.

2.2 Gas Supply - Liquid Petroleum Gasses

At the present moment there is no gas supply to the plant although the original intention was to use L.P.G. for the initial heat up of the furnace, for the fire finisher on the press, for the window glass line and for certain other ancilliary processes.

Gas, however, is also needed on the bottle machine, for the conveyor and for the front of the lehr and there is no provision for this.

Laying on the site is a large L.P.G. storage tank (54' 4" long x 84" diameter) with a water capacity of 14,500 U.S. gallons which has not yet been installed but the foundations for this have been prepared. It is recommended that this tank be set up on the supports already provided and that an L.P.G. system covering vapourising units, air mixer etc. be installed to supply the container line and its ancilliary equipment.

A much more important and additional use would be to fire the feeder and forehearth, currently an oil fired system, and this will be sighted under a separate recommendation.

2.3 Heavy Fuel Oil System

The heavy fuel oil line is a dead end system as opposed to a ring main system consisting of a 3" pipe with an equivalent length of approximately 1,000 feet.

The unloading facility will need replacement in that as at present arranged, a delivery from the oil company cannot be taken into the storage tank without interfering with the factory supply line. Only a single pump to fulfil both unloading and supply is at present installed.

The heater used to bring the oil to anatomising temperature is situated in the compressor house some 370 feet from the furnace. As no fuel lines are insulated, the oil temperature on arrival at the furnace will be too low for good burner performance and correct combustion, where a temperature of approximately 240° F will be required at the burner.

The average ambient temperature as reported at Timehri Airport some 7 miles from the factory falls to 70° F and an absolute minimum of 61° F. Whilst this is well above the pour point of 35° F for the oil as specified by Shell, it is some 40° F below the pumping temperature. The average maximum temperature is 87° F peaking at 100.4° F. Although an outflow heater is provided at the main storagetank, the pipeline is so long and the flow to the container furnace relatively low, there could be supply problems on this vital life-line.

The present oil line is in a trench which contains much debris and is water logged along the bottom much too close to the pipe.

It is essential that a new oil system be installed. This could either include a recirculatory system to the main storage tank or incorporate a day tank system placed near to the container furnace with a ring main circulating oil at pumping temperature. The oil would then be stepped up to atomising temperature close to the furnace itself and insulated.

The smaller gas oil (diesel) line was found to be badly corroded in places. It is essential that all the covers be taken off, the trench cleaned out and the heavy fuel oil line examined for corrosion. It is of an all welded construction and would be best if it was lifted well clear of the bottom of the trench.

In addition the instrumentation on the heavy fuel oil system is inadequate for checking temperature, pressure, tank level and flow recordings and therefore control purposes. It is recommended that a replacement system be installed incorporating a float system, pressure relief valve, filters and controls on the pre-heaters.

Totalising flow meters should be used for each large consumption area e.g. furnace, forehearth, sand drier.

(A more detailed appraisal of the existing system is given in the section on the furnace which should be read in conjunction with the above).

2.4 Gas Oil Line (Diesel)

The unloading facility must be modified so that it is completely independent of the factory supply line.

This pipe of 2" diameter like the heavy fuel oil system is very long and is used to supply the lehrs and at present the forehearths. Whilst not presenting the same problem as the heavy fuel oil line, it must be examined for current corrosion. The gas oil supply to the sand and aragonite dryer is very badly corroded and needs replacing.

The reason for taking an off feed from after the existing meter all the way back to the sand drier is difficult to understand. The feed could be taken directly from the first pump house (i.e. 50 metres rather than 200 metres) with the appropriate control valves at the drier itself.

Further instrumentation is required comprising fuel pressure gauge, flow meter and float system.

Water

The current water supply system is adequate except that a deep well pump is required to replace the one removed. The previous pump was apparently lent to Ideal Industries and has not as yet been replaced. The stand-by centrifugal pump has been purchased. Details of the Well Pump House are given in Appendix 1.

The replacement of the pump is essential as failure of the water supply under manufacturing conditions would have disastrous effects. The pump drive motor should be replaced with one of the correct H.P. as shown in the drawings.

The quality of the water is satisfactory for factory operations. A typical analysis is included as Appendix II

2.6 Compressed Air

The facilities available in the Compressor House will create an adequate supply of compressed air for all purposes and only minor work is necessary. The water cooling system requires a thorough check to assure adequate fixing e.g. connecting pipes should be supported to avoid fracture.

A dry air system is essential for the operation of the instruments. The current system is non-operational and needs repair or replacement. It is recommended however that a completely independent system for dry oil free instrument air be installed using a small 100 p.s.i. oil free compressor and drier. This would not be a major cost item.

Detail of the compressors and comments are included as Appendix III

3. RAW MATERIALS

3.1 Sand

The whole Yarrowkabra locality, in which the factory is situated, consists of an extensive deposit of white sand. The deposit is at least five miles long and a mile wide with an average reported depth of about 50 feet. The total amount of material available is incalculable but runs into many millions of tonnes.

An area about 250 by 100 yards has been cleared to the west of the factory compound. Some sand has already been removed for construction purposes. This cleared area alone however still contains some 0.25 million tonnes of recoverable sand. At 25 tonnes/day of glass which represents about 5,000 t.p.a. sand usage there is about 50 years supply.

To check the consistency of the deposit five samples were taken from various parts of the cleared site. The chemical analyses show the sand to be over 99% silica (SiO2) about 0.01% Fe_2O_3 and with a carbon content of 0.088%.

The chemical analysis indicates a very pure sand suitable for colourless glass containers and good quality pressed ware. The carbon content is unusually high for a sand of this quality and may, if it is variable, cause some colour variations in both flint and amber glasses. Analysis results are included in Appendix IV.

The grading of the samples taken showed potential melting problems in that the material from the cleared area showed sand too coarse for good glassmaking. The examination indicated the presence of of significant number of quartz grains up to 3 or 4 mm in diameter. Sand with this level of grains over 1mm (average 10% of sample) cannot be used as its use would cause constant problems in the glass from unmelted sand grains. This would lead to the scrapping of large numbers of bottles even at a low furnace pull rate.

These large particles will need to be removed. The only effective method of removal is by wet sieving. This would best be carried out in the quarry or in the cleared area to the west of the sand drier. A simple plant only is required and is briefly described in Appendix V. This plant must be built before the factory begins operation. This will be a major cost item. The sieve analysis is given as Appendix VI.

The wet sieving plant as well as removing the coarse particles which will not melt, will also perform two other functions:

1) It will remove most of the organic material present thus eliminating any potential colour problems from this source.

2) It will remove some of the fines. The removal of the very fine particles will reduce potential carryover problems in the furnace. Carryover of fine particles into the furnace regenerator can reduce furnace life and efficiency.

After washing the material can be left in the open, on a sand base, to drain. This material should normally drain to 4 or 5% moisture over 2-3 days. It would be as well however to stockpile some 3 or 400 tonnes of material under cover to prevent problems of having to dry very wet sand during long periods of heavy rain. This material could easily be held in the drier building.

3.2 Yarrowkabra Sand Deposit : Historical Note

The chemical quality of this sand is consistently excellent and matched only by very few deposits in the world.

The silica content is very high, the level of impurities low, and of iron in particular, very low. Thus chemically the sand can be used for top quality pressed ware as well as container and sheet glass, sodium silicate and silicon carbide manufacture.

Initial samples examined by General Class and Rockware International must have been taken from a small finer area of the deposit. These samples could be used as is for glass making. Unfortunately however, they are not representative of the bulk of the sand and show the grading to be better than it really is.

The more detailed examination of the sand following the RI visit indicated the material generally to be too coarse to be used as is for glass making.

This corroborates the work of other investigators.

The Yarrowkabra area (near the glassworks) has been an area of particular study due to its convenient location.

There is in existence an extensive report surveying the Guyanese white sand deposits and their possible markets. (Report on Quartz Sand Utilisation by K. Livan 1977).

In 1981 Floatex of Crick Northamptonshire put forward a design and quotation for a sand washing plant to Meverex of Cradley Heath. Meverex were acting as consultants to a foundry(ies) in Guyana and the proposal was for a 40 t.p.h. plant capable of producing an extremely good grade of sand primarily suitable for glass and foundry uses.

The plant recommended was more sophisticated and larger than the one suggested but would produce material for a number of industries. It may be possible to look upon this as a separate enterprise with the glassworks being merely one, albeit a major customer.

?I have obtained a copy of the report. Some consideration might be given to this project for both internal use and possible export.

3.3 Soda Ash

The soda ash is from Allied Chemicals plant at Green River Wyoming. Allied are one of five companies producing high quality dense ash from extensive natural deposits of trona, a mixture of sodium carbonate and bicarbonate. The products from all five producers are used all over the world including the U.K.

Provided this material is stored and handled properly from the ship to the batch plant it is unlikely to cause any problems.

Soda Ash is highly soluble in water and will in fact pick up moisture from the air to form a hydrate. The hydrated material sets hard in large lumps or forms a hard skin over the pile of ash. Once this has happened the hydrated material cannot be conveyed, weighed or mixed until it has been crushed down to powder form again.

Due to the way it has been handled and stored the existing stock of soda ash has been significantly affected by hydration.

The main area designated for storage theoretically capable of holding over 1800 tonnes probably contains about 1300 tonnes. The remaining material is not stored in the second designated area but spread out over a large area overflowing into space designated for other storage.

The material in the main bay is only slightly affected by hydration. The remaining material, however, is extensively hydrated and is set hard in large lumps. These will require crushing before use. It is recommended that it be crushed in small quantities, say a skip at a time in the cullet crusher. The work should be done on a dry day, and the material removed to the batch plant silo immediately after crushing.

To minimise the hydration reaction and its subsequent problems the soda ash should not be handled in the rain or stored outside. It should be stored under cover with minimum surface exposure to the air.

This is most effectively done by storing in a series of narrow bays about 10-12" wide and about 10' high. The material is used from one bay at a time being recovered by a front end loader from one end only. Each bay should be sealed off until required.

It is recommended that the whole of the Areas A and C (marked Soda Ash and Feldspar respectively) should be divided up in this way.

Storing and handling in this manner would reduce losses and inconvenience from hydration to negligible levels.

Overall the stock currently on site is acceptable for glassmaking given the above comments.

3.4 Dolomite

This material is only essential for flat glass. It is not necessary for container glass. Since, however, the material is on site and has been paid for, it would be sensible to use it.

The batch formulation to be used initially should include a small amount of dolomite to use it up. Once it has been used up dolomite should not be re-ordered until and unless flat glass manufacture is started.

The material from Ohio Lime, shipped in 1 hundred weight bags, is used for glass manufacture in the U.S.A. Its chemical and grading specifications are suitable. It has a very low iron content.

3.5 Aragonite

Aragonite is calcium carbonate in a different crystal form from limestone. This particular material occurs naturally in the Bahamas and is imported extensively into Guyana for sugar refining. Any material suitable for sugar refining is almost certainly chemically suitable for glass making. The initial analysis confirms this. The presence of strontium in significant amounts is interesting but does not affect the suitability of the material. Samples taken to check the consistency are satisfactory. One of the samples shows a lower CaO level and a higher SiO_2. This is possibly due to sand contamination. The iron content is exceptionally low.

The grading of the samples is satisfactory for glass making. This material is being used for glass making in the southern U.S.A. so is unlikely to give rise to problems.

Precautions will need to be taken to see that the material is not contaminated and it should be rough screened before use to eliminate bricks, bits of timber etc. which tend to get picked up in bulk cargoes. These precautions also apply to the soda ash as well as the aragonite.

Most of the aragonite is stored outside and has become thoroughly wet. It will need drying before use. The material is quite dry when shipped and if stored under cover can be used without drying. There is room in the raw materials warehouse to do this once the soda ash storage is properly organised.

Overall the material on site is acceptable for glassmaking.

3.6 Feldspar

This material has been imported, again in one hundred weight bags, from Feldspar Corporation North Carolina.

To cut costs in future it is recommended that this material be imported in bulk. This procedure would save up to $G 50.00 per tonne. It is inert and requires no special precautions. As with the aragonite it only needs to be kept dry and free from contamination.

The material is used extensively for glass making in the U.S.A. and is of excellent consistent quality.

3.7 Sodium Sulphate

Again this material is imported from the U.S.A. in 1 hundred weight bags. Like soda ash it is soluble in water and prone to hydration. Some hydration has occurred but it is not significant. To minimise hydration the bags should only be split just before use. It is recommended that this material be treated as an additive and weighed out on the small scale. It should not be put in the silo hopper to be fed into the main weigh hopper as it will cake solid. It is suitable for glassmaking purposes.

3.8 Sodium Nitrate

Sodium nitrate, whilst useful, is not essential for flint glass manufacture. Good colour can be maintained by the use of saltcake and arsenic in conjunction with the selenium.

The material here is stored in bags and has been extensively affected by hydration. Many bags are set rock hard and the material will have to be crushed before use.

It is understood that some of this material has been sold to a chemical company. It is recommended that if possible it would be best to sell off the rest.

The recommended batch does not incorporate sodium nitrate and it has not been included in any theoretical calculations

3.9 Iron Pyrites

This material is stored in paper sacks. Some have set hard but the material seems to powder again easily. The material is only required for amber glass and should store without trouble until required.

3.10 Cullet

Crushed cullet was stored in three concrete bays constructed for this purpose. Two bays contained about 150 tonnes altogether of white flint and one bay about 200 tonnes of amber. The materials both contained a significant number of crown corks but otherwise were clean and uncontaminated.

A somewhat battered shelter obviously intended to protect people hand sorting the cullet is on site. A few oil drums were visible containing cullet and several piles of crown corks were dotted about the area. Obviously a start had been made on hand sorting at some time. All the material in the bays should be hand sorted and passed through the crusher before use. The magnet in the exit chute should remove most of the remaining crown corks.

It is strongly recommended that at least one more magnet, and preferably two, be placed over the mixed batch conveyor to remove the remaining metal contamination. Contamination of this nature reaching the furnace will affect the bottom of the melting tank and penetrate the refractories. In view of the design of the furnace, i.e. unpaved furnace bottom, it is essential that all tramp metal is removed from the cullet and batch before delivery to the furnace.

3.11 Arsenic and Selenium

These materials are contained in drums as normal. One drum of each was opened and the contents found to be in satisfactory condition.

Some drums did appear to have deteriorated due to attack by nitrate. It is recommended that they be placed in pallets to minimise this attack.

4. SITE TREATMENT OF RAW MATERIALS

4.1 Wet Sieving

As indicated in the earlier section there is a requirement to wet sieve the sand before delivery to the site for drying.

4.2 Drying

A 15 t.p.h. rotary drier has been erected on site. It is fed by a 40 t.p.h. bucket elevator and the dry material is removed by a 40 t.p.h. conveyor. The drier is intended to handle the sand and aragonite. The dried material being diverted into the appropriate bay by a two way chute at the end of a conveyor. The feed to the hopper of the bucket elevator is via a platform, a double deck vibratory screen and steel chute.

The arrangement requires one man to shovel the material onto the screen and another man to push it down the chute into the boot of the bucket elevator. By removing the equipment the material can be fed from the shovel directly into the boot of the bucket elevator. The top 1 inch screen will remove tramp material e.g. roots, branches from the sand and bricks, planks etc. from the aragonite.

This could equally well be done by merely placing a 1 inch or 2 inch grid over the top of the elevator feed hopper.

The bottom screen, whose purpose appears to be to remove fines, is far too fine to be effective. The damp sand and aragonite simply do not pass through.

Neither screen will effectively remove the coarse (i.e. the + 1mm fraction) material from the sand.

The whole arrangement merely impedes direct feeding of the material to the drier and interjects an unnecessary requirement for two men whilst the drier is running.

The platform, screen and chute should be removed from this present position before start up. The screen, with a top deck and solid bottom deck, plus the chute could be used in the sand washing and sieving process. They are perfectly satisfactory for this purpose.

As mentioned before, the present cargo of aragonite is thoroughly wet and will require drying before use. Subsequent cargoes if stored under cover should not require drying.

The dryer is a Dressar Industries rotary type without a cooler. It is simple, reliable and will do the job effectively, although not very economically.

The fuel consumption of the drier is estimated at 2.5 gallons per tonne which will add to the cost of the batch preparation.

Rockware International would not have advocated the use of dry sand in this plant. The batch house is designed and built to handle dry materials and at start-up this should be the case. However at a point where some operating experience has been obtained a conversion to damp sand operation would be appropriate. Some economy in operation could be achieved using a wet sand operation with minor modifications.

4.3 Raw Material : Existing stocks and cost

Details of assessed stocks and raw material costs are given in Appendix VII.

5. BATCH PLANT

A full description of the batch house and its intended operation is given in Appendix VIII. Overall the basic facility is sound although certain actions will be required to be taken before start-up. These are assessed in Appendix IX together with assessments of action to be taken on the raw materials and batch handling operation.

One major ommission is the provision of an operating manual or a description of the batch handling system. This will need to be compiled before assessments on manning and operation can be made. In addition an assessed six weeks of expert assistance from Toledo Engineering personnel is required to commission the weighing system together with a repair to the 100lb scale.

5.1 Batch and Raw Material Handling Equipment Capacities

Full details of the various capacities of raw material and batch handling and storage equipment are given in Appendix X.

6. BATCH AND GLASS COMPOSITION

During the various investigations carried out at Guyana Glassworks several batch formulae have been put forward. Rockware International have completed analyses of raw materials as described above and have drawn up recommended batches.

These batches are similar to those already suggested but with some important modifications.

The flux levels, i.e. soda plus potash and lime plus magnesia are similar to those recommended in the Persson report, but it is suggested that less alumina is required. The lower feldspar usage will show considerable batch cost savings.

The flint and amber batches are the same except for the different colourants added. The suggested levels of pyrites and carbon in the amber will probably have to be modified according to the actual colour produced. This is normal.

The use of dolomite is not essential and its elimination will give further savings. Two batches are thus given for each glass, one with dolomite to use up the material in stock and the preferred one without the use of dolomite.

As mentioned earlier, nitrate is not included in the first batch as it is not necessary and is difficult to handle in the hot, humid climate.

Depending on the actual colour produced it may also be possible to do without selenium in the flint glass batch.

The iron content of all raw materials is very low and trial melts in the Rockware Technical Centre show exceedingly good colour. Provided care is taken on separating iron from the cullet and amber cullet from flint cullet this good colour should be achieved in practice thus eliminating the use of an unpleasant and expensive material.

The batches are shown in Tables 1, 2, 3 and 4 along with target compositions.

The full calculations are shown in Appendix XI.

TABLE 1

6.1 FLINT GLASS (WITHOUT DOLOMITE)

BATCH		COMPOSITION		
Sand	1000	SiO_2	73.2	
Soda Ash	330	Na_2O	13.9	
Aragonite	285	K_2O	0.3	
Feldspar	100	CaO	10.7	
Saltcake	10	MgO	0.06	
Arsenic	0.8	SrO	0.22	neglecting decolouriser
		Al_2O_3	1.28	
		Fe_2O_3	0.02	Fusin Factor 84.4%
		SO_3	0.30	
		As_2O_3	0.05	

Theoretical Batch redox + 13.4

TABLE 2

6.2 AMBER GLASS (WITHOUT DOLOMITE)

BATCH		COMPOSITION		
Sand	1000	SiO_2	73.1	
Soda Ash	330	Na_2O	13.8	
Aragonite	285	K_2O	0.3	
Feldspar	100	CaO	10.7	
Saltcake	10	MgO	0.06	
Pyrites	2	SrO	0.22	
Carbon	8	Al_2O_3	1.27	
(Charcoal)		Fe_2O_3	0.11	Fusion Factor 84.1%
		SO_3	0.4	

Theoretical Batch redox - 23.4

TABLE 3

6.3 FLINT GLASS (WITH DOLOMITE)

BATCH		COMPOSITION		
Sand	1000	SiO_2	73.3	
Soda Ash	330	Na_2O	13.9	
Aragonite	250	K_2O	0.3	
Dolomite	35	CaO	10.1	
Feldspar	100	MgO	0.6	
Saltcake	10	SrO	0.22	
Arsenic	0.8	Al_2O_3	1.28	neglecting decolouriser
		SO_3	0.3	
		As_2O_3	0.05	

Fusion Factor 84.4%

Theoretical Batch redox + 13.4

TABLE 4

6.4 AMBER GLASS (WITH DOLOMITE)

BATCH		COMPOSITION	
Sand	1000	SiO_2	73.1
		Na_2O	13.8
Soda Ash	330	K_2O	0.3
Aragonite	250	CaO	10.1
Dolomite	35	MgO	0.57
Feldspar	100	SrO	0.20
Saltcake	10	Al_2O_3	1.28
Pyrites	2	Fe_2O_3	0.11
Carbon	8	SO_3	0.50

Fusion Factor 83.7%

Theoretical Batch redox - 23.4

6.5 Glass - Sample Melt

An experimental melt was carried out in the laboratory using the materials carried back from Guyana. These were graded and prepared using a standard batch formula.

A sample will be sent to Guyana Glassworks and details of the melts are given in Appendix XII. The glass produced was excellent in colour and acceptable for both container glass and tableware although there were some further indications of the need to wet sieve the sand before use.

7. FURNACE

7.1 General Appraisal

The furnace is the key operational and cost item in any glass plant.

The furnace built at Guyana Glassworks appears to be a cross between a unit melter type and an old type end fired regenerative furnace with a form of over port firing. It is an old design and will be comparitively very inefficient especially at the low load now required. The melting end area is 31 sq.m. approximately. A modern design of the same physical size would melt 90 tonnes per day as opposed to the rated 45-50 tonnes per day.

There is no insulation on the side walls, regenerators, furnace crown or other parts of the structure except at the top of the regenerator where an inefficient type of insulation has been applied. The side walls are of high conductivity electrocast materials and the heat losses from these will be considerable adding up to 20% to the total.

The glass depth in the furnace is 34" which is too shallow for a normal life furnace of approximately five years on a nominal load of colourless glass. The furnace bottom is of siliminite and is not paved. The bottom will run very hot and this will reduce furnace life and increase heat loss. The proposed low load will ease this situation and reduce wear on the furnace bottom but not significantly in terms of expected furnace life.

Examination of the furnace interior indicated signs of diversion from the drawings supplied, a poor level of bricklaying and construction and that two critical blocks were missing from the throat area. Had this discovery not been made, an attempted start-up would have resulted in serious problems.

The furnace will, after minor modifications and inclusion of the two ommitted blocks, melt the required tonnage albeit at a very high fuel consumption.

The heat recovery, a vital factor in thermal efficiency, of the regenerators is too low, the relevant ratio being approximately half that of current modern practice. The port area ratio is also on the small side but can be coped with unless the furnace load is increased, in which case it could pose some difficulties.

The instrumentation on the furnace is not comprehensive and the existing level control instrument should be replaced. Two optical pyrometers for temperature measurement are required and were not available on site.

In terms of fuel consumption the information supplied by the contractors was of no help and there appears to be no operating experience of a furnace of this type. Theoretical calculations based on Rockware experience and design work and comparisons to appropriate furnaces have been completed. These calculations have been made in reference also to the various existing calculations, i.e. those of K. Badelt, Chinese Delegation, H.B. Persson, N. Crandon and comparative figures from J.A. Lamond.

It is Rockware International's assessment that the potential fuel consumption of the furnace will be in the region of 3038 Imperial Gallons at a 25 tonnes per 24 hour load. (3952 Imperial Gallons at 50 tonnes load per 24 hours). This is a total of 121.5 Imperial Gallons per tonne of glass at 25 tonnes load, 79 Imperial Gallons at 50 tonne load.

A furnace of modern design and construction pulling at its rated load would consume between 35-40 Imperial Gallons per tonne of glass. Pulling on a load below its rated value this consumption would rise, but still be below the consumption figure for Guyana Glassworks furnace (i.e. 45-50 Imperial Gallons per tonne).

There is no method of providing draft to the furnace should the ejector fan require maintenance or fuel. Alternative provision is essential and must be made.

The oil supply is referred to in detail elsewhere but the reversal panel for the furnace requires replacement. The fuel flow needs to be monitored and recorded for this most important cost centre.

The various constraining factors given above indicates the expected life of the furnace under normal operating conditions to be 2 years following the essential work and alterations.

It is obvious therefore that for the plant to continue in operation a new furnace will be required in year 3 of production. The estimated cost of a replacement furnace at a daily tonnage of up to 40 tonnes to account for increased demand would be in excess of £(sterling) 1 million. This furnace however would be fuel efficient and possibly require no civil changes to the factory layout, foundations etc.

Major structural changes to the furnace to improve its operational efficiency are possible but would not extend the furnace life or reduce costs enough to give a financial payback.

A full technical review of structural and operational aspects of the furnace is included in Appendix XIII.

A full review of the design aspects of the furnace is included in Appendix XIV.

8. BOTTLE PRODUCTION LINE

8.1 Forehearth and Feeder

The forehearth and feeder is of a design fired by oil and whilst this will work it is not compatible with the control needed for providing containers to international standards. Experienced personnel could operate the oil fired forehearth with some degree of control but given the lack of indigenous experience in glassmaking this would be a severe problem area. It should be noted that there are no oil fired forehearths operating in the United Kingdom or Europe. Rockware International have knowledge of only one operating in the Far East but this is about to be replaced.

Temperature control in the region of $\pm 1^{\circ}$ C is required to perform to the required standards and this would be most difficult if not impossible with the existing facilities.

The spout is a standard one required for the 144 type feeder and not deep well type as specified in the General Glass works contract. Whilst this is perfectly satisfactory for the 10 oz capacity beers and minerals on the 6 section I.S. single gob machine, it is towards the limit of its range for the bigger bottles.

In the light of this ware range limitation and the performance of the forehearth, it is recommended that the complete forehearth and feeder facility be replaced by a modern gas-fired type. This would require the L.P.G. installation to be completed. The total activity would be a major cost item but would give Guyana Glassworks a much more efficient cost effective unit and the opportunity to produce at the required speeds and quality standards.

The existing forehearth channel construction is incorrect resulting in the spout bowl being ½" lower than the channel block. The spout depth has been decreased by ½" to bring it level with the top of the channel block. Additionally the thermocouple hole has not been drilled in the spout and the thermocouple hole position in the channel is incorrect i.e. ½" below the glass level line. The glass level control system is of an old design. A more reliable system for this critical production area should be installed.

The use of radiation pyrometers will give better temperature measurement and therefore control.

Full detail of the existing forehearth and feeder is given in Appendix XV.

8.2 Machine to Lehr Entry

The Maul Bros. 6 section I.S. Single Gob machine is in good condition and is 'dry-run' several times each week. This is essential to retain this condition and keep the lines water free. Only minor work will be required on the I.S. machine itself and it is anticipated that its performance will allow satisfactory bottle production.

The machine conveyor and drive assembly are satisfactory. However the ware transfer unit is of an old design and would result in excessive lost time. It is of a type which requires removal and complete overhaul to fix any operating problems. Modern transfer units are constructed to allow minor repairs etc. to be carried out by interchangeable units. It is recommended that a replacement transfer unit and back-up unit be purchased. This would avoid the loss of production anticipated through the existing transfer unit failure and maintenance time.

Additionally the intention to produce flasks will cause difficulties and poor lehr stacking with excessive ware loss with the existing unit. The recommended replacement system will incorporate both straight and radial arms.

The ware stacker is of old design but in good mechanical condition. The trip mechanism is faulty but can be easily replaced.

Detailed specification of the I.S. Machine is given in Appendix XV. It should be noted that no provision has been made for firing on the conveyor or lehr entry. This is recommended to give more control in production. This activity is provided for in the comments of the proposed IPG system.

The generation of cooling air is a requirement on all bottle production machines. The existing cooling fan is adequate for this purpose but badly sited. (Static Pressure 20 inches, CFM 16,000; 75 HP, 1760 RPM on full load – overhead ducting with manual damper control). The fan is sited 5 feet from the lehr entrance and close to the machine area During the trial periods the noise level from the fan was excessive. Drawings supplied show the fan should have been sited in the basement. It is recommended that this should be done.

8.3 Annealing Lehr

Whilst the lehr is of an old design and oil fired it will anneal the bottles from the IS 6 Section single gob machine. The manufacturer is not shown on the lehr and the unit has only 2 zones. It is adequate in size being 71 ft long and 6 ft 8in inside with a belt width of 5 ft. The lehr was shown to be in good mechanical order during the trial. However with the limit of 2 zone operation some annealing difficulties may occur.

Covers were missing from the front of the lehr and no provision has been made for underbelt heating. This could cause problems with the production and some provision is recommended. All roller, drive, motor and belt guards were missing. These should be fitted before production begins.

The instrumentation by Honeywell is adequate.

It should be noted however that although muffled, gas oil does contain some sulpher and it could be that in time the lehr could give rise to "bloom" as the combustion chambers develop leaks. This is harmless but bad for the appearance of containers which are not washed, for washed containers it does not cause a problem. It does however cause difficulties for the spirit containers and also poses a problem with decorating.

At a later date the lehr could be converted to L.P.G. firing which is sulpher free or replaced by a modern lehr.

8.4 Cold End and Inspection

The cold end is currently equipped with a lehr unloader/unscrambler, 37ft of track and an accumulating table from which the production is intended to be packed. This area is further equipped with inspection machines comprising Powers dual head gauge, Dodge SCR Squeeze tester and an EIM Model 317 Check Detector.

The dual head gauge and squeeze tester operated satisfactorily during the trial but the check detector had no drive motor and could not be run. The track plates in the conveyor were of the Delrin type material and will not stand up to damage caused by cullet from lehr and handling breakage. The visual inspection screen is poorly sited on the accummulating table and the overall lighting in the inspection area is poor.

It is recommended that the conveyor track be replaced with a more durable type of plate i.e. stainless steel. The check detector should be removed as it is a complicated piece of equipment to set up and maintain. Given the lack of local knowledge and back-up it will be more of a problem than it is of value. Lighting should be improved and a second screen installed.

However the major recommendation is to revert to a simple lehr-end sorting system with emphasis on manual sorting and handling. This would improve performance and reduce losses and operational difficulties on the inspection machines.

8.5 Decorating Facility

The decorating facility as presently laid out is incomplete. The facility consists of 2 Strutz semi-automatic body and shoulder decorating machines with electric drive. The machines feed a curved 16ft conveyor running across the lehr front where the decorated bottles would be hand fed into the lehr. The machines are in good mechanical order and were trial run. However the layout requires personnel loading the lehr to lean across the conveyor to place ware on the lehr belt. A stacker should be purchased to replace this potentially problematical layout or the conveyor layout redesigned.

The lehr is of unknown manufacture and fired by electricity, but is well equipped with instrumentation. It is 78ft long and 5ft wide with 6 zones. It was not possible to trial the lehr because the drive motor was missing. Again the lighting in and around the decorating facility was poor. Good lighting in this area is essential for visual quality checking.

In the light of the variable performance of decorating screens and to give flexibility to local demand it is recommended that a screen production unit be installed in the decorating area. A facility could be set up at low cost which would give reliable service to the decorating machines.

9. ANCILLIARY SERVICES

9.1 Warehousing and Storage

The current purchasing practices of Guyana Glassworks potential customers are geared to the import of containers. Production of containers by Guyana Glassworks will give the opportunity to review the existing pattern. This is essential as there is inadequate space for storage of finished goods.

Containers awaiting decoration will take up much of the space remaining in the production hall. However space not taken in the flat glass area can be used. This will not however offer a large stock holding volume. Some storage will be possible outside. If this is to be considered basic shrink-wrapping equipment and pallet purchases must be made.

The problem will depend on the storage and holding facilities of customers and their willingness to hold stocks. It will also be useful to designate an area for resorting of packed containers to eliminate faulty ware following Quality Control checks and customer complaints.

9.2 Machine Repair Shop

The area currently designated Machine Repair Shop is more appropriate to the Mould Repair Shop and is regarded as such for the purpose of this report.

The facility is reasonably well equipped comprising:

MACHINE	SIZE	MANUFACTURER
1 x Lathe	16 x 14 Bed	South Bend
2 x Lathes	3.5 Bed	South Bend
2 x Drill Press	20"	Clausing
1 x Miller Rotary Table		Bridgeport
1 x Shaper		Southbend
1 x Power Saw		Excelsior
1 x Small Compresser		No name plate

The above machinery appears to be in new or good condition with the exception of a missing motor on one of the small lathes. A good selection of hand tools are available. However there is no provision for hand grinding tools or spray welding equipment. These are essential for a mould repair facility. Workbenches and cupboards will be required together with racks for tools. A pre-heating oven for preheating mould equipment before spray welding should be constructed.

9.3 Mould Cleaning and Storage Room

At the time of the visit this room was being used for storage of various items of equipment. Before start up the room should be designated as above and racks constructed for the mould equipment or similar facilities built elsewhere. The equipment in the room comprised one hydraulic press, 1 drill press and one dry blast machine. The dry blast machine was incomplete with several parts missing e.g. operator gloves, operating pedal, door catches. In addition the installation is incomplete i.e. pipework and electrics untested. This machine must be refurbished.

The hydraulic press should be removed as this is for use in the sheet glass plant. Small hand pulled trolleys should be purchased for the carriage of mould equipment to and from the production floor and repair shop.

Part of the room could be designated for small machine repair work. Larger facilities for machine repair may be required at a later stage. A set of jigs and fixtures for the production equipment is essential and should be purchased.

9.4 Mould Equipment and Design

The mould equipment on site was examined and is overall in good condition. A full list is given in Appendix XVI.The supply is adequate for the initial production with the exception of the 12oz Jam Jar equipment. Cooling tubes are required for this equipment.

The basic parison mould designs are acceptable for production purposes though not as Rockware would have ordered. In addition all neck-rings should be vented. The mould equipment for the flasks should be reverted. This venting will ease manufacturing problems. Design should be reconsidered when re-ordering takes place.

9.5 Stores and Parts Inventory

Guyana Glassworks have a comprehensive stock of spares and an excellent recording and storage system. The stock is being added to daily as crates are opened and examined. These crates contain a mixture of new, old and scrap equipment. The stores level is estimated to be in excess of normal practice.

Particular items found to be required however were:-

- I.S. Machine take out mechanisms (complete)
- Shear Mechanisms (complete)
- Single gob shear holders.

9.6 Laboratory and Quality Control

A small laboratory/quality control room was located in the engineering services section. It contained two workbenches one of which was tiled and the other with a fume cupboard (no gas supply could be located).

Some of the equipment in the laboratory was being held in there for storage (i.e. 4 off ± 25g bottle weighing scales, 1 of the two polariscopes, and one 15 MHz dual trace oscilloscope). The basic items of equipment are listed below:-

2 – General Glass Polariscopes

1 – A.G.R. Pressure tester (Single head 0-400 p.s.i.)

1 – Pistorius Model D diamond wheel saw

1 – General Glass design thermal shock tank

4 – Hot bottle scales

Assorted test tubes, beakers, flasks, clamps, measuring cylinders, crucibles, chemicals (e.g. sodium carbonate and borate, acids solvents).

1 - Valance analytical pan balance

1 - Preston density comparator

1 - Sewage test apparatus (i.e. for dissolved oxygen, etc.)

A large number of power points were located around the laboratory and a shower was located from the ceiling near the door, presumably for use in emergencies. No microscope, seedscope, inhomogeneity measurement system, bunsen burners or sieving systems could be located in the laboratory.

Overall the laboratory is reasonably well equipped although some re-ordering of the more frequently used consumables would have to be completed on confirmation of start-up.

The following additional items should be purchased - one simple polarising microscope with Babinet compensator attached, sieving equipment for raw material examination and a gas cylinder for supply to the benches.

Quality Control Department supplies a very valuable service to the Production department and Inspection department. A high level of ability is required from its personnel.

9.7 Additional Technical Requirements

The complete glass plant includes many major complicated items of equipment. Each will require a separate operating and maintenance manual. In addition a preventive maintenance programme will be required. Much work will be required to produce a series of manuals adequate to allow the operation of the glassworks without massive production downtime covered by failure in any one area.

9.8 Lynch PBM Pressware Line

The forehearth for this line is shorter (14ft 7½in) than that on the bottle production line. The firing system is incomplete as is the temperature control system. The assembly has no feeder platform and the gob delivery system is incomplete. In addition there is no gob disposal chute provided. The shear cooling system is also incomplete.

The Lynch PBM press has 12 heads with an off set delivery system and automatic take out. It has a 10 valve timer system but this is not installed. The air receiver is 90" x 50". The machine could not be trial run because of incomplete installation.

The glazing machine and star wheel transfer gave no problems on the trial run. The stacker could not be run and the trip mechanism had not been fitted.

The lehr on this line is the same as the bottle line and the same comments apply. There is no single line unit to the lehr entry. The lehr could not be trial run because the drive motor was missing.

APPENDICES

WELL PUMP HOUSE

APPENDIX I

Well Depth	60 ft
Casing Size	10" I.D.
Pump Manufacturer	Allis - Chalmers
Pump Series	2,000
Pump Model	150
Pump Capacity	300 G.P.M.
Pump Height Capacity	200 Ft Head
Impeller Diameter	7.22
Drive Motor Manufacture	Baldor
H.P.	26
R.P.M.	3,525
Storage Tank Capacity	100,000 Gallon

WATER SAMPLE FROM TIMEHRI AIRPORT 20.4.81

Analysis

Colour (Hazen Units)	less than 5
Temperature	-
Appearance	Clear
Reaction pH	-
Specific conductivity	1.53×10^2
Free Acidity as CO_2	-
Ammonical N	Nil
Albuninoid N	Nil
Nitrite N	Nil
Nitrate N	0.08
Oxygen absorbed from acid $KMnO_4$	-
Total hardness as $CaCO_3$	27.5
Carbonate hardness as $CaCO_3$	27.5
Non-carbonate hardness	Nil
Total alkalinity as $CaCO_3$	148
Total solids at 105°C	245
Total fixed solids at 470°C	157
Total volatile solids at 470°C	88
T.D.S. at 105°C	97
Total suspended solids	148
Iron as Fe	0.0118 ppm
Calcium as Ca	9.1
Magnesium as Mg	4.4
Sodium as Na	37.3
Potassium as K	3.[illegible]
Chlorides as Cl	29.75
Sulphate as SO_4	-
Nitrate as NO_3	0.35
Dissolved oxygen	5.7
B.O.D.	1.35
Fluoride as F	2.8
Bicarbonate as HCO_3	90.28
Carbonate as CO_3	-
Nitrite as NO_2	Nil

Comment — Fluoride above level
Fairly clean water

COMPRESSOR HOUSE

APPENDIX III

Number of Compressors	5
Manufacturer	Ingersol Rand
Model	Pack-Air, Screw Type

1 & 2 Compressor Details

H.P.	100
Maximum Discharge	125 P.S.I.G.
Rated Operating Pressure	115 P.S.I.G.
C.F.M.	590
Water Cooled	Yes
After Cooler	Yes

3, 4 & 5 Compressors

H.P.	100
Maximum Dishcarge	110 P.S.I.G.
Rated Operating Pressure	100 P.S.I.G.
C.F.M.	490
Water Cooled	Yes
After Cooler	Yes

Comments

Equipment trialled - 60 P.S.I. on main receiver with 2 compressors running and all No. 1 line equipment running; 50 P.S.I. at secondary receiver.

Dry air system for instrumentation inoperative.

APPENDIX IV

ROCKWARE GLASS LTD.
ANALYTICAL REQUEST/REPORT FORM

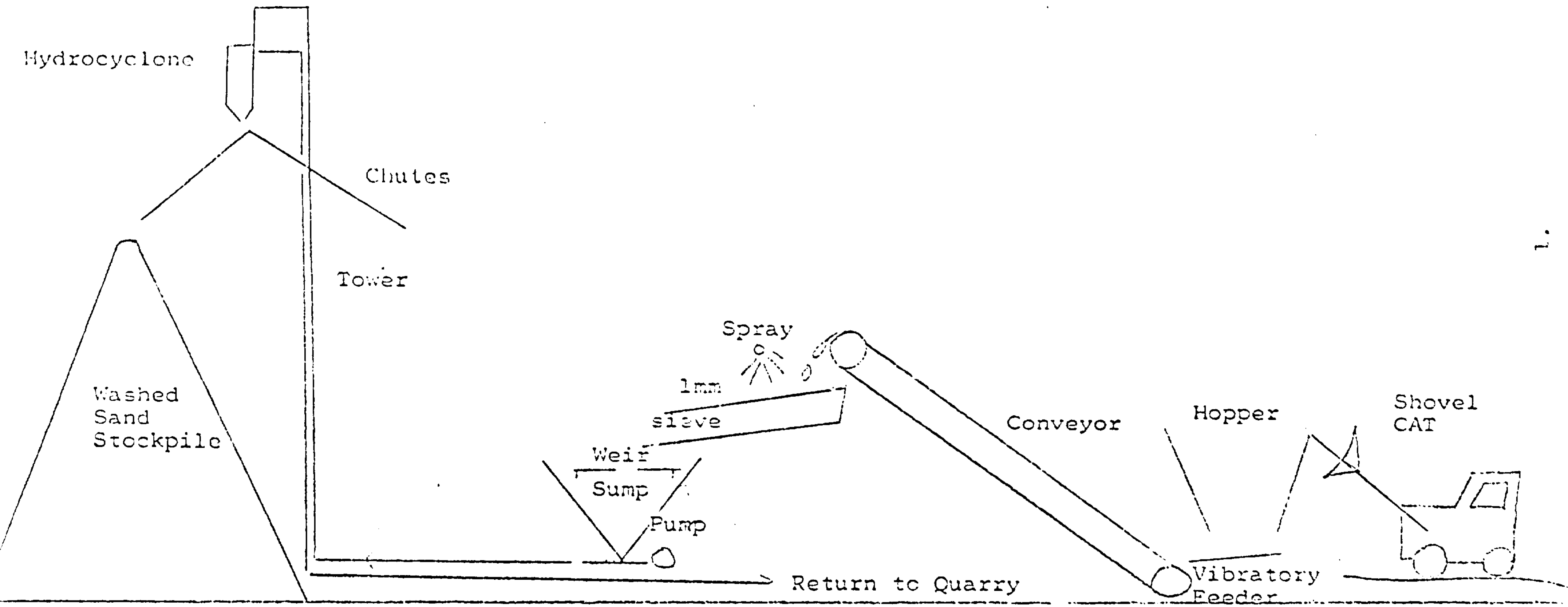
Origin Guyana Glass R.I. (N) 70 Date 25.10.82 Request by R.I. (N) Jar

Material	Sand →				
Identification	Position 1 LH Top (20.10.82) →	2 LH Middle	3 RH Bottom	4 RH Bottom	5 RH Middle
Lab. No.	C2866*	C2867*	C2868*	C2869*	C2870*
SiO_2	99.8	99.8	99.8	99.8	99.7
Na_2O	<0.01	<0.01	<0.01	<0.01	<0.01
K_2O	<0.01	<0.01	<0.01	<0.01	<0.01
CaO	<0.01	<0.01	<0.01	<0.01	<0.01
MgO	<0.01	<0.01	<0.01	<0.01	<0.01
BaO					
TiO_2	0.04	0.04	<0.01	0.04	0.03
Al_2O_3	0.04	0.04	0.04	0.04	0.04
Fe_2O_3	0.010	0.009	0.008	0.012	0.020
Cr_2O_3					
SO_3					
F					
Loss on Ignition	0.14	0.15	0.18	0.15	0.13

Remarks

Chief Analyst

LAYOUT OF SAND SILVING AND WASHING PLANT 20 t.p.h.



ROCKWARE GLASS LTD.

SIEVE ANALYSIS REPORT

3339

Factory Guyana Glass Date 26.10.82 Request by [illegible] Jar

R.I.(D) 70

Material	Sand →				
Identification	Pos. 1 LH Top (20.10.82) →	2 LH Middle	3 LH Bottom	4 RH Bottom	5 RH Middle
Lab. No.	C2866*	C2867*	C2868*	C2869*	C2870*
MESH SIZE					
+ 4·0mm.					
– 4·0mm. + 2·8mm.	0.2	0.0	0.1	0.0	0.2
– 2·8mm. + 2·0mm.	2.3	1.4	0.0	1.9	0.7
– 2·0mm. + 1·4mm.	5.1	2.6	0.2	6.3	2.0
– 1·4mm. + 1·0mm.	9.0	4.9	1.1	10.8	4.9
– 1·0mm. + 710μm.	13.4	8.1	3.1	15.2	8.9
– 710μm. + 500μm.	20.4	12.7	6.4	21.3	15.0
– 500μm. + 355μm.	6.9	9.7	11.8	7.4	11.3
– 355μm. + 250μm.	4.7	10.2	35.5	5.4	13.4
– 250μm. + 180μm.	9.2	15.5	27.1	7.2	17.8
– 180μm. + 125μm.	11.8	16.8	8.7	9.8	12.7
– 125μm. + 90μm.	9.8	9.5	3.3	7.2	6.6
– 90μm.	7.2	8.6	2.7	7.5	6.5

Remarks

Chief Analyst

RAW MATERIAL STOCKS ON SITE

Material	Bulk or Bagged	Amount in tonnes	Location
Soda Ash	Bulk	1826*	Raw Material Bond.
Aragonite	Bulk	1292*	About 800 tonnes in cullet bays outside. Remainder in drier house bays.
Feldspar	Bagged	433	Raw Material Bond.
Dolomite	"	46.6	" " "
Salt Cake	"	46.5	" " "
Iron Pyrites	"	18.1	" " "
Sodium Nitrate	"	11.5	" " "
Arsenic	Drums	4.4	" " "
Selenium	"	600 Kgs.	" " "

* Estimated - Allowing 10% losses of material invoiced.

At 50 tonnes of batch/day this represents about 6 months supply of all major materials and 12 months of pyrites and selenium.

RAW MATERIAL COSTS - DELIVERED

Material	Cost/tonne ($ Guyanese)	5$ Guyanese = £1
Sand (Delivered, undried)	5*△	* Estimated by DCB
Soda Ash	393.8+	
Aragonite	90.1+△	
Dolomite	497.4+	
Feldspar	482.0+	
Saltcake	648.4+	
Sodium Nitrate	797+	
Arsenic	2957+	
Iron Pyrites	1091.4+	
Charcoal	320*+	Estimated from cost per bag at Willems
Selenium	87.21/Kg.+	

\+ Cost is amount invoiced divided by materials in stock after losses. Source G. Martindale CGL Accountant. In case of soda ash and aragonite losses assumed to be 10% of stated delivered weight. All other materials actual weights.

All costs are delivered to the factory and include c.i.f. Georgetown plus unloading charge and transport in 5 tonne tipper lorries from jetty to plant.

△ Sand and aragonite will also carry a drying cost. This is estimated at 15$ Guyanese per tonne, 11$ Guyanese/tonne fuel costs at 11 litres (2.5 galls.) diesel/tonne of material $1/litre plus labour and electricity.

The plant consists of two concentric steel cylinders 24 feet and 36 feet in diameter. They are tapered at the top and the total height to the top of the main structure is some 66 feet. A 10 foot high cabin on top encloses a short cross conveyor and turnhead arrangement for the raw materials distribution.

Total capacity is about 1500 tonnes in one central and nine radial bins.

Materials are raised by three bucket elevators, one for all the raw materials, feeding the various bins via a short cross conveyor and turnhead; one for window glass cullet, feeding directly via a chute into a radial bin; one for all container glass cullet with double flaps diverting material down one of three chutes into the appropriate radial bin, one each for flint, amber and green.

The design and operation philosophy is the same as Rockware's Wheatley plant in England. The plant is designed to handle dry, free flowing materials only.

All materials are raised to the top of the silo and fed directly from the bottom into a single cumulative weigh hopper They are then fed into a collecting conveyor which carries them to a Munson GB60 mixer.

The scale system is Toledo with a steel yard connecting to the single scale dial FSD 5000 lbs. There is also a load cell which feeds a single digital weight display. The system is described as an Automatic, Single Scale, Eight Material, Two Formula, Glass Batching System.

The two batch formulae are flat glass and container glass.
All container glass formula will be identical except for the colourants which are added separately outside the automatic system.

The automatic operation of the plant is controlled by a small Texas Instruments (Tl) computer.

A Tare Module is fitted to current for varying tare weights, the sequence signals are generated by the Batcher Module and the weights can be displayed on the Digital Indicator or printed out by an Addo-X machine via the Printer Coupler.

Manual control of the plant can be taken over at anytime by the Auto/Manual switch on the front panel.

All target weights, dribble and present prints and tolerances are set for each material by means of thumb wheels on the front panel.

There is provision for manual operation of weights under tolerances. There is also provision for reject of above tolerances.

All materials are fed from short chutes into the cone shaped weigh hopper by means of two speed FMC Syntron vibrating tray feeders.

There is an excellent mimic diagram with the main power on/off switch. Indicator lights are incorporated, as would be expected, showing conveyors, elevators, mixer running, etc. also turnhead position and bin levels.

Although bin low level lights are shown on the mimic there was no sign of a low level device in any of the silo bins.

There is no access to the central bin. Access to the radial bins is limited to the 1ft square panels in the upper taper containing the high level indicators and 18in circular batches on the underside of the bottom taper.

The bottom 20 feet of the radial bins is dead space and will have to be filled (sand being the obvious choice of material) before operations can begin.

A separate 100 lb Toledo platform scale and small mixer are provided for weighing and mixing the minor ingredients. The platform scale does not work and the mixer only has a container without lid. Before operations can start the scale must be repaired and at least another two or three mixer containers plus lids, either purchased or fabricated.

The addition of the ingredients is not included in the automatic system. They will always have to be added manually to each batch. Addition is made via a small access hopper chute onto the end of the collecting conveyor belt.

A covered brick annexe allows plenty of room for the storage, weighing and mixing of the minor ingredients. Drums and containers for storing the materials and premises will be required before the plant can be operated. The maximum usable volume of the weigh hopper is about 90 cu. ft. which at 30% cullet represents about 8000 lbs. of batch.

According to the handbook provided the nominal capacity of the Munson mixer is 60 cu. ft. and the maximum recommended weight of batch is 7500 lbs.

This latter figure seems optimistic. If the 60 cubic ft refers to the batch volume then at 30% cullet this represents just over 5000 lbs. of batch.

In any case the limiting factor on batch size would appear to be the weigh scale capacity which is 5000 lbs. full scale deflection.

This is a satisfactory size of batch in relation to furnace sizes.

Batch can be diverted from the mixer discharge onto the ground via a reject chute, if this proves to be necessary. In Persson's report mention is made of a facility for sweeping the batch from the mixed batch conveyor. There was however no sign of this facility.

The inclined mixed batch conveyor is about 150 yds. long. The diverter for the flat glass batch hopper is about 120 yds. from the batch plant and the end of the bolt feeding into the container furnace batch hopper is a further 25-30 yds on.

The container glass hopper is square shape, nominal capacity 35 tonnes. It is fitted with an extensive array of baffles/splitters to reduce segregation of the dry batch.

An operating manual and full description of the Toledo scale system was available but there is no operating manual or description of the whole batch plant operation.

As the operating information was not available and the plant was not in operating condition then the cycle time is not known. Verbal information from Duffy of General Glass was 'I think it is about 10 minutes'. From observation of the plant this sounds a reasonable figure.

The plant was designed to mix about 90 tonnes of flat glass batch per day on one shift and about 60 tonnes of container glass batch per day on a second shift.

At 15 hours per day operating time this would give a requirement of 10 tonnes/hour i.e. just over 4 batches per hour. Allowing for start up times this would fit in well with an operating cycle of about 10 minutes.

BATCH HOUSE AND DRIER - ESSENTIAL ACTIONS BEFORE START-UP

REQUIREMENT	METHOD/PROCEDURE	COST/TIME
1. Remove platform, sieve and chute feeding to bucket elevator feeding to drier.	Take down timer frame work. Dissassemble chute and sieve. Demolish concrete piers - place 2" mesh metal grid over ground hopper.	Three man weeks labour
2. Crush hydrated soda ash and saltcake back to powder form.	Feed through cullet crusher at minimum setting on a DRY day. Remove as crushed immediately into batch plant storage silo.	Two man weeks. Use of shovel.
3. Refurbish or replace John Deere front end loader	-	Local Purchase.
4. Complete electrical connections in batch house. Replace lost and stolen starters.	Purchase new coils for starters. Possible help from Crandon from GNEC for one week. Also Toledo engineer one week.	Two man weeks from electricians plus one man week from Toledo engineer.
5. Fit 2" metal mesh or grid over feed hopper to R.M. bucket elevator.	Purchase	Two man days labour.
6. Install and commission Toledo electronic fittings and instruct in use.	All parts in sotre. Bring Toledo engineer to site.	Three to four man weeks of Toledo service engineer's time.
7. Complete connection of compressed air supplies. Strip down and refurbish actuators.	Obtain flexible connections and spare parts.	Two man weeks for fitter.
8. Repair or replace Toledo 100lb scale.	Return to Toledo service depot.	Purchase. Allow 6 months elapsed time.
9. Refurbish small mixer.	Purchase or fabricate two more containers complete with lids. Find lid for existing container.	Local fabrication.
10. Batch House Operation Manual required.	This should be written by a competent glass technologist in conjunction with Toledo engineer.	One man week.
11. Purchase and fit permanent magnet either on collecting conveyor just before discharge or on mixed batch conveyor or preferably both.	Purchase and fit	Local supply and purchase.

BATCH HOUSE AND DRIER - ESSENTIAL ACTIONS BEFORE START-UP

	REQUIREMENT	METHOD/PROCEDURE	COST/TIME
12.	Fill up dead space in radial bins in silo.	This will be best done by filling with sand as dug from the quarry. It will be a tedious job assessing the level and will require someone to actually get inside the silos through the bottom access doors.	Two man weeks of labour.
13.	Fit screen under mixed batch conveyor belt where it goes over the furnace.		Local fabrication and fitting.

CAPACITIES OF VARIOUS ITEMS OF RAW MATERIAL AND BATCH HANDLING EQUIPMENT

Item	Dimensions/Speed	Capacity or Rate
1) Bucket elevator to Drier	11" wide, 225 ft./ min.	42.5 t.p.h. at 100 lbs./ft.^{3}.
2) Rotary Drier	40' long, 6' dia.	15 t.p.h. Est. fuel consumption 2.5 galls./tonne approx.
3) Conveyor from drier to storage bays.	18" wide 150 ft./min.	42.5 t.p.h. at 100 lbs./ft.^{3}.
4) Cullet crusher	Opening 7" by 12" Motor Speed 380 r.p.m.	1 to 1.5 tonnes/hr.
5) Raw Material Elevator to silo	11" wide, 167' long 225 ft./min.	42.5 t.p.h. at 100 lbs./cu. ft.
6) Flat glass cullet elevator	7" wide, 141' long 225 ft./min.	10 t.p.h. at 85 lbs./cu. ft.
7) Container glass cullet	7" wide, 167' long 225 ft./min.	10 t.p.h. at 85 lbs./cu. ft.
8) Raw Materials Hopper to	18" wide 40 ft.?! /min.	42.5 t.p.h. at 100 lbs./cu. ft.
9) Cross conveyor from R.M.	18" wide, 17' 4" centres 150ft./min.	42.5 t.p.h.
10) Collecting conveyor from weigh hopper to mixer	18" wide 49' centres 150 ft./min.	42.5 t.p.h.
11) Mixed batch conveyor from mixer to furnace	18" wide 150 ft./min.	42.5 t.p.h.
12) Cullet vibrators feeding cullet elevators	F220 FMC	-
13) Material vibrators to weigh hopper	FMC Syntron 2 speed 12" wide 50" long trough	-

STORAGE CAPACITIES

Item	Dimensions	Capacity/tonnes
1) Outside cullet bays (7 off concrete)	30' wide by 30' deep by 8' high.	250 tonnes each.
2) Dry material bays (4 off concrete in drier house).	28' wide by 28' deep by 10' high.	300 tonnes each.
3) Raw Materials Storage Bond.	200' long by 100' wide. 12' door at each end. 2 by 12' doors along one long side.	
	Soda Ash at 10' depth.	2500 tonnes.
	Feldspar at 10' depth.	1100 tonnes.
	Dolomite Area 32" x 54'. Other areas EFGH 10' x 34'. Saltcake Area B 8' x 34'. Dolomite Area D 16' x 34'. Reserve Area 30 x 34'. Space Area K 48' x 34'.	
4) Central Silo Hopper Sand.	24' diameter by 26' high cylinder 10' high cone 45° bottom.	At 100 lbs. a ft. 600 tonnes.
5) Radial bins in Silo All 6' radius 34' high.	19000 cu. ft. Total	870 tonnes at 100lbs. cu. ft.
6) Cullet A (Flint)	38° arc 2030 cu. ft.	78 tonnes.
Cullet B (Amber)	38° arc 2030 cu. ft.	78 tonnes.
Cullet C (Green)	38° arc 2030 cu. ft.	78 tonnes.
Window Glass Cullet	38° arc 2030 cu. ft.	78 tonnes.
Soda Ash	78° arc 3900 cu. ft.	113 tonnes.
Limestone (Aragonite)	60° arc 3204 cu. ft.	145 tonnes.
Dolomite	25° arc 1335 cu. ft.	61 tonnes.
Feldspar	25° arc 1335 cu. ft.	61 tonnes.
Saltcake	25° arc 1335 cu. ft.	51 tonnes.
7) Weigh Hopper	Cone 4'6 radius 4' high 1' square chute 5' long	Usable volume 90 cu. ft. 8000 lbs. of batch.
8) Mixer	4 Munson GD 60	Max. batch wt. reac. 7500 lbs.
9) Furnace Hopper (container glass)	10' square 45° bottom angle.	35 tonnes nominal.

APPENDIX XI

GUYANA GLASS

AMBER GLASS

(WITH DOLOMITE)

MATERIAL	ELEMENT WT	SiO_2	Na_2O	K_2O	CaO	MgO	Al_2O_3	Fe_2O_3	Cr_2O_3	SO_3	SrO	
SAND		99.8	-	-	-	-	0.04	0.012				ANALYSIS OF RAW MATERIAL
SODA ASH			58.1									
LIMESTONE		0.4			54.2	0.3		0.010			1.1	
DOLOMITE		0.06			31.1	21.6		0.05				
PYRITES								64.3		137.5		
FELDSPAR		67.4	6.6	4.4	1.3	-	18.2	0.08				
SULPHATE			35.0							45.0		
COLOURANT												
SAND	1000	998					0.4	0.120				WT. CONTRIBUTION BY
SODA ASH	330		191.7									
LIMESTONE	250	1.0			135.5	0.75		0.025			2.75	
DOLOMITE	35				10.5	7.56		0.018				
PYRITES	2							1.285		2.75		
FELDSPAR	100	67.4	6.6	4.4	1.3		18.2	0.080				
SULPHATE	10		3.5							4.5		
CARBON	8											
WT. RAW MATERIAL	1735	1066.4	201.8	4.4	147.3	8.31	18.6	1.528		7.25	2.75	1458.338
YIELD GLASS		73.12	13.84	0.30	10.10	0.57	1.28	0.105		0.50	0.19	

GUYANA GLASS
FLINT GLASS
(WITH DOLOMITE)

ANALYSIS OF RAW MATERIAL

MATERIAL	ELEMENT WT	SiO_2	Na_2O	K_2O	CaO	MgO	Al_2O_3	Fe_2O_3	Cr_2O_3	SO_3	SrO	As_2O_3	
SAND		99.8					0.04	0.012					
SODA ASH			58.1										
LIMESTONE		0.4			54.2	0.3		0.01[illegible]			1.1		
DOLOMITE		0.06			31.1	21.6		0.05					
CALUMITE													
FELDSPAR		67.4	6.6	4.4	1.3	-	18.2	0.08					
SULPHATE			35.0							45.0			
ARSENIC											1.0		

WT. CONTRIBUTION BY ELEMENT

MATERIAL	ELEMENT WT	SiO_2	Na_2O	K_2O	CaO	MgO	Al_2O_3	Fe_2O_3	Cr_2O_3	SO_3	SrO	As_2O_3	
SAND	1000	998					0.40	0.120					
SODA ASH	330		191.7										
LIMESTONE	250	1.0			135.5	0.75		0.025			2.75		
DOLOMITE	35	-			10.9	7.56	-	0.018					
CALUMITE													
FELDSPAR	100	67.4	6.6	4.4	1.3		18.20	0.080					
SULPHATE	10		3.5							4.5			
COLOURANT	0.8										2.75	0.8	
WT. RAW MATERIAL	1725.8	1066.4	201.8	4.4	147.3	8.31	18.60	0.243		4.5	2.75	0.8	
YIELD GLASS		73.29	13.87	0.30	10.12	0.57	1.28	0.017		0.31	0.19	0.05	100.00

2455.10

APPENDIX XI

GUYANA GLASS -
AMBER GLASS
DOLOMITE FREE

MATERIAL	ELEMENT WT	SiO_2	Na_2O	K_2O	CaO	MgO	Al_2O_3	Fe_2O_3	Cr_2O_3	SO_3	SrO	As_2O_3
ANALYSIS OF RAW MATERIALS												
SAND		99.8	-	-	-	-	0.04	0.012	-	-	-	
SODA ASH		-	58.1	-	-	-	-	-	-	-	-	
LIMESTONE		0.4	-	-	54.2	0.3	-	0.010	-	-	1.1	
DOLOMITE		0.1	-	-	31.1	21.6	-	0.05	-	-	-	
CALUMITE								64.35		133.7		
FELDSPAR		67.4	6.6	4.4	1.3	-	18.2	0.08	-	-	-	
SULPHATE		-	35.0	-	-	-	-	-	-	45.0		
CARBON												100
WT. CONTRIBUTION BY ELEMENT												
SAND	1000	998.0	-	-	-	-	0.40	0.012	-	-	-	
SODA ASH	330	-	191.7	-	-	-	-	-	-	-	-	
LIMESTONE	285	1.1	-	-	154.5	0.86	-	0.029	-	-	3.14	
DOLOMITE	-	-	-	-	-	-	-	-	-	-	-	
PYRITES	2	-	-	-	-	-	-	1.285	-	2.75	-	
FELDSPAR	100	67.4	6.6	4.4	1.3	-	18.20	0.080	-	-	-	
SULPHATE	10	-	3.5	-	-	-	-	-	-	4.5	-	
CARBON	2	-	-	-	-	-	-	-	-	-	-	
WT. RAW MATERIAL	1729	1066.5	201.8	4.4	155.8	0.86	18.60	1.406	-	7.25	3.14	
YIELD GLASS	1459.8	73.06	13.82	0.30	10.67	0.59	1.27	0.096	-	0.50	0.22	
FUSION FACTOR	84.43%											

1459.756

GUYANA GLASS - FLINT GLASS DOLOMITE FREE

APPENDIX XI

ANALYSIS OF RAW MATERIAL

MATERIAL	ELE'T WT	SiO_2	Na_2O	K_2O	CaO	MgO	Al_2O_3	Fe_2O_3	Cr_2O_3	SO_3	SrO	As_2O_3	
SAND		99.8	-	-	-	-	0.04	0.012	-	-	-		
SODA ASH		-	58.1	-	-	-	-	-	-	-	-		
LIMESTONE		0.4	-	-	54.2	0.3	-	0.010			1.1		
DOLOMITE		0.1	-	-	31.1	21.6	-	0.05	-	-	-		
CALUMITE													
FELDSPAR		67.4	6.6	4.4	1.3	-	18.2	0 08	-	-	-		
SULPHATE		-	35.0	-	-	-	-	-	-	45.0	-		
COLOURANT	Se												
WT. CONTRIBUTION BY ELEMENT													
SAND	1000	998.0	-	-	-	-	0.40	0.120	-	-	-		
SODA ASH	330	-	191.7	-	-	-	-	-	-	-	-		
LIMESTONE	285	1.1	-	-	154.5	0.86	-	0.029	-	-	3.14		
DOLOMITE													
CULUMITE													
FELDSPAR	100	67.4	6.6	4.4	1.3	--	18.20	0.080	-	-	-		
SULPHATE	10	-	3.5	-	-	-	-	-	-	4.5	-		
COLOURANT	0.8	-	- -	-	-	-	-	-	-	-	-		
WT. RAW MATERIAL	1725	1066.5	201.8	4.4	155.8	0.86	18.60	0.209		4.5	3.14	0.8	1455.809
YIELD GLASS	1455.8	7325	13.85	0.30	10.70	0.06	1.28	0.014		0.21	0.21	0.05	
FUSION FACTOR	84.39%												

TRIAL MELTS - GUYANAN RAW MATERIALS APPENDIX XII

Melt 2999

		Kg	g
Sand	C2867 - LH middle	1000	50.0
Soda Ash	- Allied Chemicals 14.10.82	330	16.5
Limestone	C2871 - Aragonite I/S Bay 3	260	13.0
Felspar	C2876 - E20 S. Carolina	50	2.50
Nitre	- nitrate 6.10.82	2.5	0.125
Saltcake	- sodium sulphate	9.0	0.450
			82.58g

No decolourising agents were added.

Two duplicate melts using above materials melted for 4 hrs. at 1450°C in a Platinum/5% Gold crucible.

The batch had been mixed for 10 minutes in the laboratory Rotomixer.

The glass was released from the crucibles after the melt period and placed into an annealing furnace at 560°C for 1 hour, the furnace then being switched off and allowed to cool naturally to ambient.

Results - 69.5g of glass obtained FF = 84.2%.
Colour good - well refined except for undissolved silica on surface due to coarse sand.

CONTAINER FURNACE AT GUYANA GLASS COMPANY

Technical Appraisal - Structural and Operational

The container furnace was built to a General Glass specification which was basically for an un-insulated end fired regenerative furnace using overport heavy fuel oil firing and a shadow wall design. Other features of the "unusual" design were: no zircon paving on top of the sillimanite bottom blocks, tuckbricks instead of electrocast tuckstones, relatively small port size, small regenerator packing volume and a furnace pressure system which controlled the combustion air as well as stack ejector system. The original concept of the plant was as a labour intensive operation and some of the control systems on the furnace reflect this philosophy. Details of the individual parts of the plant are outlined below:

1. Melting End Bath

The melting end bath consisted of 0.3m thick Corhart Unicor 501 REF electrocast sidewall blocks to a height of 0.91m giving an effective glass level of 0.86m. Tuckbricks laid on top of the electrocast blocks and backing onto the breastwalls were Mullite on the 0.27m wide bottom layer. The other two layers 0.15m and 0.11m in width respectively, were mullite to approximately 1/3 the length of the tank from the gable end wall and silica from then on into and including the working end. Findlay Vacuum Cast Sillimanite blocks 0.3m thick with no zircon or electrocast tiles above were used on the furnace bottom. The melting end area including the doghouse is 30.9m^2

The internal dimensions of the doghouse were 0.6m wide and 0.99m deep, it was angled 5^{o} towards the gable end wall and the edge on the gable end wall side was 0.25m from the wall itself.

The bridgewall consisted of 1.07m Unicor 501 blocks, overlaid with an 0.15m thickness of Findlay fortified sillimanite and then a silica shadow wall. On either side of a straight central section 1.22m wide, the bridgewall was angled towards the gable end wall at 15^{o} from this straight. The throat was 0.61m wide, 0.23m high and 1.07m deep, its flooring is 0.05m below the melting end level.

Two 2" diameter holes were pre-drilled in the sillimanite flooring 2.29m from the gable end wall and 0.91m from each sidewall; these were designed as tapping holes.

In general terms, the condition of the refractories in the melting end bath were satisfactory. Some superficial cracks were visible on the electrocast sidewall blocks and chips were off the corners of the side blocks at the entry to the throat but no serious defects were found.

2. Melting End Superstructure

A combination of mullite (for the first 3.05m from the gable end wall) and silica bricks were used to construct the 0.3m thick and 0.86m high breastwalls. Skewback bricks were electrocast Unicor above the mullite and silica for the other sections.
Four peepholes in the sidewalls gave views across the tank,

the gable end wall and the shadow wall but they were small (0.06m diameter) and visibility inside the melting end was only moderate, a single 0.032m expansion joint was located 4.26m from the gable end wall.

The shadow wall reached a maximum of 10 layers of silica brick (0.76m high) for a 2.39m width across the bridgewall, the height of the crown above the shadow wall varied between 0.12m at the outer edge and 0.28m in the centre of this section. A space of 0.18m was left between the edge of the shadow wall and the breastwall. Overlaps between the silica bricks were approximately 0.02m.

Unicor 501 electrocast blocks formed the doghouse arch and jambs, with 4 courses (0.25m high) of mullite in between the top of the arch and the electrocast skewbacks.

The gable end wall was basically consructed from 0.3m thick Unicor 501 blocks, with electrocast tuckstones.

3. Melting End Crown

The furnace crown is not built to the General Glass drawing specification. Apart from a 0.086m wide spacer brick next to the skewbacks, there should have been 34 silica bricks either side of the central keybrick. These bricks should have been sequenced with one 0.073m (2 7/8") wedge then one 0.07m (2¾"), two 0.073m, one 0.07m wedge. This one two one sequence should have been repeated until a single 0.073m wedge preceded the relief brick on the other side. Excluding the 0.086m to 0.07m wedge relief bricks, the outer span of the 69 bricks should be 5.25m and the inner span 4.97m.

In reality, the one two one sequence was lost 11 bricks in from the sides and mixed manufacturers bricks (Star and Vega) were found for the 0.073m wedges. The central key block was off centre with 34 wedges to the right (looking towards working end) and 33 to the left of it, with the key block itself being apparently individually cut wedges tapering from 0.15m wide at the gable end wall to 0.11m at the expansion joint towards the shadow wall (on the top of the crown) and 0.1m to 0.08m respectively inside the crown Thus, the crown was uneven both from side to side and also along its length. The inner span was actually 4.99m at the gable end wall down to 4.96m at the expansion joint, the outer span being 5.25m at the g.e.w. and 5.21m at the expansion joint.

Expansion joints in the crown were at the junction with the gable end wall and 6.15m from the wall, these joints were both 0.038m wide. The key bricks in the centre of the crown gave up to 0.013m variation in level inside the crown, elsewhere in the crown the joints looked even but a lot of cement used internally tended to mask cracks and clips. Three blocks (0.46m deep protruding 0.15m above the external surface) were inserted amongst the key blocks (1.08, 2.88 and 4.75m from the gable end wall) and each had two holes 0.025m diameter for blind crown thermocouples. Catwalks ran either side of the crown, but the left hand side one was not directly accessible from the furnace platform.

The crown consisted of a single 0.3m layer of silica brick, once again there was no insulation on its structure, the distance from melting end floor to peak of crown internally is 2.21m.

4. Working End

The nearly semi-circular working end bath consisted of 0.3m thick Findlay vacuum cast sillimanite sidewall and bottom blocks. The sidewall blocks were 0.81m high at the shadow wall and 0.66m high around the feeder entries.

The throat construction was incomplete although the tank was supposedly finished. Two 0.3 x 0.3 x 0.45m sideblocks were missing on the working end side leaving large gaps. 0.025m between bottom blocks and a potentially disastrous start up. Although General Glass said they had been fitted but later stolen it would have meant a major engineering operation to remove them from the completed tank. They were located later on top of a pallet with the spare refractories. Obviously, these blocks should be fitted immediately.

The working end tuckstones and breastwalls were 0.3m thick silica, with sillimanite feeder entry blocks 1.25m from the edge of the shadow wall. The entry blocks were 0.46m above floor level in the ~ of the feeder, glass level in the working end was decreased to ue to the bottom being 0.25m higher than the melting end. A third arch for a feeder entry was located in the centre of the two existing ones although there were obviously no plans to use it at the time of the visit. 0.032m expansion joints were left unpacked in the breastwalls either side of each feeder entry arch. A 0.46m by

0.23m section just after the shadow wall had been constructed so as to allow access to the shadow wall silica bricks.

The working end crown (supported by silica skewbacks) was a fairly complex pattern to accommodate the radial design of the working end and a 0.23m drop in crown height in between the expansion joint prior to the shadow wall and the working end side of the shadow wall. This complex pattern obviously created a problem for the bricklayers and the quality of the finished job reflected this in places. A single blind thermocouple block was located in the centre of the working end crown.

A 0.05m diameter plugged hole in the throat served as a potential draining point, and a pressure tapping position was located 0.41m above glass level, 0.3m away from the sillimanite blocks on the bridgewall. Some of the sillimanite blocks had significant (100 x 50 x 12mm) chips out of them, particularly the sidewall blocks, but given the state of construction of the tank, replacement was out of the question. A large corner had been chipped off the electrocast block forming one side of the throat in the working end but again replacement was pointless.

No provision existed for working end burners or cooling in the working end.

5. Ports

The gable end wall underneath the crown was constructed from Unicor 501 blocks, with the ports being 1.077m wide, 0.79m high at the centre of the arch and 0.65 high at the outer edge of the arch. The total port area was 0.8m^2 (i.e. 2.5% of the melting area). Two General Glass design burners were sited at 0.41m centres in each port and were angled downwards at 15^{o}

from the horizontal through electrocast blocks at the top and back of the ports rather than through the port roofs. The burner nozzles were approximately 1.07m from the inner face of the gable end wall. Electrocast tuckstones were used along the gable end wall with a 45^{o} slope towards the glass level on those directly in front of the port. Moving towards the regenerators from these tuckstones, the port bottom was flat for 0.41m and then angled 45^{o} downwards for 2.5m to its junction with the regenerator walls, this angled section being Findley fortified sillimanite blocks. The port roof was Corhart Unicor blocks right back to the junction with the regenerator walls. The port sidewalls were fabricated from mullite bricks.

6. Regenerators

No detail drawings of the regenerators were available in the drawing file so a detailed cross check of original design against actual construction was not possible for some of the data.

The internal dimensions of each regenerator chamber was 2.11m in width and 5.08m in length. 38 layers of Mohite (an alumia-sillicate) bricks in a pigeon hold pack formed the checkers with a total height of 4.34m. The total packed regenerator volume was therefore 46.5m^{3} giving a 1.5/1 ratio with melting end area. Regenerator inner walls, crown and rider arches were also constructed from the "high fire super duty" (Mohite) bricks, the outer walls from a "super duty" brick. The only insulating material in the tank was surprisingly used to form a flat roof on top of the regenerator crown arch and this only looked like a low grade material. The outer walls were 0.34m thick, with the inner dividing wall being 0.46m thick. The external regenerator dimensions were 2.11m in width, 5.76m in length and 8.89m in height with the top of the packing being 6.02m above floor level and 2.26m below glass level in the tank. Excluding the flue entry arch, there were 10 rider arches supporting the packing, and the 0.17m square chimneys which could be checked all looked to be in good condition with no movement detectable. The rider arches were 1.07m above the floor level at the centre of the arch. The regenerator paving was described as 1st quality firebrick in the bill of materials but no identification was visible on the bricks themselves.

7. Flues

The flue entrances from the base of the regenerators were 0.97m wide 1.83m long and 1.07m high at the centre of the arch. In between these flues was a chamber 1.52m long and 1.37m wide which led to the stack system and was separated by 1.6m high walls from the flue entrances. The butterfly type reversal damper was located in the centre of the chamber held centrally on a horizontal shaft running parallel to the flues and the damper resting at one edge on the wall dividing the chambers and the other edge on the roof above the dividing wall. Thus combustion air was forced into the flue entrance on the other side and then over the dividing wall and out through the central chamber to the stack.

The stack damper was located 0.61m away from the exit from the central chamber, the flue being 1.07m wide 1.32m high to the peak of the arch. 7 metres further along the flue from the stack damper, it narrowed to 0.91m wide but at its original height, and then 2.29m further along was the stack itself. The stack was 0.91m diameter and brick lined for the firs approximately 3 metres and then reduced in diameter to approximately 0.76m with no brick lining around the venturi for the ejector fan. The stack height above ground level was 18.6m.

Cleanout doors were fitted on either side of the flue after the stack damper at the section in between the regenerator and butterfly valve and at the melting end side of the regenerators to allow the removal of debris.

8. Instrumentation and Control Systems (excluding Oil Firing System)

The majority of the furnace instrumentation was located in a single control panel on the furnace platform. Sixteen thermocouple sites were available on the furnace, four of these were located in the key blocks of the crown (three in the melting end and one in the working end) and these gave read outs on a Honeywell Electronic 15 strip chart recorder. Two thermocouple positions in the regenerator crowns were not linked to recorders, but to Dilatrol controllers and an alarm klaxon presumably to indicate over maximum set temperatures only (no information available on site). The other 10 thermocouple positions were linked into a single Honeywell Electronic 15 strip chart recorder and were sited as follows:

Two in regenerator sidewalls at top of packing on both regenerators (i.e. 4 in total).

One in each regenerator target wall at the top of the packing.

One in each chamber between the regenerator bottoms and reversal damper.

Two through the roof of the flue in between stack damper and the stack itself.

No thermocouples were actually in situ but only a very small amount of work was required to extend some of the compensating cables to their final positions. The condition of the compensating cable could not be checked but it looked satisfactory and the condition of the chart recorders was good.

The furnace pressure control system was also located on this control panel. The signals were taken from just inside the working end rather than the melting end. Part of the pipework on the long (approximately 30 metres) run to the control panel needed more support to stop it sagging and acting as a blocking point due to condensation from the atmosphere. The signal was converted using a Leeds Northrup D.P. transmitter (Range -0.05" to 0.15" water gauge) and recorded on a Honeywell Electronic 15 circular chart recorder again with a -0.05" to + .15" water gauge scale. The output signal from this recorder/controller drove the inlet iris on the combustion air fan and the stack ejector fan iris (both via a Honeywell Electro-pneumatic system.

No throughput data was available for the combustion air fan which was driven by a 40 H.P. 1765 r.p.m. Westinghouse Motor (Frame 324T). The fan was a Silentvane DU size 3027 SWS1 Class II style RBY1007-1 the casing dimensions were 1.22m diameter and 0.55m width and the output was through 0.74 mx 0.56m ducting. The original position for this fan was in the basement, but it had been re-sited during installation onto the ground floor and after a 10m staight section, the ducting dropped vertically into the top of the reversal damper assembly. A slide door was positioned in the ducting just after the fan which would allow natural draught combustion air to be used.

The stack ejector system was a Morgan size 4 annular ejector driven by a 40 H.P. 1765 r.p.m. Westinghouse Motor and the Westinghouse size 3027 SWS1 Class 3 fan was rated at 13,500 C.F.M. 12.5" water gauge static pressure. Again, an electropneumatic control system governed the setting of the inlet iris via the signal from the furnace pressure system. No standby system was available to cover a failure in the ejector motor or fan. An automatic/manual facility was available for the furnace pressure system on the main control panel.

Both the stack damper and the butterfly reversal valve were controlled manually with winches on the furnace platform. It was not possible to gauge the positions of these valves from the platform itself. The operation of the valves were checked but although both valves moved satisfactorily, the reversal valve seating was not perfect and some short circuiting of air could take place depending on how the system expanded when in use.

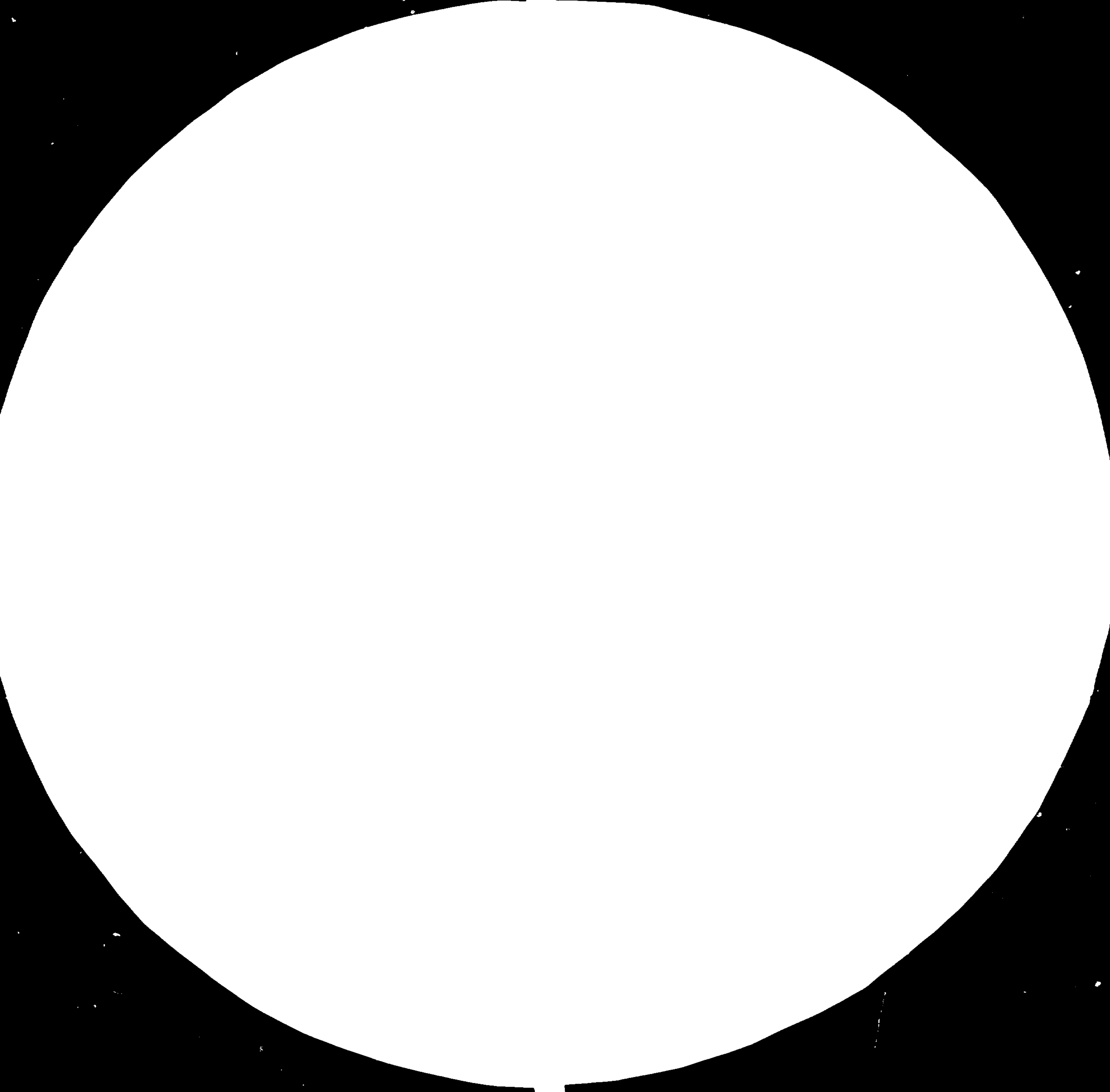
9. Batch Feed and Charging System

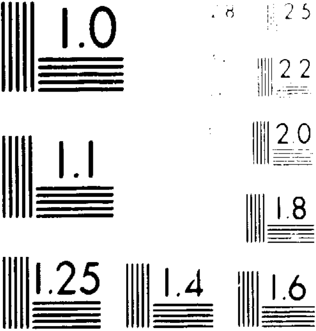
The batch infeed from the 0.46m wide main batch conveyor belt was to a 3.05m x 3.05m x 2.14m high rectangular top to the furnace hopper. This section contained a number of divertor vanes to spread the batch more uniformly across the hopper. The 4 sides were then tapered using flat sheets at an angle of 60° to the horizontal to a 0.3m x 0.3m box section exit at the centre and bottom of the furnace hopper. The hopper seemed to be of a standard design because it had to be modified by the inclusion of a 0.20m diameter outfeed pipe angled at 45° to the horizontal placed nearly halfway up the inclined section to allow batch to feed into the Hydramix screw conveyor. This left approximately 50 per cent of the inclined section as a dead batch area and probably reduced the effective storage capacity of the hopper to between 30 and 35 tonnes. Alternatively, the batch could be diverted to feed in after the Hydramix screw by continuing its passage along the 0.20m pipe. A monitor bin level detector was located in the roof of the hopper to give a high level warning to the batch plant.

No detailed information could be found on the Hydramix screw conveyor system. Its basic principle of operation is that the batch is carried through a number of spray heads situated above a screw conveyor to wet the batch and in theory, to reduce carryover into the regenerators. The infeed section of the screw (driven by a 3 H.P. motor) was 0.29m diameter, expanding to 0.37m diameter in the spray section. The water pressure and flow were regulated using a small control panel mounted by the side of the screw conveyor.

B-226

83.10.03
AD.85.03




1.0
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

From the hydramix system, or through the bypass pipe the batch was fed into a 0.53m wide Ganaglass non-oscillating charger. The batch infeed to a small hopper above the charger should have been controlled by a small rotating vane bin level detector which stopped and started the Hydramix conveyor as and when necessary. However it appeared that this had never been installed nor had any control panel been installed to regulate the charger speed. The signal for the charger was derived from a General Glass level control system comprising two tubes sensing air pressure one 0.08m from the surface and a second one approximately 0.025m above the surface and moveable. Air flows down these pipes (controllable between 10 and 30 p.s.i. and 0 and 90 SCFH) sensed back pressure differences as the glass level changed and gave a signal to a circular chart recorder and thence presumably onto the batch charger. The absence of a manual covering these parts of the batch feed system was all the more surprising in view of the fact that the systems were General Glass' own versions. Three identical chargers had been delivered for the sheet glass tank although none of them had motors on when they were seen. The doghouse entry dimensions (internal) were 0.61m wide and 0.3m deep.

10. Oil Firing System

The two heavy oil storage tanks (100,000 gallon nominal capacity) were located next to the raw material storage area about 200 metres from the container furnace. The tanks were interlinked by a single 0.10m diameter pipe with a gate valve 2m away from the only tank to have an outflow heater on it (Adamson Dura 66 Kw, 550 g.p.hr valve capacity). The suction heater has a 0-160 p.s.i. pressure gauge and 0-240^{O}F gauge on it and outfeeds via a 0.076m pipe to the main pumphouse. The pumping system had been modified so that the same pump (180 g.p.m. at 50 p.s.i.) could provide the main pumping power to the furnaces and off-load tankers, unfortunately these did not appear to be possible at the same time so the furnace supply would have to be isolated during tanker off-loading. Duplex filters with a bypass loop were fitted upstream of the pump (on the storage tank side). No pressure gauges, regulators or thermometers existed on the lines in the pumphouse and the only standby pump was the diesel pump which was interlinked to the heavy oil line.

There was a second pump system located in the engineering services building some 180 metres (through 6 off 90° bends) away from the main pumphouse. In this system Duplex Haywood filters (with bypass loop) preceeded two 550 g/hr pumps (one acting as a standby) driven by 1.5 H.P. Baldon motors. A second oil heating system was based on a 92 Kw Adamson Dura-lec heater controlled by two Honeywell thermostats with line temperature and pressures indicated on rotary dial gauges. A bypass loop around the heater was available, the line had also been modified by the incorporation of a 0.02m diameter pipe directly linking the inlet and outlet pipes near the wall of the building (the reason for this was unknown but it may have been a very primitive pressure relief system). No insulation had been fitted to the pipe runs, and in some sections pipe corrosion was evident due to the pipes being close to the bottom of the trench in sections where water collected. The 0.02m pipe supplying the sand dryer had been badly affected by corrosion and as much as 50% of it could need replacement.

After the second pumphouse the line fed a 0 to 1 million (U.S.) gallon meter with a bypass loop and possible crosslink between diesel and heavy fuel oil liners. The oil lines reduced to 0.025m diameter after the meter, a reduction from 0.075m to 0.05m diameter having taken place after the pumps in the machine services building. A 0.22m line fed all the way back to the sand dryer from this meter, a distance of some 200 metres.
The heavy oil control system on the furnace platform started with a pressure reducing valve (with a bypass loop) before passing through a Brooks flowmeter (0-6 gallons per minute of a liquid with a specific gravity of 0.9 and a viscosity of 80 S.S.U.) or its assiciated bypass loop. In the middle of the furnace platform just behind the regenerators two "everlasing" on/off valves were used to control the oil flow to the correct side of the furnace. After the control valve a 0 to 300^{O}F mercury thermometer was positioned on each line and then individual gate valves just before the burners completed the oil control system. Two additional off-takes supplying warm-up burners and to a drain store were not connected up.

The atomising air system was based on the 60 p.s.i. air supply from the compressors. This was passed through a pressure reducing valve or bypass loop to the manual reversal valves (Everlasting Corporation) for each side of the furnace. Alternatively to going through the reversal valve, air could be passed to the burners via a pressure reducing valve incorporated with pressure gauges (0 to 30 p.s.i.) before and after it. This valve system provided cooling air to the burners on the non-firing side. A gate valve was included just prior to the burners so they could be isolated individually.

The burners supplied were of General Glass design. They could be adjusted to move to or away from the burner blocks and their angles were also adjustable. They contained a central 6.4mm diameter orifice and twelve peripheral holes 1.6mm by 1.6mm on a 12mm radius from the centre of the nozzle. No detailed information was available on site of the burner design or throughput capabilities.

11. Cooling Services

Air cooling to the furnace was supplied by one or both of two fans rated at 12000 CFM at 8" static pressure. The fans (Silentvane Size 3027 Class II) were driven by 20 H.P. 1800 R.P.M. Westinghouse motors and fed 0.61m diameter ducts into the furnace area. Ten 0.15m diameter offtakes came from the main ducting to cool the sidewall blocks on the side opposite the batch charger.

Eight 0.15m diameter offtakes and two 0.09m offtakes either side of the doghouse cooled the sidewall on the batch charging side. Each side had an additional 0.15m diameter offtake cooling the sides of the throat and three 0.15m diameter offtakes giving underport cooling. It was possible to link or isolate each side of the cooling system using a slide damper on a pulley system located under the working end. Additional cooling was applied to the burner blocks using 0.076m offtakes for each port.

Water cooling was applied to the cover and melting end facer blocks of the throat via 25mm diameter tubing and to the water box section of the Ganaglass charger system.

12. Furnace Support System

The main supports for the furnace were twenty four 0.41m by 0.41m reinforced concrete columns 17.3m high with external brick cladding to give an overall dimension of 0.58m by 0.58m. Four columns ran across the furnace and 6 rows of columns ran along the length of the furnace with 0.15m by 0.11m steel I beams making horizontal connections between each column and its neighbours. The furnace bottom was located onto a steel grating sited on top of forty 0.15m by 0.1m I beams running across the furnace above six 0.3m by 0.17m I beams running along the length of the tank and on top of the concrete columns.

The buckstay system was based on none 0.25m by 0.18m girders along each side of the furnace and butting directly onto the external breastwall surface. A further 7 girders supported the working end sidewalls and five girders were located on the gable end wall. Buckstays on the regenerators were single thickness I beam sections 0.3m by 0.17m (rather than the double thickness design used in the melting and working ends) with 4 buckstays running along each sidewall and three running along the target wall. Three lengths of strapping and associated jackbolts supported each of the electrocast sidewall blocks in the melting end.

Melting and work end tie rod systems were based on 38mm diameter bars. Two rods ran the length of the furnace on each side of the melting end, and one along the centre of the melting end. Two cross links existed along and above the gable end wall, 6 tie rods ran across the melting end at 1.37m centres and a further two rods were located above the shadow wall. Six tie rods ran in a radial pattern to support the working end crown from the centre of a large cross beam to the individual buckstays. The regenerator tie rods were 19mm in diameter and arranged with 4 at 1.83m centres running across the crown and 3 at 2.54m centres running along the crown.

FURNACE

Design Appraisal

The basic design of the furnace is old by modern European standards and is probably consistent with designs not used today. Comments on the individual sections are as follows:-

Melting End Bath

A melting area of 30.9m^2 in an end fired furnace would be considered adequate in a modern design to give an output up to 90 tonnes per day. The original specification was for a 20 U.S. ton daily throughput although this was revised during the design stage to approximately 43 tonnes per day. The grounds for this revision are not stated in any available document or specification. It can be said however that the output of the furnace as specified is less than half that of a modern furnace of equivalent melting area.

The melting end is very shallow (0.86m) for the production of flint glass (1.1m would be more appropriate) Indeed the depth of the furnace would be more appropriate for green glass production. When combined with the lack of zircon or Zac tiling on the furnace floor, very high bottom temperatures and rapid attack on the sillimanite flooring are to be expected. The furnace life is therefore limited by this factor.

The doghouse was very close to, and angled towards, the port entry. Large amounts of batch carryover into the regenerators (particularly on the side next to the charger) would accelerate attack on the packing and shorten their life significantly.

Melting End Superstructure

The lack of electrocast tuckstones is surprising as they are incorporated in the design of and have been fitted to the only partially completed sheet glass tank. Again the mullite/silica breastwalls are of an old design system not planned to give the life expectancy obtained from electrocast blocks. The shadow wall design does not allow the control obtainable with a separate working end and could give rise to problems when melting low tonnages or with amber glass. The actual construction of the shadow wall was very open with overlaps between bricks of only 12.5mm which do not give rise to a very secure structure. The gable end wall being constructed of electrocast blocks reflects the high fuel flows necessary to run the furnace and hence high wear rates in this area.

Melting End Crown

Although possibly not disastrous, the deviations in the crown construction from design indicate a shortage of the correct wedge sizes and a relatively poor bricklaying job. The use of mixed manufacturers' bricks in this area is never good policy and the off centre positioning of the key blocks was poor. Internally a lot of silica cement had been used and this gave little reassurance of the stability of the structure. The expansion joints had been left totally unpacked instead of having a layer of aluminosilicate fibres on the inner sections on top of which the final packing could be made on completion of heat up.

This could lead to rounding of the edges of the bricks on the port end of the joint and sting out through the expansion joint. A catwalk along the centre of the crown is required to allow repair work on the crown thermocouples.

Working End

The throat construction in the finished furnace was incomplete. Two 0.3 x 0.3 x 0.45 sideblocks were missing on the working end side leaving large gaps. The consequence of starting up in that kind of condition would have been an immediate close down, cooldown, repair and re-heat. In other words the loss of 6 weeks to 2 months production.

The blocks were eventually located on a pallet with spare refractories for the window glass furnace.

The 38mm expansion joints in the breastwalls were too large and would need packing prior to start up. A fair number of chips were visible in the sillimanite blocks in the working end although they were not bad enough to call for replacement at such a late stage.

fibres on the inner sections on top of which the final packing could be made on completion of heat up.

This could lead to rounding of the edges of the bricks on the port end of the joint and sting out through the expansion joint. A catwalk along the centre of the crown is required to allow repair work on the crown thermocouples.

Working End

The throat construction in the finished furnace was incomplete. Two 0.3 x 0.3 x 0.45 sideblocks were missing on the working end side leaving large gaps. In terms of furnace construction this is a major error. The consequence of starting up in that kind of condition would have been an immediate close down, cooldown, repair and re-heat. In other words the loss of 6 weeks to 2 months production. There was no possibility that these blocks had been fitted and later stolen after completion of the furnace as was suggested.

The blocks were eventually located on a pallet with spare refractories for the window glass furnace. A major engineering effort would have been required to remove the blocks from the completed furnace.

The 38mm expansion joints in the breastwalls were too large and would need packing prior to start up. A fair number of chips were visible in the sillimanite blocks in the working end although they were not bad enough to call for replacement at such a late stage.

Working end burners may not have been a common design feature when shadow wall systems were in use, but in view of the range of tonnages and very differnt glasses to be produced on this furnace, provision should have been made to allow firing or cooling at this point.

The complex pattern of the crown had again resulted in a difficult job for the bricklayers and the uneveness internally was evidence of this. A pair of bricks on either side of the crown did not have crossed joints. In general terms the working end crown was inferior in construction to the melting end crown.

Ports

Overport firing never has been a technique commonly used by Rockware because it is believed to be less efficient and more difficult from the point of view of maintenance. The ports on the furnace are small (2.5%) when expressed as a percentage of the melting area but on an inefficient furnace such as this one, this limitation becomes even more important. 128 gallons per hour per square metre has been specified as a maximum oil flow by Laidlaw and Drew. Whilst a Rockware end fired furnace of a similar size may be loaded slightly higher than this at top load (140 g. $hr^{-1}m^{-2}$) the furnace at Guyana Glass would probably be around 170g $hr^{-1}m^{-2}$ at top load. It was not therefore surprising that so much electrocast refractory was in the ports but even so, they must also be considered an area of potential weakness. The quality of construction in the port area was again only average.

The sharply angled port bottom led to another limitation in terms of the regenerator packing whose height and therefore efficiency was reduced in least in part by the low junction of port bottom and regenerator walls.

Regenerators

The regenerator chambers were long but narrow by Rockware standards giving an internal area approximately 10% less in total than believed required. The height of the packing was, however, very much less (approximately 45%) than current designs. In total the ratio of volume of regenerator available for packing to the melting area of the furnace was 1.5 to 1 rather than 3 to 1 resulting in drastic reductions in regenerator efficiency and higher waste gas outlet temperatures.

The pigeon hole pack system used gives a less stable structure and less bricks in the packing in comparison to the basket weave design. Modern packings also used graded refractory compositions in the packing to improve pack stability and efficiency but the Guyana Glass furnace has only a single material. It was likely that the above limitations in port and regenerator design could reduce the thermal efficiency by up to 20%.

Flues

Only one problem could be seen in the flue system and that involved the butterfly reversal valve. There were gaps of between 12mm and 25mm between the valve and its seatings, but in view of the high temperatures likely to be experienced here, due to the inefficiency of the regenerators, experience suggests that warping is likely on the valve. This could lead to the valve jamming during reversal or significant short circuiting of combustion air into the waste gas streams.

Instrumentation

It is surprising to find 8 thermocouples located between the regenerator crown and the top of the packing when only 4 thermocouples are located in the whole of the melting and working ends. The total absence of thermocouples in the furnace bottom was again difficult to understand. The implication appeared to be that control of regenerator temperatures was more important or more difficult than control of glass temperatures.

The incorporation of one bottom thermocuple close to the doghouse, two approximately 0.3m in front of the throat (one blind, i.e. not penetrating the refractory/glass interface and one through into the glass for faster response) and one in the working end is essential for furnace temperature control.

The furnace pressure control system had two shortcomings. The sensing system should be located in the melting end rather than the working end to give a more sensitive response (some of the pipework needed better support to avoid water filling the line and blocking the signal) and the signal should drive only the stack ejector fan inlet rather than the combustion air as well.
The combustion air should be a completely independant variable, being altered only to follow changes in fuel input to maintain correct combustion conditions. The furnace should be run at a steady furnace pressure for a fairly wide range of loads and combustion air inputs.

Although the concept of a fairly labour intensive plant is understood, the totally manual reversal system is open to a large number of possible operator errors. The adaptation of the oil and atomising air systems for an automatic reversal is described later, but a new automatic reversal control panel with a manual over-ride and safety interlocks would also be required. The furnace reversal valve should be put onto an electrical drive (with manual over-ride) and connected into the automatic reversal controls. It should be possible to clearly identify the positions of valves or dampers at the winch sites themselves.

In view of the reliance of the furnace operation on the forced draught in the stack caused by the ejector fan, it would be advisable for a standby motor and fan to be fitted by the existing fan for emergency operation.

Batch Charging

The furnace hopper looked to be of a standard design which had been adapted for this job. Instead of modifying the outfeed from the hopper, the hopper should have been moved between 1m and 1 5m towards the furnace and the supporting steelwork modified accordingly. This would have allowed the complete hopper to be used for storage instead of cutting off a large portion of the tapered section (which was in effect a dead area) and would eliminate a possible blockage point in the 45° chute used to bring the batch into the hydramix screw feed.

Water addition systems such as the Hydramix have been used in Rockware but where fitted they are now generally (if not always) bypassed. Their mechanical reliability is questionable and some research work has indicated that they can increase batch carryover into regenerators rather than decrease it (which is their stated primary objective). Having stated these reservations the system should be given a chance to prove itself in its situation on this furnace as it may be able to contribute more than it loses from the above reservations.

The batch charger control system looked to be incomplete. A charger panel with auto/manual control facilities and a variable speed control is required. The high level detector on the charger hopper had not been fitted. More modern versions of the Ganaglass charger have the ability to vary the batch feed towards the gable end wall and then further down the tank (to allow satisfactory coverage of the melting end by batch piles) but no variation is available on this model.

10. Oil Firing System

The two heavy oil tanks would give a minimum oil supply of two months on site. If regular oil supplies could be guaranteed then the use of one storage tank only could be contemplated but at least initially both tanks should be used. There are no facilities for pumping across from the second tank into the first, this means that the second tank can only be emptied by emptying the first (fitted with outflow heater) No facilities existed for measuring the quantity of [illegible]e tanks, a dipstick system should be incorporated immediately. A pump should be incorporated to give this flexibility if the second tank was to be used. The tanker infeed to the storage tanks should be made completely independent of the line pumping system rather than linking the two through one pump. If the delivery tankers do not have reliable pumps then a permanent one on site should be fitted as a standby.

The oil supply system to the furnace should be based on a ring main system rather than the dead leg used currently to even out line pressures at reversals and other variable flow situations. A standby pump should be added in the main pumphouse wired to start automatically if the main pump trips out for any reason (currently the standby is a diesel pump which may be required for diesel at the time it is needed for heavy oil and may not be suitable to pump heavy oil).

To complete the ring main, 0.076m pipe should be continued from the existing booster pumps and pre-heaters on to the furnace platform. A complete section of 0.05m piping would be needed to act as a return line to the storage tanks. The booster pumps in the compressor house section looked to be considerably smaller than the 550 gallons per hour specified in the design drawing and were only driven by 1.5 horse power motors. 550 gallon per hour pumps should be installed here and wired so that in the event of one failing the second one cuts in automatically. The pre-heater should be re-sited on the furnace control cabin and should be located on a 0.025m line feeding the burners rather than the ring main. Prior to the pre-heater on the 0.025m line should be the pressure relieving valve and bypass system with gauges on the inlet and outlet. A 92Kw heater is far too powerful for the oil flows on the container furnace and a smaller 10 Kw heater is needed in series with the larger one to ensure reasonable temperature control. (Thermometers to be placed downstream of this heater).

Rather than using manual reversal valves, the oil flow to the burners should be controlled using pneumatically operated ejector valves getting their signal from the automatic reversal panel (with a pneumatic manual over-ride system). The air supply to the burners should also be modified to incorporate a basic feed to both ports at up to 10 p.s.i. (for burner cooling) and a secondary feed up to 40 p.s.i. for atomising air directed towards the port on the firing side and controlled by a linkage onto the reversal valve.

The throughput rating of the burners supplied should be carefully checked to ensure that they can take of the order of 70 gallons per hour comfortably.

Cooling Services

Although the capacity of the cooling air system was smaller than would have been installed by Rockware, it was likely that both fans running together would cope with most if not all the flux line cooling required on this design of furnace during its life.

Furnace Support System

The foundations support columns, buckstays and the rod systems appeared more than adequate and no signs of structural problems were visible.

Additional comments

The structure of the building and the space around the furnace are good. Apart from the lack of access to the left hand side of the furnace at flux line level from the furnace platform and the centre of the crown, most areas were acceptable. A ladder up the side of the furnace hopper to enable the furnaceman to check level would be helpful rather than expecting the batch plant operator to walk all the way. A telephone is also a very useful item for a furnaceman, when help is needed the response sometimes has to be rapid and a good communication system is essential.

The lack of operating manuals on individual items is surprising. Perhaps more importantly a furnace operating manual covering the interaction between individual components is more critical when the lack of furnace experience on plant is considered. Simple troubleshooting instructions would prove invaluable in passing through the troublesome first stages of the "learning curve" on furnace co-operation.

BOTTLE LINE

FOREHEARTH AND FEEDER DETAILS

APPENDIX XV

Type	Emhart ZW
Fuel	Oil
Width	26"
Depth	7"
Length	18' 7½"
Rear Burners	4
Spout Burners	1
Spout Burner Type	Single Diagonal Burner
Temperature Measurement	Thermocouples
Temperature Recorders	Honeywell
Spout Type	Standard 144
Spout Size	14" Wide - 6" Deep
Tube Size	6" x 17"
Plunger Size	2¾" x 27"
Metal Line Height	13' x 8"
Platform Type	Weldmesh
Tube Drive	Chain
Shear Spray Equipment	Incomplete. Make unknown
Level Control	General Class?
Feeder Type	Maul 944 Type D? No name plate

MACHINE DETAILS

Machine Type	E. 4¼ 6-SG
Machine Manufacture	Maul. 1976
Lines on Drum	21
Vaccum	No
Wipe Out Type	Maul Retractable
Dead Plates	D.G. Asbestos
Machine Drive	Helical Bevel Gear
Lubrication System	Lincoln Centre-Matic
Machine Conveyor Length	30' 9" Overall
Machine Conveyor Drive	Friction Wraparound
Air Receiver Size	90" x 50"
Low Pressure Control	Cash Valve
Max. High Pressure	50 P.S.I.
Ware Transfer Unit	Hartford Type 178 Curved
Ware Stacker	Powers? No name plate
Stacker Trip Mechanism	Micro switch - M/C drive

MOULD EQUIPMENT ON SITE APPENDIX XVI

200 ml RUM FLASK

Blowmoulds and Bottom Plates	20
Blank Moulds	24
Baffles	24
Blowheads	16
Funnels	16
Take Out Jaws	12 pair
Neckrings (complete)	75
Sleeves	50
Plungers	50

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375 ml RUM FLASK

Blowmoulds and Bottom Plates	20
Blank Moulds	24
Baffles	24
Blowheads	16
Funnels	16
Take Out Jaws	12 pair
Neckrings (complete)	75
Sleeves	50
Plungers	50

750 ml PLAIN ROUND RUM

Blowmoulds and Bottom Plates	20
Blank Moulds	24
Baffles	24
Blowheads	16
Funnels	16
Take Out Jaws	12 pair
Neckrings (complete)	75
Sleeves	50
Plungers	50

* * * * * * * *

100 LIMACOL FLASK

Blow Moulds and Bottom Plates	20
Blank Moulds	24
Baffles	24
Blowheads	16
Funnels	16
Take Out Jaws	12 pair
Neck Rings (complete)	75
Sleeves	50
Plungers	50

250 ml LIMACOL FLASK

Blow Moulds and Bottom Plates	20
Blank Moulds	24
Baffles	24
Blowheads	16
Funnels	16
Take Out Jaws	12 pair
Neck Rings (complete)	75
Sleeves	50
Plungers	50

* * * * * * * * *

500 ml LIMACOL FLASK

Blow Moulds and Bottom Plates	20
Blank Moulds	24
Baffles	24
Blowheads	16
Funnels	16
Take Out Jaws	12 pair
Neck Rings (complete)	75
Sleeves	50
Plungers	50

12 oz JAM JAR

Blow Moulds and Bottom Plates	15
Blank Moulds	18
Baffles	18
Blowheads	12
Funnels	10
Take Out Jaws	9 pair
Neck Rings (complete)	60
Sleeves	18
Plungers	60
Plunger cooling tubes	

* No plunger cooling tubes located

* * * * * * * *

10 oz RETURNABLE PEPSI

Blow Moulds and Bottom Plates	10
Blank Moulds	12
Baffles	12
Blowheads	8
Funnels	9
Take Out Jaws	6 pair
Neck Rings (complete)	38
Sleeves	25
Plungers	25

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DRAWINGS ON SITE

200 ml RUM FLASK

375 ml RUM FLASK

750 ml ROUND RUM

10oz BEER BANKS

100 ml LIMACOL FLASK

250 ml LIMACOL FLASK

500 ml LIMACOL FLASK

12oz JAM JAR

10oz PEPSI

ROCKWARE GLASS LTD.
ANALYTICAL REQUEST/REPORT FORM

Origin: Guyana Glass R.I. [illegible] 70 Date: 26.10.82 Request by: R.I.([illegible] Jar

Material	Aragonite	→			
Identification	I/S BAY 3 (20.10.82)	O/S BAY 5	O/S BAY 6	O/S BAY 7	→
Lab. No.	C2871*	C2872*	C2873*	C2874*	
SiO_2	1.38	0.05	0.12	0.03	
Na_2O					
K_2O	0.01	<0.01	<0.01	<0.01	
CaO	53.2	54.6	54.5	54.6	
MgO	0.29	0.29	0.26	0.28	
BaO					
TiO_2					
Al_2O_3	0.04	0.01	0.01	0.01	
Fe_2O_3	0.010	0.009	0.010	0.010	
Cr_2O_3					
SO_3					
F					
SrO	~1.1	~1.1	~1.1	~1.1	
Loss on Ignition					

Remarks: SrO figures from semi-quantitative XRF scan comparative with A0217* (analysed at BCRA).

Chief Analyst

ROCKWARE GLASS LTD.

SIEVE ANALYSIS REPORT

3339

Factory [illegible] Glass [illegible] Date 26.10.82 Request by R.I.(H) Jar

Material	Aragonite	→			
Identification	I/S BAY 3 (20.10.82)	O/S BAY 5	O/S BAY 6	O/S BAY 7	→
Lab. No.	C2371*	C2372*	C2373*	C2874*	
MESH SIZE					
+ 4·0mm.					
− 4·0mm. + 2·8mm.	0.0	0.2	0.0	0.0	
− 2·8mm. + 2·0mm.	1.2	1.1	0.8	1.3	
− 2·0mm. + 1·4mm.	1.2	1.1	1.0	1.2	
− 1·4mm. + 1·0mm.	1.4	1.7	1.6	1.6	
− 1·0mm. + 710µm.	2.1	2.2	2.3	2.1	
− 710µm. + 500µm.	3.9	4.2	4.5	4.0	
− 500µm. + 355µm.	8.9	8.7	9.3	8.9	
− 355µm. + 250µm.	28.8	29.7	33.7	31.9	
− 250µm. + 180µm.	32.3	32.0	28.9	29.9	
− 180µm. + 125µm.	15.8	15.3	14.1	15.2	
− 125µm. + 90µm.	3.8	3.5	3.2	3.5	
− 90µm.	0.6	0.3	0.6	0.4	

Remarks

Chief Analyst

ROCKWARE GLASS LTD.
ANALYTICAL REQUEST/REPORT FORM

Origin Guyana Glass R.I.(N) 70 Date 26.10.82 Request by R.I.(N) Jar

Material	Dolomite	Feldspar			
Identification	Ohio Lime (20.10.82)	E20 South Carolina →			
Lab. No.	C2875*	C2876*			
SiO_2	0.06	67.4			
Na_2O		6.6			
K_2O	<0.02	4.35			
CaO	31.1	1.27			
MgO	21.6				
BaO					
TiO_2					
Al_2O_3	0.01	18.2			
Fe_2O_3	0.05	0.08			
Cr_2O_3					
SO_3					
F					
Loss on Ignition	47.4	0.16			

Remarks

Chief Analyst

ROCKWARE GLASS LTD.

SIEVE ANALYSIS REPORT

3339

Factory [illegible] Glass Date 2[illegible].[illegible].82 Request by [illegible]

[illegible] 70

Material	Dolomite	Feldspar			
Identification	Ohio Lime (20.10.82)	E20 South Carolina →			
Lab. No.	C2375*	C2376*			
MESH SIZE					
+ 4.0mm.					
− 4.0mm. + 2.8mm.	0.0				
− 2.8mm. + 2.0mm.	0.5				
− 2.0mm. + 1.4mm.	39.2				
− 1.4mm. + 1.0mm.	38.6	0.0			
− 1.0mm. + 710μm.	17.3	0.9			
− 710μm. + 500μm.	2.7	9.2			
− 500μm. + 355μm.	0.6	13.1			
− 355μm. + 250μm.	0.5	24.2			
− 250μm. + 180μm.	0.1	19.8			
− 180μm. + 125μm.	0.1	14.2			
− 125μm. + 90μm.	0.1	10.9			
− 90μm.	0.3	7.7			

Remarks

Chief Analyst

PRE PRODUCTION CAPITAL COSTS - TECHNICAL

This section covers the estimated costs of various items and services discussed and approved in the preceeding sections, deem essential in the pre production period up to the end of 1984.

All costs are assessed in Guyanese Dollars using a conversion rate of:

G$ 3.00 = $US 1.00
G$ 5.00 = £1.00 (sterling)

SERVICES		G$
1.	Additional Generator Set I.D.E. 1 MW Set (US$150,650)	451,950.00
2.	Switch Gear parallel and mains operation (US$50,000)	150,000.00
3.	Completion of LPG Installation Pipework, Carburettors, Wobbie Index, Design Testing and Installation (£35,000)	175,000.00
4.	Heavy Oil Unloading System Separate pumping facility Pipework, control system Installation and testing (£10,000)	50,000.00
5.	Furnace Firing Day Tank System Recirculation, line, Tank, Preheaters, Design installation and testing (£60,000)	300,000.00
6.	Full Instrumentation for Fuel Oil System Float system, flowmetering and Pressure Control System (£25,000)	125,000.00

7.	Refurbishing, modification and Instrumentation - Sand Drier Line (£4,000)	20,000.00
8.	Water Pump (Deep well) and drive motor repair (£1,000)	5,000.00
9.	Dry Air Compressor for Instrumentation wire pipework (£2,000)	10,000.00
		$G1,286,950.00

RAW MATERIAL HANDLING AND TREATMENT

1.	Wet Sieving Plant Design, Construction & Installation (£100,000)	500,000.00
2.	Vehicles for Quarry and batch area handling (£50,000)	250,000.00
3.	Modifications to Batch House and Technical Support from Toledo Engineering (£14,000)	70,000.00
		G$820,000.00

FURNACE

This subsection details the capital costs of replacing the existing Guyana Glassworks furnace with a modern design unit.

This section assumes that the existing foundation for the furnace and regenerators will be acceptable for continuation of the new furnace. A short survey will be required to ascertain this. Should the survey prove that new foundations are required the costs in this section will be substantially increased.

The prices given are estimated costs given by professional engineers on 'site unseen' basis. They can be assumed to give an indication of cost but not precise figures. These figures cannot be regarded as a quotation. These are however in Rockware International's opinion reflective of current costs.

		G$
1.	Demolition of existing furnace (£15,000)	75,000.00
2.	Additional ejector fan and motor (£10,000)	50,000.00
3.	Furnace Rebuild (20 sq.metres) including all steelwork, refractories, installation, construction, light-up, design and supervision. This figure assumes use of U.K. labour in construction (£820,000)	4,100,000.00
4.	2 Optical Pyrometers (£1,500)	8,000.00
		4,233,000.00
5.	Furnace Repair 1990 full repair to refractories, refurbish equipment and construction, labour etc. (£490,000)	2,450,000.00

PRODUCTION EQUIPMENT	G$
1. I.S. Machine - Minor Repairs and relocation of cooling fan ducting etc. (£2,000)	10,000.00
2. Jigs and fixtures for I.S. Machine (£10,000)	50,000.00
3. Transfer Unit Replacement (£4,500)	22,500.00
4. Additional Mould Sets (£80,000)	400,000.00
5. Mould Repair Equipment Spray Welding, hand grinders ancilliary equipment (£8,500)	42,500.00
6. Decorating Screen Manufacturing Unit (£5,000)	25,000.00
7. Improvement to Cold End Lighting (£1,000)	5,000.00
	G$555,000.00

GENERAL AND SPARES	
1. Electrical Spares (£500)	2,500.00
2. Manpower Input - local (£20,000)	100,000.00
	G$102,500.00

2ND PRODUCTION LINE	
1. Forehearth and feeder mechanism steelwork, refractories, instrumentation erection commissioning. (£100,000)	500,000.00
2. I.S. Machine and auxilliary equipment transfer stacker etc. (£125,000)	625,000.00
	G$1,125,000.00

SUMMARY

	G$
Production Services	1,286,950.00
Materials handling	570,000.00
Production Equipment	555,000.00
General and Spares	102,500.00
	2,514,450.00
Materials handling - Vehicles	250,000.00
Furnace Construction (1983/4)	4,233,000.00
Furnace Repair (1990)	2,450,000.00
Second Production Line	1,125,000,00
	10,572,480.00
ADD Contingency @ 10%	11,629,728.00
ADD C.I.F. Charges @ 15%	13,374,187.00

PART II

PERSONNEL, TECHNICAL ASSISTANCE, TECHNICAL MANAGEMENT AND TRAINING REQUIREMENTS.

PART II : CONTENTS

1. GENERAL

This section covers the requirements for commissioning and operation of Guyana Glassworks Ltd. in terms of personnel, technical assistance, technical management and training. Assessment of potential costs for each of these requirements is also given as these will be incorporated into the financial projections for start-up and operating costs.

A provisional organisation for GUYANA GLASSWORKS has been planned and drawn up. This was supplied to Rockware International in the form of a chart together with a schedule of wages and salaries. The origins of the organisation plan are not known. Similarly it is unclear as to whether job descriptions, duties and reporting lines have been drawn up and clarified.

Whilst it is difficult to assess the costs of employment etc. for each factory function in Guyana, for the purposes of this report, the totals quoted in the budget information supplied to Rockware International have been accepted. The figure of G$1,825,500 would appear to cover total employment for the full plant and it is likely that actual levels of employment would be much less.

2. PERSONNEL PLANNING AND RECRUITMENT

The success of Guyana Glassworks Limited is critically dependent on the indepth strength of the management and skilled work force it develops. In a continuous process industry acceptable levels of productivity will not be achieved regularly by a team of experienced managers and consultants alone.

The importance therefore of recruiting a work force with the experience or potential to operate successfully in a new environment and in the demanding conditions imposed by the nature of the process must not be underestimated. This is the essential first step to developing a skilled and cohesive team through training.

Set out below are the services which will need to be provided:

a. The provision of a suitable organisation chart and management plan for Guyana Glassworks

b. The provision of job descriptions for all levels of staff

c. The provision of Personnel requirements and qualifications for all levels of staff, in line with an assessment of local abilities and skill levels

d. Attendance and participation with Guyana Glassworks management personnel in interviews with selected candidates, supervising aptitude tests etc.

Existing Personnel Plan

From the material supplied to Rockware International it is not clear whether contracts of employment have been issued in relation to the jobs listed. The budget total supplied for wage and salaries indicated a total workforce of (327) persons.

It would be inappropriate to comment in too much detail at this stage given the assumption that the total may include the sheet glass personnel. It is likely that the total workforce for operation of the bottle line only would be in the region of 200 persons.

Costs for the personnel planning, recruitment, testing and organisation exercise are detailed in Appendix C.

3. ORGANISATION PLAN : GUYANA GLASSWORKS

The details below outline the form of organisation plan for the operation of GUYANA GLASSWORKS in the opening period. No proposals are made for senior management as in the opening period the key posts will be held by the full-time team. It is proposed that the Superintendent positions indicated be regarded as trainee positions for selected personnel. If these personnel prove effective they will succeed to the full role as Supertintendent in each department in line with the reduction of the full time team. Similarly no reference is made to the Board of Directors or reporting lines linking the production organisation thereto.

The proposed plan concentrates on the production and support areas of the factory operations. Nominal figures are given for areas where local knowledge may indicate the need for additional personnel,

e.g. Personnel Department,
Canteen,
Security,
Stores,
Medical.

The actual level of personnel in each position shall be continuously reviewed by GUYANA GLASSWORKS management dependent on performance of appointees and ability to handle the full range of duties specified for each post. As a result of these necessary generalisations, the assumptions in terms of cost for financial projection purposes have been rounded to G$2.million to include salaries, N.I.S. costs, medical scheme, transportation costs etc. as an overall package. This budget item will be finalised on completion of the personnel planning and recruitment exercise. The figure has been uplifted by 5% per annum to 1985 to G$2.35 million. A decision on this possible pay increase will be for GUYANA GLASSWORKS Management.

The majority of the production related positions indicated will need to be filled towards the beginning of the pre-production year to allow training and assessment prior to start-up. It is likely that there will be a requirement to recruit more personnel than are required to allow wastage and failure to achieve operating potential. It is assumed that such actions do not contravene any local employment regulations and that the idea of 'probationary' periods is acceptable

The layouts overleaf indicate the general approach to organisation and manning and are for guidance purposes only.

DEPARTMENTAL PLAN

FACTORY MANAGER

5.	4.	3.	2.	1.
Personnel, Accounts & Administration Superintendent/ Manager	Plant Engin'rg & Maintenance Superintendent.	Inspection, Q.C. and Decorating Superintendent.	Production Superintendent.	Raw Materials Batch & Furnace Superintendent

N.B. The factory production departments, i.e. 1 - 4 will operate on four crew, 3 shift system where required. All other personnel will operate on a 'day' basis. Any local regulations or conditions affecting this situation will need to be reviewed.

RAW MATERIALS, BATCH AND FURNACE

Superintendent

- Quarry and Delivery (Nos. to be decided).
  - Sand Drier Operators (2)
- Batch & Batch House.
  - Foreman (3) *
  - Drivers (3) *
  - Labourers (3)*
- Furnace Operation
  - Foreman (4) *
  - Assistant (4)*
- Instrumentation
  - Technicians (2)
  - Asst. Technician (1)

* Shift Personnel

PRODUCTION DEPARTMENT

Superintendent

Shift Supervisor (4)*

- Forehearth & Feeder
  - Specialist Team (2)
- I.S. Operation
  - Operators (4)*
  - Asst. Ops (4)*
- Lehr Control
  - Controllers (4)*
- Mould Shop
  - Supervisors (1)
  - Fitters (4)*
  - Fitters (2)

* Shift Personnel

INSPECTION, QUALITY CONTROL AND DECORATING

- Superintendent
  - Supervisor
    - Inspection
      - Foremen (4)*
      - Sorters (12)*
      - Packers (4)*
    - Warehouse
      - Foremen (4)*
      - Drivers (4)*
  - Supervisor
    - Decorating
      - Foremen (1)*
      - Operators (4)*
      - Sorters/ Inspector (2)
    - Screen Room
      - (3)
  - Quality Con.
    - Laboratory (2)
    - Assistants (1)

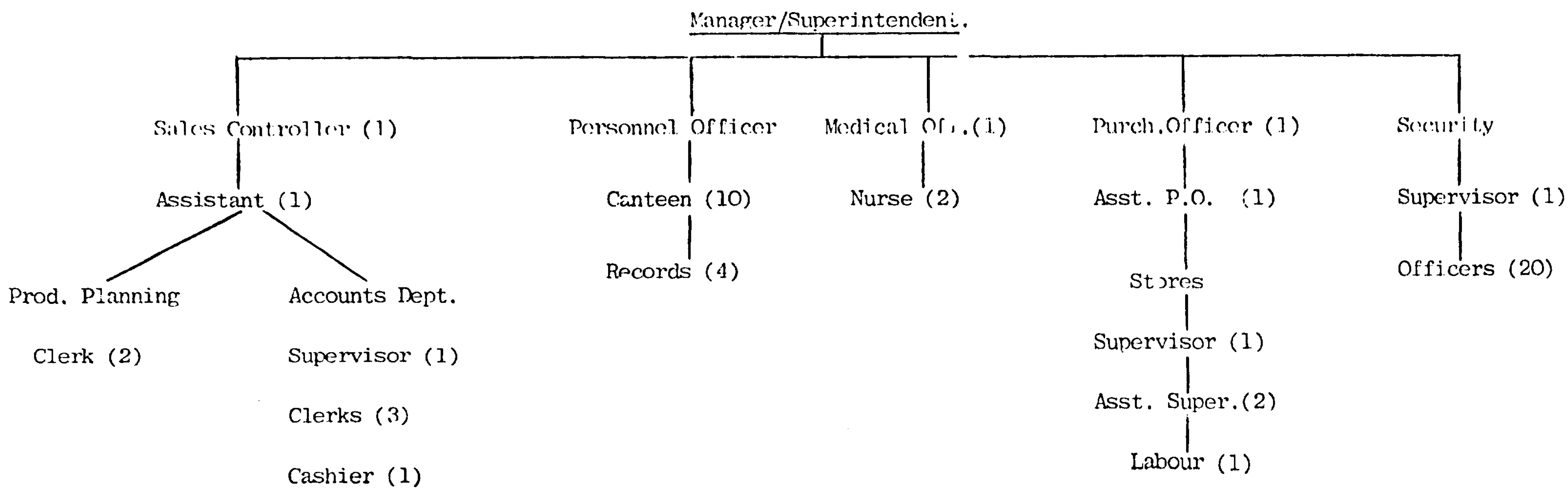
* Shift Personnel

PLANT MAINTENANCE AND ENGINEERING

- Superintendent/Engineer
  - Shift Engineer (4)
    - Maintenance Foreman (1)
      - Electrician (4)*
      - Bricklayer (1)
      - Vehicle Repair (3)
      - Plumber (1)
      - Carpenter (1)
      - Labourers (3)
    - I.S. Repair
      - Foreman (1)
      - Fitters (4)*
      - Fitters (1)
    - Ancilliary
      - Instruments etc. (2)
    - Compressor and Generator Personnel Days (2) Shifts (4)*

* Shift Personnel

PERSONNEL AND ADMINISTRATION



4. TECHNICAL ASSISTANCE

There is abundant evidence that companies entering the glass container industry for the first time frequently underestimate the difficulties of a continuous process industry.

The recruitment and training of men of experience is a key factor, but the difficulties of recruiting people from technologically advanced companies in the industry are considerable and costs are high and numbers are often strictly limited.

Traditional 'on-call' Technical Assistance Agreements do not really provide the level of support to offset the dependence of the very few experienced men in a new organisation when a polyglot and disparate work force is being brought into harmony and Rockware International have therefore designed a programme of technical assistance which provides additional expertise with a view to assisting new producers to reduce the length of their learning curves.

The principles of such an agreement are:

a. the provision of a full time team during the difficult initial stages, (commissioning planning, actual and post commissioning and in early production)

b. on call support to the local management and the full time team from RI resources, factories, Technical Centre etc. under a Technical Assistance programme

c. the extension of the full time team into the opening years with a decreasing number of specialists as local skills are established.

The benefits of such a scheme to the client are:

i). Immediate production available for sale and protection of equipment from damage due to inexperience and bad handling.

ii). The management of the client company have a constant and immediate technical experience available to them throughout the inevitably difficult opening years of operation.

iii). Continuous on the job training proceeds with continuous assessment of local needs.

The only disadvantage is clearly cost, which must exceed traditional Consultancy type Technical Assistance packages. However, it should be taken into account that very limited periods of production below planned levels in the factory could exceed these costs.

An agreement for a period of 5 years is felt appropriate for initial consideration between RI and GUYANA GLASSWORKS, with review at the end of this period to assess needs for further support.

An agreement would be drawn up laying out the obligations etc. of the parties generally as below.

<u>Obligations of Rockware International</u>

<u>Technical Information Support</u>

RI would make available to GUYANA GLASSWORKS all the necessary technical information and "know-how" in its possession at the date of the agreement or which may subsequently come into its possession.

RI would make available to GUYANA GLASSWORKS copies of relevant drawings, although such documents would remain the property of RI at all times.

RI would make available to GUYANA GLASSWORKS access for consultation to Rockware resources e.g. Factories, Research and Development Centre and Advanced Training Centre.

RI would carry out on behalf of GUYANA GLASSWORKS on a regular basis, analysis of raw materials and glass samples and analyse and report on GUYANA GLASSWORKS production statistics.

RI would provide opportunities for nominated GUYANA GLASSWORKS senior personnel to consult and discuss information, designs, or any topic relating to the manufacture of glass containers.

Manpower Support

Rockware International, recognising the importance of these first 5 years of operation, would second a team of technical experts to be resident in Guyana and working full time for Guyana Glassworks. The experts would be chosen to cover the essential areas of technology and production, but will remain employees of Rockware International in order to maintain flexibility of skills as Guyana Glassworks develops.

Rockware International would supplement this team with additional specialists when necessary to cover holidays and to assist with particular problems or emergencies.

Rockware International would support the resident technical assistance team by regular visits or contact by a senior technical consultant including technical audit at the end of each year to develop objectives and targets within the framework of Guyana Glassworks long range plan.

Rockware International would use its best endeavours, skills and experience in performing the services, aid and advice to be rendered by it throughout the period of the agreement.

Rockware International would undertake to offer to Guyana Glassworks advice and technical 'know-how' in all areas of glass container production and specifically on

a) Consumables and their supplies, e.g. lubricating oils mould repair equipment and materials. Repair tools, expendables, decorating screens colours and materials, spare parts, etc.

b) Batch composition based on the major use of materials being available locally including suggestions on ways and means to improve the quality of local materials as necessary.

c) Mould design and maintenance techniques.

d) The bottle decorating process.

e) Quality control and laboratory techniques.

f) Maintaining technology and operating levels. to acceptable standards in all areas of production.

GUYANA GLASSWORKS and RI would discuss and agree the establishment of a regular reporting system between the two companies so that technical information, production figures, progress reports, could be passed on to RI for comment and suggestions for improvement.

Throughout the life of any agreement RI would ensure that all personnel it designated to assist GUYANA GLASSWORKS would be qualified and experienced to carry out the duties assigned to them under this contract effectively.

Full-Time Team

The full time team to support the start of production in Guyana is assessed below:-

1	Team Leader
1	Batch & Furnace Specialist
2	I.S. Machine (Ancilliary Equipment equipment) Engineers
4	Production Specialists
2	Inspection and Quality Control Specialists
10	

The team may appear large to operate a plant of the size intended but with a continuous process and assuming no other experienced glass makers it is essential in the first year of operation given the requirement to maintain high production efficiencies.

This team would be present on site before start-up and would form the core of the commissioning team. Additional specialists would be required in support during commissioning up to a total of 50 man weeks.

In the second and subsequent years of operation the team would diminish as local staff achieve sufficient skills to take over and the envisaged plan is shown over.

YEAR	1	2	3	4	5	6	7	8	9	10
Team Leader	1	1	1	1	1	–	–	–	–	–
Batch & Furnace	1	1	1	1	1	–	–	–	–	–
Additional Furn. Support (Man Wks)	–	–	–	–	30	–	–	–	–	–
I.S. and Equip. Engineers	2	1	1	1	1	–	–	–	–	–
Prod. Specialists	4	2	2	1	1	–	–	–	–	–
Inspection and Quality Control	2	1	1	–	–	–	–	–	–	–
Additional Back-up support from U.K. (man wks)	50	40	40	25	25	75	75	75	75	75

Notes:

1. The additional furnace support in year 5 is to assist with the furnace rebuild.

2. The support from U.K. is to provide either
   - U.K. analysis, design work, planning etc.
   - Temporary help in Guyana to supplement the team.

Details of the costs of the above Technical Assistance and man power support are given in Appendix D and in the Technical Assistance Agreement in Appendix B.

5. PRE PRODUCTION TECHNICAL ASSISTANCE

The unique position of GUYANA GLASSWORKS requires close attention to the existing facilities and the new equipment to be purchased. An extensive rehabilitation programme is required to take the factory to a position for successful start-up.

It is essential therefore that effective project control be applied to all areas, - i.e. planning, design and design approval procurement, checking, installation etc.

Rockware International will provide this service over the two year pre production period envisaged and expla... in Section III. This service will also be combined with the commissioning input.

Totals for the input are given in Appendix C together with other pre-production personnel costs.

6. TECHNICAL TRAINING, TRAINING FACILITIES AND PROPOSED INITIAL PROGRAMME

Introduction:

Without both the basic and highly specialised skills essential to the glass container manufacturing process, even the most automated up-to-date plant could not perform to the standards of efficiency and product quality demanded.

The importance of selecting and then training the GUYANA GLASSWORKS work force has been fully emphasised above. A training plan cannot however be finalised until the recruitment exercise has been completed and the strengths and weaknesses of the particular staff have been reviewed.

Rockware International has, however, drawn up training proposals on a conservative basis to illustrate the quality and extent of training that is likely to be required. This programme is geared to develop skills to a level which should ensure satisfactory production performance is achieved after commissioning in support of technical specialists and thereafter as the specialist support is reduced.

The plan is drawn up on manning levels associated with the production planned by GUYANA GLASSWORKS and covers skilled and semi-skilled personnel only.

No attempt has been made to forecast training for the Factory Manager or non technical personnel but at a minimum it will be necessary for them to spend time at a later stage with senior personnel from an existing glassworks to become familiar with techniques and operating standards.

Outline assumptions have been made for the training needs of the

4 plant superintendents but actual programmes will be related to their final job descriptions and previous experience. These will be discussed and agreed with GUYANA GLASSWORKS management before implementation.

It is also assumed that the majority of the training manweeks will be completed on site. It is Rockware International's experience that this is the most effective and least-cost solution for training the main body of skilled operatives.

It is therefore recommended that the plant specification include a small training centre and an allowance for training equipment should be made. Rockware International can supply a specification both for the layout of the centre and the equipment to be acquired for it. This is a minor cost item.

Initial Training Plan

The training plan assumes the involvement of Rockware International training specialists.

Rockware International would make available to Guyana Glassworks its full experience and expertise in technical training to carry out specific training assignments the timing of which will be agreed between Rockware International and Guyana Glassworks but intended to be carried out both before and within the first year of operation.

This training programme is based on Rockware International's experience of the requirements of new plant operation, commensurate with size of operation and indigenous ability.

The programme is envisaged as:-

i). Training of 4 senior GUYANA GLASSWORKS Superintendents in the RI Advanced Training Centre and in the appropriate Rockware Glass factories each for a minimum of 10 weeks during this initial operation. The GUYANA GLASSWORKS engineers individually to be trained in specific areas to be defined by GUYANA GLASSWORKS and RI and the programming planned to suit the timing requirements of the project.

ii). Two Rockware International specialists to supervise and train GUYANA GLASSWORKS production staff in I.S. Machine operation. This training will be carried out on site for a minimum of 20 weeks in line with the commissioning programme. These specialists will also be available to give assistance where necessary to the commissioning team.

iii). One Rockware International specialist to supervise and train GUYANA GLASSWORKS batch and furnace operators on site on an 8 hour daily basis for 8 man weeks spread over the commissioning and post commissioning period.

iv). One Rockware International specialist to supervise and train GUYANA GLASSWORKS annealing and cold end inspection staff for a period of 12 weeks on site. Working periods on this activity to be mutually agreed to suit requirements.

v). Our Rockware International specialist to supervise and train special personnel in forehearth and feeder operation for a period of 6 weeks.

vi) One Rockware International specialist to train personnel in I.S. Machine maintenance and auxilliary equipment for a minimum period of 8 weeks.

vii) One Rockware International specialist to supervise and train personnel in mould maintenance and repair techniques for a period of 6 weeks.

viii) One Rockware International specialist to supervise and train personnel in screen production, decorating machine operation and material preparation for four weeks.

The initial training programme will therefore cover a man week total of over 100 weeks of trainer time and would concentrate on the three key areas.

1. 4 Senior Engineers/Superintendents
2. I.S. Machine Operation/Engineering
3. Cold end inspection personnel/quality control/decorating.

On completion of the initial training programme a review would be completed by Rockware International and GUYANA GLASSWORKS to assess any additional areas of training required and to plan the training requirements up to the second year of operation.

7. ADDITIONAL COMMENT

Details of Rockware International's experience of supplying technical training to clients is given in Appendix A

Training in non technical areas of container production, i.e. accounting systems, personnel, marketing etc. can also be included in our training package.

Technical Assistance and Training Agreement.

A sample agreement is included in Appendix B to this section, and outlines the costs involved in the provision of the recommended assistance.

These are summarised in terms of pre production costs in Appendix C.

APPENDICES

A. Rockware International Experience.

B. Sample of a typical agreement for Technical Assistance, modified to the circumstances of GUYANA GLASSWORKS LIMITED.

C. Pre-Production Personnel costs.

D. Summary of Technical Assistance and Training Fees for ten year operation.

ROCKWARE INTERNATIONAL EXPERIENCE

Details are given of the technical assistance, training and other assistance given by Rockware International to its clients. Where the specific activity is of special interest a short account is given of work under the contract.

Rockware International's full list of clients to date is given overleaf.

TECHNICAL ASSISTANCE AND TRAINING EXPERIENCE 1972 - 1982

1972-1975	Kenya Glass Works	Kenya	Technical Assistance and Training Agreement (T.A.T.A.)
1972-1975	E.M.C.O. Limited	Kenya	T.A.T.A.
1972-1975	Kioo Limited	Tanzania	T.A.T.A.
1972-1975	East African Glass	Uganda	T.A.T.A.
1972-1977	Maliban SA	Lebanon	T.A.T.A. and Management Agreement.
1974-1976	Mina Glass	Iran	T.A.T.A. and Management Agreement
1974-	Turkiye Sise Ve Cam	Turkey	T.A.T.A.
1975-1980	Bormioli Rocco E Figlio	Italy	Furnace Design and Operation
1974-1977	Garrafas De Portugal	Portugal	Turnkey Project
1976-	Irish Glass Bottle	Eire	T.A.T.A.
1976-1978	Azzizia Glass Company	Libya	T.A.T.A. & Management Contract.
1976-	Nienburger Glas	W.Germany	T.A.T.A.
1977-	Stotzle A.G.	Austria	Furnace Design,Operations and Technical Assist.
1977-	West Indies Glass	Jamaica	T.A.T.A. - Management and Full Plant Rehabilitation Prog.
1977-	Malaya Glass	Malaysia	T.A.T.A. - Furnace Design Instal - Commissioning.
1977-1980	Sicilvetro	Sicily	T.A.T.A. and Management Agreement.
1977-1978	V.I.P.A.	Spain	T.A.T.A. and Turnkey New Plant.
1978-	P.T. Iglas	Indonesia	T.A.T.A. Assistance Programme.
1978-1980	Domglas	Canada	Tech.Train.Agreement.
1978-	Kapiri Glass	Zambia	T.A.T.A. and Rehabilitation Programme.
1979-	Latchford Glass	U.S.A.	T.A.T.A.
1979-	Foster-Forbes	U.S.A.	Computer Software
1979-	Indian Head Group	U.S.A.	T.A.T.A.

1979-1981	National Bottle	U.S.A.	T.A.T.A. Programmes
1979-1981	Chattanooga Glass	U.S.A.	Tech. Consultancy
1979-	State Glass	Bulgaria	T.A.T.A.
1979-	State Glass	Poland	T.A.T.A.
1979-	Riihimaen Laji Oy	Finland	Tech. & Marketing Ass. Programme
1979-80	Bangkok Glass	Thailand	Tech.Assistance Prog.
198 0-	West African Glass	Nigeria	T.A.T.A. Management & Expansion Programme
1980-	Yioula Glassworks	Greece	Training Assistance
1981-	Ruby Industries	Philippines	T.A.T.A.
1981-	Pacific Enamel & Glass	Philippines	T.A.T.A.
1981-	Aboso Glass	Ghana	Technical Ass. Programme
1981-	Glass Bottle	Ethiopia	T.A.T.A.
1981-	Fraser & Neave	Singapore	Plastics Ind. Consultancy
1980-	T.I. Reynolds	Birmingham England.	Training Assistance
1981-	Kastrup	Denmark	Computer Software
1981-	Baluchistan Glass	Pakistan	T.A.T.A.
1982-	Ujscie Glassworks	Poland	Training Assistance
1982-	Santos Barosa	Portugal	T.A.T.A.
1982-	Orashazi	Hungary	Technical Assistance
1982-	African Glass	Nigeria	Bottle Decorating Training

ROCKWARE INTERNATIONAL EXPERIENCE IN PROVIDING TECHNICAL ASSISTANCE, ENGINEERING AND CONSULTANCY SERVICES.

Malaya Glass Factory Berhad

72A Jalan Tampoi
P.O. Box 60
Jahore Bahru
Jahore
Malaysia.

Production Capacity

Furnaces : 2 - 1 x 60; 1 x 30 TPD

1 - 100 TPD (under construction)

Machines : 3 x 1S6; 1 x 1S8

Products : Primarily containers for beers and soft drinks.

Date of Contract: 1977 - on-going

Details of Assistance :

An across the board technical assistance consultancy agreement covering a full range of operational activities including comprehensive training programmes in U.K. and Malaysia for full management and supervisory team. An additional contract was concluded in 1980 for the design and commissioning of a 100 tonne regenerative furnace.

Rockware International's services include the following:-

- design of furnace and support steelwork
- recommendations on electrical loadings and other auxiliary systems
- financial analysis
- supervision during construction and "warm-up"
- supervision of initial production runs
- continued technical support
- assistance with production planning

West African Glass Industries Limited

134 Trans Amadi Industrial Layout
P.O. Box 642
Port Harcourt
Nigeria.

Production Capacity

Furnaces : 1 x 115 TPD - 2 x 50 TPD

Machines : 3 x IS Machines

Products : Primarily containers for beers and soft drinks

Date of Contract : 1980 on-going

Details of Assistance:

The project entails a major rehabilitation programme including the installation of 3 new furnaces. As technical consultants to the project Rockware International are supplying the following services:

- a full time team of Rockware specialists to supervise and assist day to day production and operation
- site layout
- plant specification
- consultation on furnace design
- supervision in plant construction and erection
- supervision of installations
- plant commissioning
- on-going technical assistance
- technical training programmes

Kapiri Glass Products Limited

P.O. Box 96
Kapiri Mposhi
Zambia.

Production Capacity

Furnaces : 2 x 60 TPD

Machines : 2 x IS6; 2 x IS8

Products : Containers for foods, beers and soft drinks

Date of Contract : 1978 - on-going

Details of Assistance :

Rockware International were originally engaged by the Company who constructed the factory to provide across the board technical assistance on the full range of production problems. An extended role is now involved following a decision to double the plant output. This includes:-

- a full time team of Rockware specialists to supervise and assist day to day production and operation
- site layout
- plant specification
- consultation on furnace design
- supervision in plant construction and erection
- supervision of installations
- plant commissioning
- on-going technical assistance
- technical training programmes

Azzizia Glass Company

P.O. Box 12581
Tripoli
Libya.

Production Capacity

Furnaces : 1 x 50 TPD

Machines : [illegible] ines

Products : Containers for soft drinks

Date of Contract : 1976 - 1978

Details of Assistance :

The project involved a small new plant built by a French civil engineering company and completed in 1976. Rockware International were called in as technical consultants to the project to assist with commissioning and initial production runs.

The contract was for a 2 year period and during this time Rockware International supplied a team of between 4 and 8 technical specialists to work at the plant on a continuous basis.

Specifically, technical assistance was provided in the following areas:-

- furnace operation
- production engineering
- mould engineering
- electrical engineering
- quality control

Garafas De Portugal S.A.

Lisbon
Portugal.

Production Capacity

Furnaces : 1 x 160 TPD

Machines : 3 x IS Machines

Products : Wines and Soft Drinks

Date of Contract : 1974 - 1977

Details of Assistance:

Rockware International were shareholders and technical partners in the Company, formed to manufacture wine and soft drinks bottles in Portugal. The other shareholders were the C.U.F. Group - the larges industrial company in Portugal and other glass and industrial companies.

Rockware International had full responsibility for the design, specifications and supervision of construction, through a civil contractor, commissioning and providing on-going technical assistance.

Prior to completion of the plant a decision was taken not to proceed further with the project in the light of the economic circumstances which followed the Revolution in 1976.

ROCKWARE INTERNATIONAL TRAINING EXPERTISE AND FACILITIES

Each Rockware plant has its own training centre for basic operator, engineering and inspection training. In addition a purpose built Advanced Training Centre to handle all additional training requirements was designed.

This Advanced Training Centre is located on the site of Rockware's modern manufacturing plant at Wheatley, Doncaster in Yorkshire, and provides excellent opportunities to practice immediately the lessons learned during instruction periods.

At the Centre there are three single section IS Machines deployed in various forms to provide the fullest possible insight into the operation of the entire machine. The same approach has been adopted with forehearths and feeders and where mechanisms are complex, working schematic models have been specially constructed to aid the learning process. In addition to production equipment the Advanced Training Centre is stocked with a wide range of manuals, bottle fault libraries and other training aids.

There are ample classroom facilities for small or large groups, including a lecture room capable of seating 120 people, equipped with 16 mm film projectors, overhead and 35 mm slide projectors. This room can be divided into two parts to suit the size of the audience.

Recognising the important role of visual aids in class instruction, the A.T.C. has built up a library of video tapes and films, the majority of which has been made by the Centre's staff. Facilities for producing visual aids were extended in 1978 on completion of a larger studio, and at the same time colour video was introduced. There are also editing facilities to allow two cameras to operate simultaneously, and so emphasise points of particular importance by close-up filming.

The Centre is particularly proud of one of its developments, this being a method of animating overhead projector transparencies. The use of these slides has been successful in simplifying the explanation of the various mechanisms of complex machinery.

There are now eleven full-time Technical Training Staff working from the Advanced Training Centre servicing the more advanced needs of Rockware Glass and all overseas clients, as well as additional instructors based at each of the four plants to cover basic training. All have practical experience and cover different expertise. Some have been responsible as Shift Production Engineers for running plants of up to seventeen machines, demonstrating the essentially practical approach adopted.

Fully equipped Training Centres have been set up for clients of R.I.L. in Canada, Eire, Italy, the United States, Africa and the Far East on similar lines to the facilities described in this document.

R.I. - Training Contracts

R.I. has to date planned and completed training programmes with over twenty clients world-wide. Details of the type of training etc. are given below.

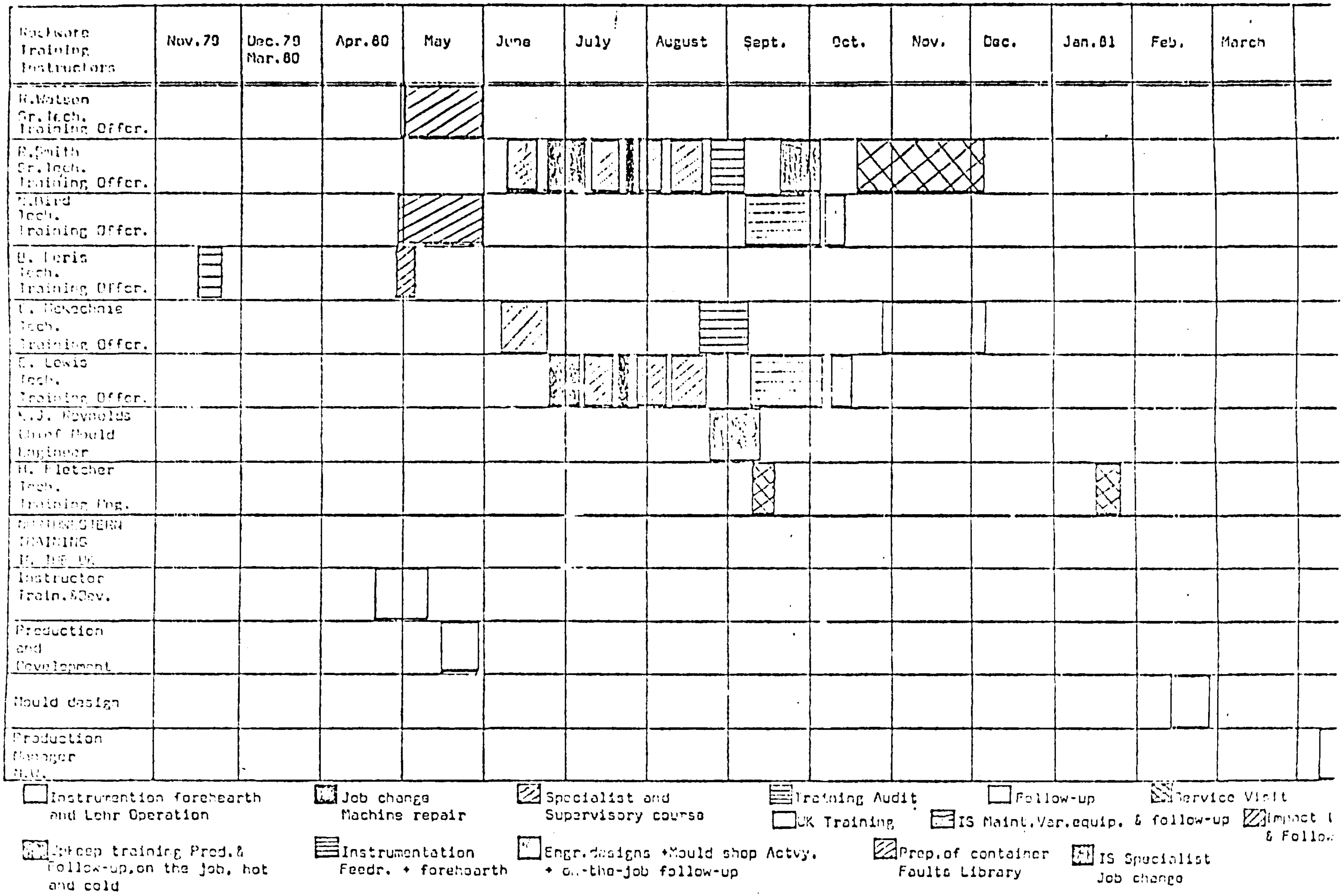
Indian Head Group - (North Western Glass) - Seattle, Washington, U.S.A. (1979 - continuing).

R.I. was contracted to Northwestern to carry out a full training programme in all manufacturing departments. This has to-date covered approximately 80 man weeks of training covering several general and specialist areas. Detail of the training plan so far implemented can be seen at Figure 4.

The training programme is continuing but the following results have been achieved as agreed by the clients:-

- Quality Improvement
- Increase in general efficiencies
- Increase in machine speeds
- Improvements earlier in efficiencies after job change
- Improvement in team work

ROCKWARE INTERNATIONAL TRAINING AT NORTHWESTERN



- Development of personnel
- Improvement in safety and housekeeping
- Engineering improvements

It has been estimated by Northwestern personnel that general efficiencies have improved from around 75 - 77% at the beginning of the training activity to up to 81% at the last service visit. Some production jobs previously run at low efficiencies are now being successfully run at 85% plus efficiency.

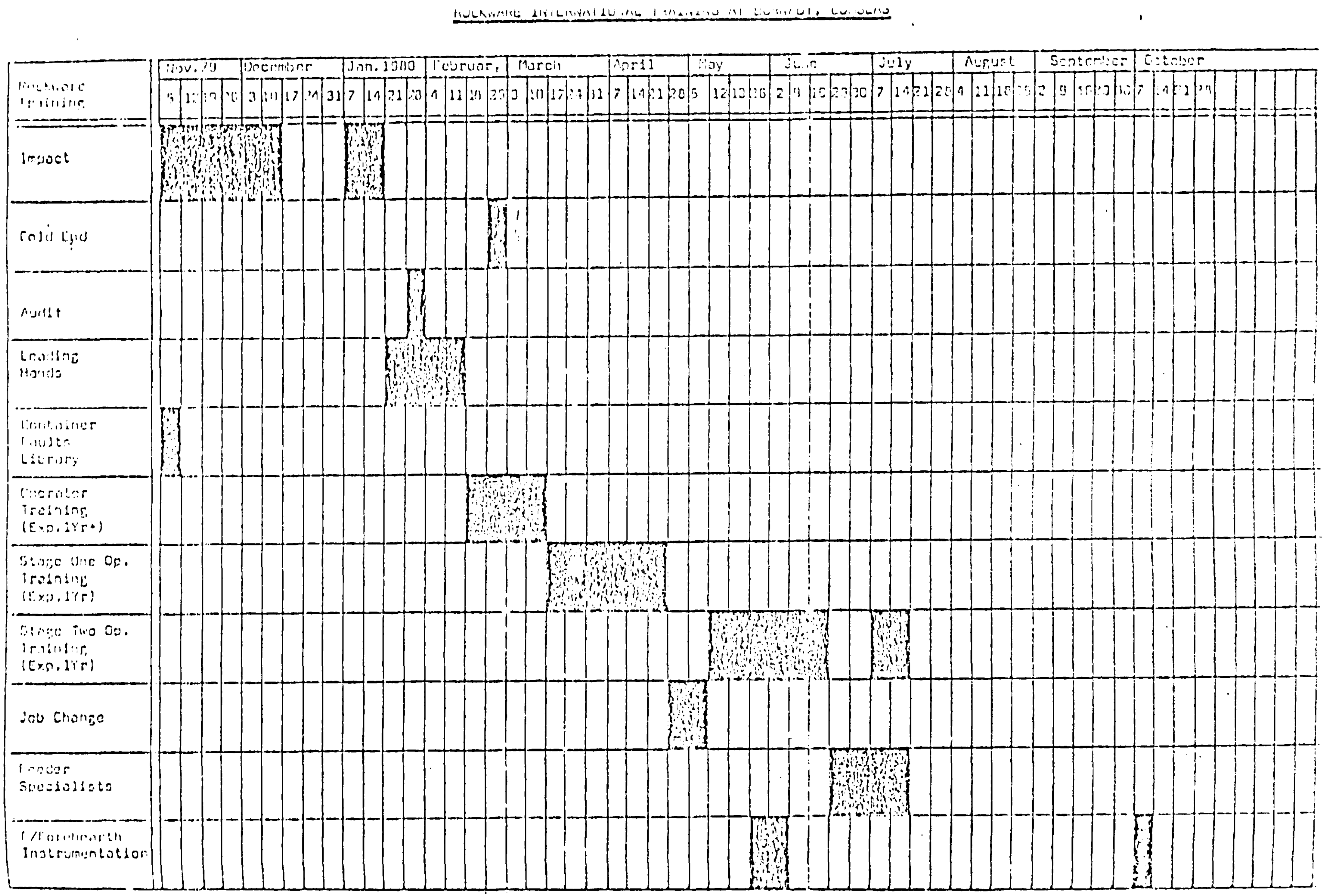
Northwestern Glass Limited	:	5 furnaces
		550 - 640 TPD
		10 IS Machines

Additionally R.I. set up and equipped a local training centre and trained the local instructor to the appropriate standard.

Domglas Inc. Toronto, Canada - (1978 - 1980).

The contract with Domglas ran for two years and in addition to normal training covered the establishing of a training centre at each of the five plants together with training of the potential instructors. Full training programmes were implemented at each plant and the local instructors were gradually phased in to handle all training. The programme covered approximately 150 man weeks of training. An example of the plant to plant programme can be seen in Figure 5. Over 1000 people passed through the Domglas training programme. Domglas Inc. operate a total of 5 glass container manufacturing plants.

FIGURE 5



ROCKWARE INTERNATIONAL TRAINING AT [illegible]
Nov.79
December
Jan.1980
February
March
April
May
June
July
August
September
October
Rockware Training
Impact
Cold End
Audit
Leading Hands
Container Faults Library
Operator Training (Exp.1Yr+)
Stage One Op. Training (Exp.1Yr)
Stage Two Op. Training (Exp.1Yr)
Job Change
Feeder Specialists
F/Forehearth Instrumentation

SAMPLE OF A TYPICAL AGREEMENT
FOR TECHNICAL ASSISTANCE, MODIFIED
TO THE CIRCUMSTANCES OF GUYANA
GLASSWORKS LIMITED.

THIS AGREEMENT is made day of

GUYANA GLASSWORKS, a corporation incorporated in Guyana and having its principal place of business at

and ROCKWARE INTERNATIONAL LIMITED, a company registered in England and having its registered office at Riverside House, Riverside Way, Northampton, England.

WHEREAS :

(A) ROCKWARE INTERNATIONAL LIMITED is possessed of and has access to much expertise and "know-how" in the manufacture of glass containers.

(B) GUYANA GLASSWORKS operates one plant in Guyana engaged in the manufacture of glass containers and desires the assistance of ROCKWARE INTERNATIONAL LIMITED and ROCKWARE INTERNATIONAL LIMITED is willing to supply such assistance on the terms and subject to the conditions set out below.

NOW in consideration of the premises and of the mutual purpose herein set forth GUYANA GLASSWORKS requests the services of ROCKWARE INTERNATIONAL LIMITED and ROCKWARE INTERNATIONAL LIMITED agrees to provide such services upon the terms following that is to say:

SECTION 1

DEFINITIONS

In this Agreement unless otherwise clearly indicated by the context, the following terms shall have the meanings hereinafter set forth:

1.1 GUYANA GLASSWORK/G.G. - Guyana Glassworks

1.2 INTERNATIONAL/RI - Rockware International Limited

1.3 The Premises - The one glass container manufacturing plant operated by GUYANA GLASSWORKS in Guyana with one furnace and one I.S. Machine.

1.4 Commencement Date - means ....

1.5 Period of the Agreement - means the period commencing on the Commencement Date and terminating ten years thereafter.

1.6 ROCKWARE - Rockware Glass Limited.

SECTION 2

OBLIGATIONS AND LIABILITIES OF INTERNATIONAL

2.1 INTERNATIONAL undertakes to provide the following services for G.G.

2.1.1 Access through INTERNATIONAL to ROCKWARE'S technical expertise and experience in the operation of glass container plants and in glass container technology save as provided in Section 2.4 hereunder.

2.1.2 All necessary assistance in the design, specifications, procurement and supervision in connection with the equipping and start-up of Guyana Glassworks.

2.1.3 Assistance in all technical aspects of plant operation and maintenance in connection with the operation of GUYANA GLASSWORKS.

2.2 SPECIFIC ASSISTANCE AND GENERAL BACK-UP SERVICES

2.2.1 To make available these services, INTERNATIONAL undertakes to provide suitably qualified individuals to assume responsibility for technical and production operations in the plant; the Team Leader of which shall report to the Managing Director. Throughout the life of the Agreement all such individuals shall be International's employees.

The individuals designated will be provided on a normal working day basis of 5 days 40 hours per week. It is planned that the Team Leader will unless otherwise agreed, stay for at least two years but it is accepted that the others may be replaced more frequently by more appropriately qualified personnel as GUYANA GLASSWORKS needs for assistance develop.

INTERNATIONAL undertakes to maintain a reasonable degree of continuity in seconding individuals to Guyana Glassworks.

2.2.2 The International team shall assume technical and production responsibility for the first 5 years of this agreement allowing time for GUYANA GLASSWORKS employees to gain sufficient experience to take over responsibility in year 6 and thereafter.

The International Team Leader shall also attend Board meetings of GUYANA GLASSWORKS to discuss Technical and Production matters.

In addition to the permanent team (scheduled below) International shall make available other technical and training specialists to GUYANA GLASSWORKS up to a maximum in each year as scheduled below. International and GUYANA GLASSWORKS shall agree on the numbers, timing and types of individuals seconded to provide assistance.

SCHEDULE:

Year:	1	2	3	4	5	6	7	8	9	10
Team Leader	1	1	1	1	1	-	-	-	-	-
Batch & Furnace	1	1	1	1	1	-	-	-	-	-
Additional Furnace Support (Man Wks)	-	-	-	-	30	-	-	-	-	-
I.S. & Equipment Engineers	2	1	1	1	1	-	-	-	-	-
Prod. Specialists	4	2	2	1	1	-	-	-	-	-
Inspection and Quality Control	2	1	1	-	-	-	-	-	-	-
Additional Back-up Support from U.K. (Man weeks)	50	40	40	25	25	75	75	75	75	75

2.2.3 International shall provide GUYANA GLASSWORKS with Personnel Planning and Recruitment services covering the following:-

(a) The provision of a suitable organisation chart and management plan for GUYANA GLASSWORKS.

(b) The provision of job descriptions for all levels of staff.

(c) The provision of Personnel recruitments and qualifications for all levels of staff, in assessment of local skills and skill levels.

(d) Attendance and participation with GUYANA GLASSWORKS management personnel in interviews with selected candidates, supervising aptitude tests and recommending appointments.

2.2.3 International shall provide GUYANA GLASSWORKS with a training programme the aim of which will be to provide a basic skill level to the key job holders within GUYANA GLASSWORKS in accordance with the following programme.

	POSITION	NO.	MINIMUM MAN WEEKS OF TRAINING PER PERSON	TRAINEE WEEKS TOTAL
(a)	Superintendent	4	10	40
(b)	Production Operators	8	5	20
(c)	Batch & Furnace Ops.	8	2	8
(d)	Annealing & Cold End Inspection Staff	20	3	12
(e)	Forehearth & Feeder Staff	2	6	6
(f)	Machine & Maintenance Engineers	9	4	8
(g)	Mould Maintenance	6	4	6
(h)	Decorating/Screen	4	2	4

2.2.4 International shall provided GUYANA GLASSWORKS during the planned two years to commissioning date, technical support to plan, design and procure the equipment contained in the feasibility study dated including liaising with suppliers and agreeing schedules of work etc.

2.3 INTERNATIONAL further agrees to provide:

2.3.1 Copies of relevant ROCKWARE drawings, specifications and technical records at nominal charge to cover the cost of reproduction and postage but which copies shall remain the exclusive property of ROCKWARE and may not without ROCKWARE'S written consent be copied or reproduced, be transmitted or communicated to any third party provided that GUYANA GLASSWORKS shall have the right to retain possession thereof throughout the period of the Agreement. Any drawings, specifications and technical information prepared specifically for GUYANA GLASSWORKS will remain the property of GUYANA GLASSWORKS.

2.4 INTERNATIONAL is unable to disclose to GUYANA GLASSWORKS (as GUYANA GLASSWORKS hereby acknowledges) techniques, know-how and information in certain areas which are the subject of various confidential agreements which INTERNATIONAL and/or ROCKWARE has with certain parties, but INTERNATIONAL warrants that such agreements will in no way affect GUYANA GLASSWORKS' ability to effect the programme contained in the Feasibility Study dated

2.5 It is GUYANA GLASSWORKS' responsibility to complete the programme contained in the Feasibility Study and INTERNATIONAL shall not be liable for failure to achieve any targets or objectives except insofar as such failure shall result from a substantial and material breach by INTERNATIONAL of their obligations under this agreement.

2.6 INTERNATIONAL shall use its best endeavours, skill and experience in performing the services, aid and advice to be rendered (by it) to GUYANA GLASSWORKS but neither INTERNATIONAL nor ROCKWARE shall become liable in any way for loss or damage to GUYANA GLASSWORKS howsoever arising as a result of applying such services, aid or advice, (other than through gross negligence or wilful default).

SECTION 3

OBLIGATIONS AND LIABILITIES OF GUYANA GLASSWORKS

3.1 INTERNATIONAL shall at all times have the right of access to GUYANA GLASSWORKS and the Premises to perform its obligations under this Agreement.

3.2 GUYANA GLASSWORKS shall provide all necessary technical and costing information, including technical reports requested by INTERNATIONAL, data, and figures to enable INTERNATIONAL to carry out the duties according to its obligations.

3.3 GUYANA GLASSWORKS shall assist INTERNATIONAL's personnel as necessary in the execution of their duties in Guyana.

3.4 GUYANA GLASSWORKS shall keep secret all advice, information and recommendations given or made by INTERNATIONAL and shall ensure that advice, information and recommendations shall only be made available to GUYANA GLASSWORKS employees and will not otherwise be published except insofar as may be necessary or desirable in any legal or arbitration proceedings in which GUYANA GLASSWORKS is a party.

3.5 GUYANA GLASSWORKS shall not alter the duties and responsibilities of INTERNATIONAL'S personnel or take any action connected with the defined and agreed work programme without prior reference to INTERNATIONAL.

3.6 This Agreement is of mutual faith and understanding and GUYANA GLASSWORKS hereby acknowledges that it, its ASSOCIATED Companies and its employees will not enter into any contracts of employment with any ROCKWARE or INTERNATIONAL staff during the Period of this Agreement.

SECTION 4

LEGAL AND FINANCIAL OBLIGATIONS OF GUYANA GLASSWORKS

4.1 FEES

In consideration of the services to be performed by INTERNATIONAL under this Agreement, GUYANA GLASSWORKS shall pay to INTERNATIONAL the following fees:

(a) Personnel and Recruitment services described in clause 2.2.2. A fee of £75,000 (pounds sterling) payable £35,000 (pounds sterling) on the commencement date and a further £40,000 (pounds sterling) one year thereafter.

(b) Training Services as described in clause 2.2.3. A fee of £100,000 payable as follows:

- £50,000 when the training programme commences
- £25,000 when commissioning work commences
- £12,500 one year after commissioning work commences
- £12,500 two years after commissioning work commences.

(c) Technical Assistance Services described in clause 2.2.1. Fees payable in accordance with the following schedule:-

* Year 1	Four	quarterly	payment	in advance	each	of	£115,000
2	"	"	"	"	"	"	£71,250
3	"	"	"	"	"	"	£71,250
4	"	"	"	"	"	"	£50,000
5	"	"	"	"	"	"	£60,000
6	"	"	"	"	"	"	£18,750
7	"	"	"	"	"	"	£18,750
8	"	"	"	"	"	"	£18,750
9	"	"	"	"	"	"	£18,750
10	"	"	"	"	"	"	£18,750

* Each year being calculated from 3 months prior to the date commissioning work commences.

(d) Technical Planning services described in clause 2.2.4. A fee of £75,000 payable

£37,500 on the date of commencement

and £37,500 one year thereafter.

4.2 All reasonable expenses incurred by GUYANA GLASSWORKS personnel visiting ROCKWARE and/or ROCKWARE/INTERNATIONAL personnel visiting GUYANA GLASSWORKS and all necessary work permits shall be the responsibility of GUYANA GLASSWORKS and shall without prejudice to the generality of the obligation include:

i) Transportation to and from GUYANA GLASSWORKS and to and from the normal place of residence and via the nearest or most convenient airport.

ii) Local transportation in Guyana.

iii) All reasonable accommodation, food and living expenses throughout each visit to Guyana from leaving the normal place of residence until return.

4.3 TERMS AND CONDITIONS OF PAYMENT

4.3.1 GUYANA GLASSWORKS shall obtain any State approval which may be or become necessary and shall comply with all legal regulations which may be or become necessary to cover:

- Initial start for the Agreement with INTERNATIONAL
- Ongoing payment of fees and expenses to INTERNATIONAL.

4.3.2 Any expenses incurred by INTERNATIONAL or ROCKWARE associated with the services to be provided hereunder shall be invoiced and payable in sterling by GUYANA GLASSWORKS monthly in arrears, and shall be due for payment within 30 days after receipt of the invoice.

4.3.3 All amounts payable to INTERNATIONAL shall be payable to ROCKWARE INTERNATIONAL by sight draft drawn on a Bank in London, England.

4.3.4 In the event of payment of fees and expenses not being made on the due date for whatever reason, INTERNATIONAL shall have the right to give notice that if not paid within 30 (THIRTY) days, this Agreement will terminate (without prejudice to INTERNATIONAL's right to sue for payment for such fees and expenses and any other rights it may have arising out of such non-payment). Section 9 shall continue to have effect notwithstanding such termination. Interest will be charged on a daily basis for all amounts outstanding beyond 30 (THIRTY) days.

4.3.5 All fees and expenses in this Agreement are quoted net of any taxes payable on them in Guyana and any such taxes levied are payable by GUYANA GLASSWORKS.

4.3.6 All fees quoted in this Agreement are based on prices existing at 1st January, 1985. Fees payable by GUYANA GLASSWORKS will be inflated thereafter by calculating the average salary inflation percentage in the United Kingdom in each quarter year and adding it to figures quoted in this Agreement.

SECTION 5

PERIOD OF THE AGREEMENT AND TERMINATION

5.1 Both parties agree to consult with each other at least 6 (SIX) months before the expiry of this Agreement in order to determine by mutual consent the terms and conditions of an extension to this Agreement for a further five years period. If no mutual Agreement to extend is reached prior to the last day of Year 10 from the Commencement Date of this Agreement it will be automatically terminated at that date.

5.2 In the event of INTERNATIONAL terminating the Agreement under any of Sections 4.3.4, 5.3, 5.4 or 5.5 GUYANA GLASSWORKS as consideration for the disclosure of INTERNATIONAL's "know-how" and expertise shall pay to INTERNATIONAL an access fee of £150,000 in addition to the fees described in Section 4. In the event of termination under the provisions in Sections 4.3.4, 5.3, 5.4 or 5.5, the fees chargeable in Section 4 shall be calculated on a day-to-day basis to the date of termination and will be payable on that date.

5.3 If either INTERNATIONAL or GUYANA GLASSWORKS shall (whether by act or omission) have committed a material breach of any of its obligations under this Agreement and shall not within 60 (SIXTY) days after having been given notice of such breach by the other party specifying the matter complained of having remedied such breach the party specifying the matter complained of having remedied such breach the party not in breach shall be entitled to terminate this Agreement by giving the other not less than 30 (THIRTY) days notice in writing.

5.4 If either INTERNATIONAL or GUYANA GLASSWORKS shall have an execution or distress; levied on its goods or shall enter into liquidation (whether compulsory or voluntary otherwise than for the purpose of amalgamation or reconstruction) or shall have a receiver appointed of its undertaking property or assets or shall enter into any composition or arrangements with its creditors or shall cease to carry on business the other party shall be entitled forthwith to terminate this Agreement and shall give notice to the other party of any such termination.

5.5 In the event of GUYANA GLASSWORKS entering into an Agreement with a third party providing for the management or control of GUYANA GLASSWORKS to be undertaken by that or some other party which affects the present position of INTERNATIONAL (e.g. a competitor) or if new shareholders shall acquire shares which in aggregate carry more than 50% of the voting rights of GUYANA GLASSWORKS, INTERNATIONAL shall be entitled forthwith to terminate this Agreement and shall give notice to GUYANA GLASSWORKS of such termination.

5.6 If circumstances of Force Majeure (as defined in Section 7 hereof) shall have persisted for more than 6 (SIX) months after notice of any such circumstances shall first have been given in accordance with the provisions of Section 7 below, then either party shall be entitled to terminate this Agreement by giving the other party not less than 30 (THIRTY) days notice in writing.

The parties agree that if circumstances of Force Majeure shall occur and if it seems likely that these circumstances will persist for an extended period then the parties will endeavour to reach an understanding on how this operation of the Agreement could be suspended during the period of Force Majeure including the payment provisions hereunder. It is agreed that this provision is of a good faith nature.

5.7 Any termination under the provisions of this Section shall be without prejudice to the rights of either party in respect of any antecedent breach of any of the obligations herein contained and the confidentiality provisions of Section 9 hereof shall survive and remain in force notwithstanding such termination.

SECTION 6

NOTICE

6.1 Any notice required or which may be given hereunder by either party shall be in writing and shall be deemed duly and properly given if addressed in the case of INTERNATIONAL to the "General Manager" and in the case of GUYANA GLASSWORKS marked "For the Attention of the Managing Director" and left or sent by registered post or, (if appropriate), by telex to the last known address of the party to whom it is given and shall be deemed to have been served at the expiration of 21 (TWENTY-ONE) days by post and 2 (TWO) days by telex from the time of posting or transmission thereof.

SECTION 7

FORCE MAJEURE

7.1 If the performance of this Agreement or any obligation hereunder, except the payment of all sums of money payable under this Agreement, is prevented, restricted or interferred with by reason of:

7.1.1 Fire, explosion, breakdown of plant, failure of machinery, strike, lock-out, dispute, casualty or accident, lack or failure in part or in whole of transportation facilities, epidemic, cyclone, flood, drought, lack or failure in whole or in part of sources of supply of labour, raw materials, power or supplies; or

7.1.2 War, revolution, civil commotion, acts of public enemies, blockade or embargo, or

7.1.3 Any law, order, proclamation, regulation, ordinance, demand or requirement of any government or any department authority or representative of any such government; or

7.1.4 Any other acts whatsoever, whether similar or dissimilar to those enumerated, beyond the reasonable control of the parties hereto.

The party so affected, upon giving prompt notice to the other party, shall be excused from such performance to the extent of such prevention, restriction, or interference provided that the party so affected shall continue performance hereunder with the utmost despatch whenever such conditions are removed.

SECTION 8

CONFIDENTIALITY

8.1 This Agreement is one of mutual trust and good faith and accordingly GUYANA GLASSWORKS hereby acknowledges on behalf of itself, its employees and its associated companies the obligation to maintain the utmost confidentiality both during this Agreement and thereafter on all information, techniques, "know-how", drawings and specifications or the like which may come into its possession from either INTERNATIONAL or ROCKWARE and further GUYANA GLASSWORKS shall procure the delivery to INTERNATIONAL of confidentiality Agreements duly signed by all personnel of manager level and above to whom information techniques and "know-how" as provided by INTERNATIONAL may be disclosed. During the continuance of this Agreement and after the termination of same GUYANA GLASSWORKS shall have the non exclusive Royalty Free Licence to use for all time any technical advice and assistance furnished hereunder solely at the plant of the company in Guyana from time to time. INTERNATIONAL for its part undertakes not to disclose any information coming into its possession on the activities of GUYANA GLASSWORKS during the course of this Agreement save that which is already in the public domain.

8.2 In the event that GUYANA GLASSWORKS or any of its officers or employees shall invent, discover, control or possess any improvement in technology within the scope of this Agreement (whether patentable or not) it shall where it is legally able forthwith communicate the details thereof in its possession to INTERNATIONAL and ROCKWARE who may use the same for their own purposes without payment of any royalty or other consideration, but shall maintain in utmost confidentiality the details thereof so that 3rd parties shall not obtain the use thereof.

8.3 INTERNATIONAL shall disclose to GUYANA GLASSWORKS any improvements in technology within the scope of this Agreement of which it becomes possessed and which it is legally able to communicate during the period of this Agreement.

8.4 Neither INTERNATIONAL nor ROCKWARE shall enter into technical assistance and consultancy agreements with other Glass or Plastic Container Manufacturers in Guyana during the period of the Agreement without GUYANA GLASSWORKS written consent, such consent not to be unreasonably witheld.

8.5 Subject to the provisions of this Section 8, nothing contained in this Agreement shall prevent or restrict the right of GUYANA GLASSWORKS to enter into other technical assistance and consultancy agreements.

SECTION 9

ALTERATIONS

9.1 Alterations, amendments or supplements to this Agreement must be in writing and signed by a duly authorised officer of each party.

B-226

83.10.03

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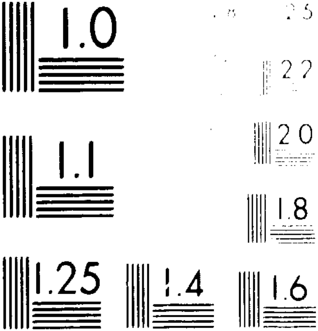
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SECTION 10

APPLICABLE LAW

10.1 This Agreement shall in all respects be governed and construed in accordance with the Law of England.

10.2 Any legal proceedings taken by GUYANA GLASSWORKS or INTERNATIONAL shall be brought in and be subject to the decisions of the English Court.

AS WITNESS the hand of on behalf of GUYANA GLASSWORKS and the hand of on behalf of ROCKWARE INTERNATIONAL.

SIGNED by the said)
)
)
)
on behalf of GUYANA GLASSWORKS)
in the presence of:)

Witness:

Address:

Occupation:

SIGNED by:)
)
)
)
on behalf of ROCKWARE)
INTERNATIONAL LIMITED)
in the presence of:)

Witness:

Address:

Occupation:

APPENDIX C

SUMMARY PRE PRODUCTION CAPITAL COSTS - PERSONNEL

	£	* G$
Pre Production Year 2		
Technical Planning, Project Control and Procurement	37,500.00	50,000.00
Personnel, Recruitment and Commissioning	35,000.00	20,000.00
Pre Production Year 1		
Technical Planning, Project Control and Procurement	37,500.00	50,000.00
Personnel, Recruitment and Commissioning	40,000.00	20,000.00
Training Programme (Part)	50,000.00	48,000.00
	£200,000.00	188,000.00
	G$ 1,000.000.00	188,000.00
TOTAL	G$	1,188.000.00

* Estimated costs - expenses i.e. airfares, local accommodation, subsistence etc.

SUMMARY OF TECHNICAL ASSISTANCE AND TRAINING FEES FOR TEN YEAR OPERATION

The table below gives the breakdown of the Technical Assistance and Training fees for the ten year period. An assessment has been made for local costs at a rate of 15% of fee level. These cost assessments cover the provision of hotel accommodation, subsistence, air fares and local transport for short-term visit personnel (e.g. training officers) and houses, services, subsistence, airfares and local transport for long term personnel. All areas under this section are to be supplied to standards acceptable to Rockware International.

GUYANA GLASSWORKS should examine these totals and confirm that they will cover the requirement.

	TRAINING		TECH. ASST.		£.	G$
YEAR	£ FEE	G$ EXPENSES	£ FEE	G$ EXPENSES	TOTAL	TOTAL
1	25,000		460,000	363,750*	485,000	363,750
2	12,500		285,000	223,125*	297,500	223,125
3	12,500		285,000	223,125*	297,500	223,125
4			200,000	150,000	200,000	150,000
5			240,000	180,000	240,000	180,000
6			75,000	93,750	75,000	93,750
7			75,000	93,750	75,000	93,750
8			75,000	93,750	75,000	93,750
9			75,000	93,750	75,000	93,750
10			75,000	93,750	75,000	93,750

* Figures include training expenses for years 1, 2 and 3.

PART III

OPERATIONAL STRATEGY AND FINANCIAL PROJECTION.

PART III : CONTENTS

OPERATIONAL STRATEGY

Aim of the feasibility study:

The aim of the feasibility study was to assess the conditions under which GUYANA GLASSWORKS could operate as below:

- to technically acceptable criteria
- to financially acceptable criteria
- with positive cash flow
- with potential profits
- with minimum capital expenditure
- with maximum savings of foreign exchange over the costs of imported containers
- with substantial employment opportunities
- with the development of industrial training

It must be stated again that if GUYANA GLASSWORKS LIMITED is required as a going concern to finance and repay the existing debts and costs (in whole or in part) then the Company will never be viable. For the purposes of the financial and technical strategy it has been assumed that this will not be the case.

Initial Appraisal.

An initial financial appraisal was completed to ascertain the viability of the plant on the following assumptions.

- all requisite pre production modifications to the existing plant are carried out (as per Part I)
- acceptance of recommended levels of technical assistance and training (as per Part II)
- acceptance of local market assessments
- sales income based on the GG budget unit price of .90¢.
- energy consumption at the predicted levels assumed to be correct
- all GUYANA GLASSWORKS budget figures for 1982 accepted or as basis for assessment, i.e. personnel costs, administration etc.
- all normal glassworks operational costs assumed appropriate for GUYANA GLASSWORKS, e.g. spares levels, efficiency levels, services.

The initial appraisal indicated clearly that any attempt to operate the plant under the above assumptions would create a continuous loss making situation over the ten year period with negative cash flow. The loss would be in excess of G$15 million; with a one year delay until possible technical start-up.

The approach was therefore reassessed concentrating on the major cost areas contributing to the operational loss.

Revised Approach

It was agreed that certain of the initial assumptions were still valid. The projected market was examined using material supplied by GUYANA GLASSWORKS and its potential customers. A typical annual consumption was created with machine and furnace loading figures. (See Appendix I

Figs. I and II). The analysis indicated a local demand of 5422 tonnes in 1982 and that at average efficiency and accepted bottle weights the market could be supplied by the existing production equipment.

However the existing furnace has a rated capacity of 15-17000 tonnes per annum. Given the poor design and construction, and the requirement to pull the furnace at less than half of its capacity, its poor thermal efficiency created a heavy financial burden through excessively high fuel consumption. In addition the anticipated life of two years necessitated a furnace rebuild in Year 3 of production. It would be inadvisable to replace the existing furnace with anything but a modern design, thermally efficient unit. Following the projected furnace rebuild to modern design, the fuel savings would be in the region of 50%.

In addition to the fuel savings a modern design furnace with appropriate specification would offer a minimum life of five years and probably require only a repair to extend operation to ten years. A modern furnace could more easily accept the varying daily tonnages anticipated and retain its overall thermal efficiency. It would also offer better scope for increased tonnage should the local market increase beyond anticipated levels or exports become a possibility. For the purposes of this appraisal an annual increase of 2% in the local market up to 1990 and 5% thereafter has been assumed.

If the existing furnace were to be started up and run for its anticipated life there would be considerable downtime in year 3 for demolition and rebuild. As it was predicted that it would take one year to get the existing plant operational and that to design and install a modern furnace would take approximately eighteen months from the decision being taken, the merit of starting with the existing furnace is limited to six to nine months expensive production and operation.

The strategy to install a new furnace before start-up was therefore proposed. This would delay the start-up of the plant by two years to the beginning of 1985 as opposed to the beginning of 1984 but would offer the following advantages:-

- time to design and plan the project effectively
- period for training and familiarisation
- economic operation of the major component
- effective start-up
- five years uninterrupted production.

Additionally the projected market expansion would require a second production line in year 6. The facility to do this would be incorporated in the design, and the tonnage at economic melting rates would be available.

A second financial appraisal was therefore made on this strategy.

Second Appraisal

All financial projections have been made without allowance for inflation from 1985 onwards. Certain costs have been increased up to 1985. All financial assumptions are described in detail in Appendix 1.

The appraisal is based on a two year pre production period and then ten years full operation.

The following additional assumptions have been made:

- Foreign Exchange Availability : a regular supply of foreign exchange is required throughout this project. The totals required and the flow is detailed in Appendix , together with the savings in foreign exchange to be made by local production over importing to meet market demand.

- the ability of GUYANA GLASSWORKS to operate at the required production efficiencies i.e. 75% in 1985, 77% in 1986, 80% thereafter. This depends entirely on the use of expatriate skilled labour, related training and the technical requirements of the project being available in its opening years. The technical assistance and training proposals are geared to the target efficiencies.

- the availability of local labour with the ability to be trained and developed over the projected periods.

- Market Protection : It must be stated that the current pricing policies of other regional glass container manufacturers could adversly affect the viability of GUYANA GLASSWORKS and the projected foreign exchange savings, if full free competition from outside GUYANA is allowed. It is essential for the success of GUYANA GLASSWORKS that its local market be protected by some measure of import control or by directives to customers commensurate with bottle requirements until such time as the company is sound and able to compete technically and financially on an equal footing.

- Capital Investment : The adoption of the proposed strategy will create the need for loans to be taken out. The level of these loans are stated and detailed in the financial assumptions. For any progress to be made on the project further investment is necessary. Indeed, investment to the level indicated is essential for satisfactory long-term operation. Full breakdown of pre-production capital requirements are included in Part I Appendix XVIII and Part III Appendix I Item 19.

- Existing Foundations : It has been assumed that the existing foundations for the furnace at GUYANA GLASSWORKS are correctly constructed and suitable for their purpose. Financial appraisals of furnace requirements do not include the need to replace the foundations. If the foundations are not satisfactory, additional costs will be incurred which will delay the project and the movement into profitability. A full structural survey will be an essential first step should the decision to proceed be taken.

Profitability of GUYANA GLASSWORKS

The financial results of the appraisal are given in Appendices 2 - 6.

- Appendix 2 Profitability statement (10 years)
- Appendix 3 Profit and Loss Account (10 years)
- Appendix 4 Funds Flow Statement (Cash Flow)
- Appendix 5 Balance Sheet 1985 - 1994
- Appendix 6 Foreign Exchange Usage & Savings

In summary the figures indicate a profitable operation over the ten year period with a positive cash flow, an operational profit of G$15.322 million and retained profits of G$9.460 million.

It is the case that some of the assumptions are variable and recalculation of their valves is possible by reference to Appendix 1.

Strategy and Appraisal Summary

Given the above strategy implications and given the various assumptions it is projected that GUYANA GLASSWORKS LIMITED could be started up and operate to required technical and financial standards, with positive cash flow and profits, offer foreign exchange savings over the current position and employ large numbers of personnel developing a light industrial experience and training base.

The basic conditions for this are:

- adoption of the new furnace strategy
- employment of project control
- employment of full technical assistance, personnel and training recommendations
- availability of foreign exchange facilities
- market protection
- obtaining of loan and equity requirements
- writing off the existing debts and costs other than to GUYANA GLASSWORKS LIMITED.

Strategy beyond Glass Container Production

Given the assumed market expansion and the adoption of the strategy, a second container line would come into operation in 1991. The facilities of the pressware line as installed will therefore be eliminated. As the pressware line stands it is incomplete and the proposed strategy requires its removal. There is no advantage to be gained at present by the reinstallation of the pressware line and its operation. However consideration could be given to this in the early production years; assuming the success of the container line and the market for pressware being present.

Additional forehearth and feeder facilities can be added to the furnace with disrupting bottle production.

The future of the flat glass production facilities have not been considered in this report. However if it should ever be started up, additional warehouse and work areas will need to be created for the container lines.

Comment

It should be noted that during the preparation of this study Rockware International has come to the firm view that the plant, if operated as it stands, would make substantial losses if judged on normal market and financial considerations, as would almost any plant of this size and output.

As part of its brief, however, Rockware International has looked for a set of circumstances that would show an acceptable return starting from the given point that the projections would not include the financing or repayment of the original debts. The circumstances that provide this acceptable set of figures are detailed in this report (and the replacement of the furnace being the key to meeting these criteria).

Many assumptions have been taken from figures supplied by Guyana Glass and other authorities within Guyana, and for the purpose of this exercise these have been accepted at face value. There is no doubt that in free market circumstances the economics of the project would not justify further investment envisaged from activating the company, but so long as the Guyanese authorities are prepared to protect Guyana Glass against imports and the assumptions given to Rockware International from

Guyana sources are correct, then the company should be capable of producing the results indicated.

Rockware International have used their best endeavours to ensure that the information in this report is as accurate as circumstances allow. We cannot advise on the acceptability or reliability of the information listed and consequently cannot be held liable in any way for the results of actions taken on the basis of this report.

APPENDIX I

COST ASSUMPTIONS FOR FINANCIAL PROJECTIONS

1. Sales : Tonnes
2. Sales Realisation
3. Raw Materials
4. Electricity
5. Heavy Oil : Furnace
6. Light Oil/Diesel : Lehr/Dryer
7. Propane Gas (Forehearth, Lehr Entry)
8. Water
9. Packing Materials
10. Selling and Distribution Costs
11. Salaries Wages and Related Costs
12. Moulds
13. Repairs and Maintenance
14. Plant Insurance
15. Training
16. Technical Assistance

17. Administration Costs

18. General

19. Capital Expenditure
    - Initial Financing Requirement

20. Depreciation

Figs. 1 - 10

COST ASSUMPTIONS FOR FINANCIAL PROJECTIONS

1. Sales : Tonnes

The projected sales in tonnes of glass is based on an assessment of the existing local demand. Materials supplied by GUYANA GLASSWORKS and its potential clients formed the basis of this research. Total tonnage for 1982 is based on requested units at an agreed weight. This typical annual bottle production is detailed in Fig. 1. Tonnages for subsequent years assume an increase of 2% per annum across all product sectors to 1990 and 5% per annum thereafter. Projected annual tonnage figures, machine loading etc. are given in Fig. 2. Assessed 1982 tonnage is 5422.

The reduction in tonnage in 1990 takes into account 90 days downtime for furnace repair.

Machine loading is given in Fig. 3 for 1982.
The increased demand indicates a requirement for a 2nd production line in 1991. Income and costs from the second line are included from 1991.

2. Sales Realisation

The projected sales income is based on an average price per tonne of glass in 1982 of G$2375. This figure is based on a 1982 price of the standard beer bottle of 95¢ at 400 grams weight. A price increase of 5% per annum has been assumed up to 1985. The sales income per tonne of glass from 1985 is G$2618. Sales income is given in Fig. 2.
The sale price of 95¢ is taken from GUYANA GLASSWORKS Notes to Budget, 1982.

3. Raw Materials

Using 1982 raw material prices supplied by GUYANA GLASSWORKS and information on general world prices, batch costs per tonne of glass have been calculated based on the proposed batch compositions detailed in Part 1 of the report.

Both amber and flint batch costs have been rounded to G$236 for 1982. This has been uplifted by 5% per annum to 1985. Calculations are based on batch cost per tonne of glass at G$273.20.

No allowance has been made for the use of existing supplies of raw materials. These will offer approximately 30% cost saving in the first year of operation.

Batch cost calculations are given in Fig. 4.

4. Electricity

i). Using data supplied by GUYANA GLASSWORKS (Crandon Report) the following consumption schedule was derived:

ITEM	KW @ 80%	HOURS	DAILY USAGE	FURNACE DOWN
Drying	26	12	312	-
Crushing	9	12	108	-
Silo Operation	26	12	312	-
Furnace	74	24	1776	-
I.S. Line	67	24	1608	-
Compressors	119	24	2856	1428
Water Supply	72	24	1728	1728
Fuel Pumping	65	24	1560	780
Shops, Sewage	30	12	360	360
Decorating	260	12	3120	-
Lighting - Day	110	12	1320	1320
Lighting - Night	220	12	2640	2640
			17,700	8,256
AVERAGE HOURLY LOAD			737.5 KW	344 KW

ii) Information from GUYANA GLASSWORKS indicates the cost of self generated power (as recommended in Part 1) as 28.9¢ per Kwh against a G.E.C. price of 58¢ per Kwh. To take account of variance in generator performance a straight average has been taken for calculation purposes i.e. .44¢ Kwh. This rate has been uplifted by 5% per annum to 1985 to .51¢ per Kwh.

iii) Assuming electricity at .51¢ per Kwh:

Daily cost when unit is operational	G$ 9027
Daily cost when furnace is down	G$ 4211

Assuming 30 days per month, 12 months per year

Cost of electricity annually – G$3,249,720

Assuming 90 days for furnace repair

Cost of electricity in repair year – G$2,816,280

iv) Assuming introduction of 2 line operation in 1991 additional Kwh required by.

Drying	–	estimated additional 20%
Crushing	–	estimated additional 20%
Silo Operation	–	estimated additional 20%
Furnace	–	estimated additional 20%
I.S. Line	–	estimated additional 100%
Compressors	–	estimated additional 100%

Additional average hourly load – 192 Kwh.

Annual cost post 1991 : G$4,095,720

v) If GUYANA GLASSWORKS can successfully generate their own electricity at 28.9¢ per Kwh a potential saving on the above over 10 years is approximately G$10.97 millic .

5. Heavy Oil - Furnace.

The consumption per tonne of glass is assessed by the furnace designers at 46 Imp. Gals., for the full five year furnace campaign and after the repair.

The quoted 1982 price of heavy fuel oil is G$3.00. This has been uplifted by 5% per annum to 1985. Heavy fuel oil price used is G$3.47 per Imp. Gal.

The production efficiency/yield quoted in Fig. 2 has been used to calculate cost of actual tonnes melted.

Annual consumption is adjusted in 1990 to take account of reduced tonnage because of furnace repair.

6. Light Oil/Diesel - Lehr/Dryer.

Consumption of light oil is assessed at 4500 Imp. Gals. per month. Consumption is assumed to double on the introduction of 2nd line assuming use of oil fired press line lehr. 90 days downtime is assumed in 1990 for furnace repair.

1982 light oil price quoted at G$4.42 Imp.Gal. uplifted 5% per annum to 1985. Price used for calculation. G$5.12 Imp. Gal.

7. Propane Gas (Forehearth, Lehr Entry).

Consumption of forehearth based on European equivalent figures is assessed at G$1190 per day using 320 operational days in 1982.

Consumption assumed to double in 1991 on introduction of 2nd line.

Price uplifted by 5% per annum to 1985 and cost included at G$1378 per day.

8. Water.

GUYANA GLASSWORKS has its own supply of water and costs are assumed to be entirely 'in-house'. No specific water treatment for operational purposes is required. A nominal figure has therefore been included for this item to cover any requirements.

9. Packing Materials

Information indicates that all packing materials will be supplied by customers, i.e. cartons, crates and pallets for delivery and collection. However a nominal cost is included for replacement of packing materials through damage, loss, usage by GUYANA GLASSWORKS.

10. Selling and Distribution Costs

Information indicates that customers will be responsible for collection of orders and distribution. A cost of .05% of sales realisation has been included to cover miscellaneous costs. However costs for sales work are also included by GUYANA GLASSWORKS in the administration costs. This item therefore may be able to be deleted.

11. Salaries Wages and Related Costs

Information supplied by GUYANA GLASSWORKS indicates a total cost of G$2,850,688 per annum for a workforce of 327 persons. Analysis of production and administrative requirements indicates an initial manpower requirement of approximately 200.

Using the manning and wages schedules a basic wage bill of G$1.3 million is obtained. Given an approximate uplift of 56% to cover N.I.S, medical scheme, allowances etc. derived from GUYANA GLASSWORKS budget, a figure for total wages and salaries is G$2.028 million rounded to G$2.0 million. This figure has been uplifted by 5% per annum to 1985 i.e. G$2.35 million. The breakdown of manning and salaries given in the text of Part II and Fig. 8 and is required as fixed but has been used only to indicate typical arrangements reflected in local costs.

The rounded figure has been used throughout the projections as little extra recruitment is envisaged as the plant develops.

Salaries, wages and personnel policy will be for GUYANA GLASSWORKS consideration and not the responsibility of Rockware International.

12. Moulds

Of the mould equipment required to carry out the assessed production, 50% is already on site. An allowance has been included in the pre production capital costs for the additional sets. Given average performance from the mould equipment and the inclusion of repair equipment and training, the annual mould costs to sustain predicted production is assessed at G$150,000 for 1983. This figure has been increased 5% per annum to 1985 i.e. G$165,000 and a further increase on the start up of the 2nd line to G$248,000 i.e. 50%.

13. Repairs and Maintenance

Schedules prepared by GUYANA GLASSWORKS indicated a level of repairs and maintenance costs at the end of 1982 to be G$702,000. This figure is uplifted 5% for two years to G$774,000.

This level is regarded as reasonable as a proportion of the total capital value of the plant. No additional allowance has been made to take account of the 2nd line. Additional costs here are assumed to be absorbed in the overall efficiency improvement of the plant.

14. Plant Insurance

The figure supplied by GUYANA GLASSWORKS represents a 1% rate on capital value of G$26 million. This figure has been uplifted 5% for two years. The overall cost of the insurance is reasonable by international standards.

15. Training

Full details of the training proposal and costs are given in Part II and Appendices. These cover both pre production and production work. A summary of costs is given in Fig. 5.

16. Technical Assistance

Full details of the technical assistance programme is given in Part II and Appendices covering both pre production and production work. A summary of costs is given in Fig. 5.

17. Administration Costs

GUYANA GLASSWORK schedules indicate a 1982 value for Administration costs of G$400,000. This has been uplifted 5% per annum for two years only to take account of the reduced level of personnel and associated activity i.e. G$441,000.

18. General

No consideration has been given to tax arrangements or dividend payments in the calculations on the financial aspects of GUYANA GLASSWORKS.

Similarly it has been assumed that there will be a requirement to pay off the loan capital within the ten year span of these projections.

19. Capital Expenditure

A full breakdown of totals is given in the relevant appendix for each item.

	G$
Production Services	1,286,950.00
Materials handling	570,000.00
Production Equipment	555,000.00
General and Spares	102,500.00
	2,514,450.00
Materials handling - vehicles	250,000.00
Furnace Construction (1983/4)	4,233,000.00
Furnace Repair (1990)	2,450,000.00
Second Production Line	1,125,000.00
	10,572,480.00
Add Contingency @ 10%	11,629,728.00
Add C.I.F. charges @ 15%	13,374,187.00

The following pre production costs will be written off separately over the first five years of operation as requested by GUYANA GLASSWORKS.

	G$
* Technical Assistance - Procurement/Planning	475,000.00
- Commissioning and Recruitment	415,000.00
* Training (Pre production)	298,000.00
Finance/Legal Expenses (Nominal)	250,000.00
Loan Interest (1983/4)	1,064,000.00
	2,502,000.00

* See Fig. 10.

Initial Financing Requirement

The initial financing requirement is assessed as:

	G$
Plant & Machinery	3,181,000.00
Vehicles	316,000.00
Furnace	5,355,000.00
	8,852,000.00
Furnace Repair	3,100,000.00
Addit. Production Line	1,424,000.00
	13,376,000.00
Pre Production - Costs	2,502,000.00
Working Capital	2,973,000.00*
	18,851,000.00

A financing provision of G$19 million to be provided.

For the purposes of this projection an equity/loan** capital split of 40%/60% has been used.

i.e.

Equity Capital (40%) = G$7,600,000

Loan Capital (60%) = G$11,400,000

* Working Capital Calculations - see Fig. 6.

** Loan Package Calculations - see Fig. 7

20. Depreciation

Depreciation for the purposes of this exercise has been split into two entries:

Depreciation (1)	-	Depreciation on new equipment obtained under the rehabilitation scheme at levels provided by GUYANA GLASSWORKS including pre production costs over the first five years of operation see Fig. 9.
Depreciation (II)	-	Depreciation on existing equipment at levels given by GUYANA GLASSWORKS.

Where the depreciation period finishes within the 10 year appraisal new purchase at same cost and therefore same depreciation has been included.

Buildings @ G$19,279.00
Plant, equipment and vehicles G$303,374.00
Sundry Equipment @ G$76,389.00

Total per annum G$399,042.00

FIG. 1

TYPICAL ANNUAL BOTTLE PRODUCTION

PRODUCT	CAPACITY	WT. GRMS.	QUALITY (000's)	TONS GLASS	COLOUR	DECORATION	PRICE (G$2375/ton)	MOULD AVAILABILITY
BEER	10 fl.oz	400	2400	960	Amber	Yes	0.95* *sale & budget estimate.	No
SOFT D.	10 fl.oz	420	1600	672	Flint	Yes	1.00	No
	10 fl.oz Pep	420	1700	714	Flint	Yes	1.00	Yes
				1386				
LIQUOR GLC & BANKS	40 oz	750	87	65	Flint	No	1.78	No
	26 oz	650	903	587	Flint	No	1.54	Yes
	12 oz	340	264	90	Flint	No	0.81	Yes
	(200ml) 6 oz	220	186	41	Flint	No	0.52	Yes
				783				
WINES	26 oz	650	42	27	Flint	No	1.54	Yes
PHARM. GPC.	100 ml	120	1600	192	Flint	No	0.29	Yes
	250 ml	250	660	165	Flint	No	0.59	Yes
	500 ml	420	444	187	Flint	No	1.00	Yes
	180 ml	210	840	176	Flint	No	0.50	No
	450 ml	420	624	262	Flint	No	1.00	No
				982				
FOOD R & S	8 oz Ketchup	280	1200	336	Flint	No	0.67	No
	12 oz "	320	1200	384	Flint	No	0.76	No
	26 oz "	470	1200	564	Flint	No	1.12	No
				1284				
		TONNAGE TOTAL...		5422				

FIG. 2

SALES INCOME

G$ Millions

		No. TONS		G$ MILLIONS	MACHINE DAYS	YIELD	AV. FURNACE PULL/DAY @ 320 PRCD.DAYS	G/s/MT GLASS	MAX PULL*	MIN PULL*
	1982	5422		-	315	-				
New Furnace	83	5530		-	321	-				
New Furnace	84	5641		-	327	-				
	85	5754		15,064	334	75	24.0	46	29.7	7.3
	86	5869		15,365	332	77	23.8	46	30.3	7.5
	87	5986		15,671	326	80	23.2	46	30.9	7.7
	88	6106		15,986	332	80	24.3	46	31.5	7.8
	89	6228		16,305	339	80	24.3	46	32.2	8.0
** Repair	90	4560		11,954	346	80	24.8	46	32.8	8.1
2nd Line	91	6671	5%	17,465	363	80	26.1	46	33.5	8.3
	92	7005		18,339	381	80	27.6	46	35.1	8.7
	93	7355		19,255	401	80	28.8	46	36.9	9.1
	94	7728		20,219	421	80	30.2	46	38.7	9.6

Market in 1982 - 5422 Tons. Assume 2% increase/year

Selling price 1983 beer bottle G$0.95 (400 gms) - G$ 2375/ton glass.

Assume 5%/year to 1985 = G$2618/ton glass.

** Repair to furnace and ancilliary equipment Glass to Glass time estimated 90 days. No change to average downtime days.

* Assume market increase in each section is equal.

FIG. 3

MACHINE LOADING ASSESSMENT - 1982

TYPE	WEIGHT GRMS	SPEED/WT* STATISTIC	PROD.SPEED PER MIN.	EFFIC.%	AVER.DLY PACK K	AVER.DLY TONNES	000's PIECES REQUD	MACHINE TIME DAYS
BEER 10 oz	400	(400)	41.5	75	44.8	17.9	2400	53.6
SOFT DRINKS 10 oz	420	(425)	40.9	75	44.2	18.6	3300	74.7
LIQUOR 40 oz	750	(750)	34.6	75	37.4	28.0	87	2.3
26 oz	650	(650)	37.6	75	40.6	26.4	903	22.2
12 oz	340	(350)	46.1	75	49.8	16.9	264	5.3
(200ml) 6 oz	220	(225)	49.4	75	53.4	11.7	186	3.5
WINE 26 oz	650	(650)	37.6	75	40.6	26.4	42	1.0
PHARMACEUTICAL								
150 ml	116	(125)	55.2	75	59.6	6.9	1600	26.8
250 ml	256	(250)	46.8	75	50.5	12.9	600	13.1
500 ml	420	(425)	40.9	75	44.2	18.6	444	10.1
180 ml	211	(225)	49.4	75	53.4	11.3	840	15.7
450 ml	421	(425)	40.9	75	44.2	18.6	624	14.1
FOOD 8 oz	280	(275)	45.7	75	49.4	13.8	1200	24.3
KETCHUP 12 oz	320	(325)	49.9	75	53.9	17.3	1200	22.3
26 oz	470	(475)	42.1	75	45.5	21.4	1200	26.4

* Weight used to assess speed (b.p.m.) from statistical tables. If above jobs were run at International Average weight, speed and efficiency machine time equates to 283 days.

TOTAL MACHINE TIME ESTIMATE: 315.4 days

FIG. 4

BATCH COST CALCULATION

MATERIAL	COST G$/ton	FLINT kg/ton	COST/TON G$	AMBER kg/ton	COST/TON G$
SAND	20	687	13.74	685	13.70
SODA ASH	495	227	112.37	226	111.87
ARGONITE	210	196	41.16	195	40.95
DOLOMITE	803		-		
PYRITES	1620		-	0.137	0.22
FELDSPAR	803	69	55.41	68.5	55.00
SALTCAKE	975	7	6.83	6.9	6.73
ARSENIC	4000				
CARBON	320				
TOTAL..		1186	229.5	1182	228.5
Local Transport			6.9		6.9
5%			236.4		235.4

Assume all materials G$236 as at mid 1982.

Uplift x 5% per annum to 1985 total cost G$273.20.

SUMMARY OF TECHNICAL ASSISTANCE AND TRAINING FEES FOR TEN YEAR OPERATION

The table below gives the breakdown of the Technical Assistance and Training fees for the ten year period. An assessment has been made for local costs at a rate of 15% of fee level. These cost assessments cover the provision of hotel accommodation, subsistence, air fares and local transport for short-term visit personnel (e.g. training officers) and houses, services, subsistence, airfares and local transport for long term personnel. All areas under this section are to be supplied to standards acceptable to Rockware International.

GUYANA GLASSWORKS should examine these totals and confirm that they will cover the requirement.

	TRAINING		TECH. ASST.		£.	G$
YEAR	£ FEE	G$ EXPENSES	£ FEE	G$ EXPENSES	TOTAL	TOTAL
1	25,000		460,000	363,750*	485,000	363,750
2	12,500		285,000	223,125*	297,500	223,125
3	12,500		285,000	223,125*	297,500	223,125
4			200,000	150,000	200,000	150,000
5			240,000	180,000	240,000	180,000
6			75,000	93,750	75,000	93,750
7			75,000	93,750	75,000	93,750
8			75,000	93,750	75,000	93,750
9			75,000	93,750	75,000	93,750
10			75,000	93,750	75,000	93,750

* Figures include training expenses for years 1, 2 and 3.

WORKING CAPITAL

VALUES G$ MILLIONS

YEAR	MATERIALS	FINISHED WARE	STORES	DEBTORS	CREDITORS	TOTAL
1985	0.393	0.628	0.569	2.511	(1.128)	2.973
1986	0.401	0.640	0.532	2.561	(1.140)	3.445
1987	0.409	0.653	0.578	2.612	(1.137)	3.115
1988	0.417	0.666	0.583	2.664	(1.141)	3.189
1989	0.426	0.679	0.587	2.718	(1.145)	3.265
1990	0.312	0.498	0.496	1.992	(0.982)	2.316
1991	0.456	0.728	0.736	2.911	(1.435)	3.396
1992	0.479	0.764	0.748	3.057	(1.447)	3.601
1993	0.502	0.802	0.760	3.209	(1.460)	3.813
1994	0.523	0.843	0.773	3.370	(1.473)	4.041

BASIS OF CALCULATION:

Raw Materials	–	3 months consumption (not including existing stocks)
Finished Ware	–	½ months sales
Stores	–	Two months operating costs (i.e. oils, lpg, packing, distribution, moulds repairs and maintenance, admin.costs)
Sales Debtors	–	2 months sales
Creditors	–	2 months purchases (i.e. power, fuel, water, packing, distribution, moulds, repairs and maintenance administration)

FIG. 7

GUYANA GLASSWORKS LTD.

LOAN PACKAGE CALCULATIONS

VALUES G$ MILLION

YEAR	DRAW DOWN	LOAN	INTEREST	REPAYMENT	ANNUAL INTEREST	ANNUAL REPAYMENT
End 1982	1.0	1.0				
Mid 1983	3.0	4.0	0.063			
End 1983	1.0	5.0	0.250			
Mid 1984	2.0	7.0	0.313			
End 1984		7.0	0.438			
Mid 1985		7.0	0.437			
End 1985		7.0	0.438		0.875	-
		7.0	0.437			
End 1986		7.0	0.438		0.875	
Mid 1986		6.285	0.437	0.715		
End 1987		5.570	0.393	0.715	0.830	1.430
		4.855	0.348	0.715		
End 1988		4.140	0.303	0.715	0.651	1.430
		3.425	0.259	0.715		
End 1989		2.710	0.214	0.715	0.473	1.430
	4.4	6.395	0.169	0.715		
End 1990		5.680	0.400	0.715	0.569	1.430
		4.965	0.355	0.715		
End 1991		4.250	0.310	0.715	0.665	1.430
		3.535	0.266	0.715		
End 1992		2.820	0.221	0.715	0.487	1.430
		2.105	0.176	0.715		
End 1993		1.390	0.132	0.715	0.308	1.430
		0.675	0.087	0.715		
End 1994		-	0.042	0.675	0.129	1.390
End 1995						

1. Two year moratorium from end of 1984; repayable by sixteen equal half-yearly instalments; interest at 12½% per year calculated half-yearly.

SCHEDULE OF WAGES AND SALARIES (Draft only)

Raw Materials, Batch and Furnace	$G
- Superintendent (1)	16,500
- Quarry Personnel (est.6)	30,000
- Sand Dryer Operators (2)	12,000
- Batch House Foremen (3)	30,375
- Drivers/Tippers (3)	16,500
- Labourers (3)	12,000
- Furnace Foremen (4)	40,500
- Ass't. Furnacemen (4)	24,000
- Instrument Technicians (2)	18,000
- Assist. Tech. (1)	5,000
	204,875

Production Department	
- Superintendent (1)	16,500
- Shift Supervisors (4)	44,000
- Forehearth Specialists (2)	16,000
- I.S. Operators (4)	32,000
- Asst. Operators (4)	20,000
- Lehr Controllers (4)	24,000
- Mould Shop Supervisor (1)	11,000
- Fitters (Shift) (4)	24,000
- Fitters (2)	10,000
	197,500

Inspection, Quality Control and Decorating

– Superintendent (1)	16,500
– Supervisors (2)	22,000
– Inspection Foremen (4)	40,500
– Sorters (12)	60,000
– Packers (4)	20,000
– Warehouse Foremen (4)	40,500
– Drivers – Fork Trucks (4)	20,000
– Decorating Foreman (1)	10,125
– Operators (4)	24,000
– Sorters (2)	10,000
– Screen Room (3)	15,000
– Laboratory/Q.C. (3)	16,000
	294,625

Plant Maintenance and Engineering

– Superintendent (1)	16,500
– Shift Engineers (4)	52,000
– Maintenance Foreman (1)	10,125
– Electricians (4)	28,000
– Bricklayer (1)	7,000
– Vehicle Repair (3)	16,000
– Plumber (1)	7,000
– Carpenter (1)	7,000
– Labourers (3)	12,000
– I.S. Repair Foreman (1)	10,125
– I.S. Fitters (Shift) (4)	24,000
– I.S. Fitter (1)	5,000
– Instrument/Ancilliary (2)	14,000
– Compressor/Generator Staff (6)	40,000
	248,750

Personnel and Administration

-	Superintendent (1)	16,500
-	Sales Controller (1)	10,000
-	Asst. Controller (1)	9,000
-	Production Planning (2)	12,000
-	Accts. Supervisor (1)	6,300
-	Clerical (3)	15,000
-	Cashier (1)	5,000
-	Personnel Officer (1)	11,000
-	Canteen Staff (est. 10)	50,000
-	Records (4)	16,000
-	Medical (3)	21,000
-	Purchasing Officer (1)	10,000
-	Asst. Purchasing Officer (1)	9,000
-	Stores Supervisor (1)	8,400
-	Asst. Stores (2)	9,000
-	Labourer (1)	4,000
-	Security Personnel (est. 21)	88,400
		300,600

Sub Total...	1,246,350.

Senior Executive Management

General Manager	29,700
Company Secretary	24,000
	1,300,050
Uplift ratio 56%	2,028,078
Rounded	G$2.0 million

GUYANA GLASSWORKS LTD.

DEPRECIATION SCHEDULE - G$ MILLION

FIG. 9

DEPRECIATION I

YEAR	FURNACE	PLANT & MACH.	VEHICLES	PRE-PROD COSTS	ADDIT. LINE	TOTAL
1985	0.908	0.320	0.080	0.496	-	1.804
1986	0.908	0.352	0.088	0.497	-	1.845
1987	0.908	0.384	0.096	0.496	-	1.884
1988	0.908	0.416	0.104	0.497	-	1.925
1989	0.908	0.448	0.032	0.496	-	1.884
1990	0.783	0.480	0.032	-	0.142	1.437
1991	0.783	0.512	0.032	-	0.142	1.469
1992	0.783	0.544	0.032	-	0.143	1.502
1993	0.783	0.576	0.032	-	0.142	1.533
1994	0.783	0.608	0.032	-	0.142	1.565

DEPRECIATION RATES:	STRAIGHT LINE OVER:
Plant & Machinery	10 years
Furnace - Structure	10 years
- Glass Bath	5 years
Vehicles	4 years

SUMMARY PRE PRODUCTION CAPITAL COSTS - PERSONNEL

	£.	G$
Pre Production Year 2		
Technical Planning, Project Control and Procurement	37,500.00	50,000.00
Personnel, Recruitment and commissioning.	35,000.00	20,000.00
Pre Production Year 1		
Technical Planning, Project Control and Procurement	37,500.00	50,000.00
Personnel, Recruitment and commissioning	40,000.00	20,000.00
Training Programme	50,000.00	48,000.00
	£200,000.00	£188,000.00
	G$1,000,000.00	188,000.00
	TOTAL	G$ 1,188,000.00

* (Local expenses - accommodation etc.)

GUYANA GLASSWORKS LTD. APPENDIX 2

PROFITABLITY STATEMENT Values G$ million

	Year 1985	Year 1986	Year 1987	Year 1988	Year 1989	Year 1990	Year 1991	Year 1992	Year 1993	Year 1994	
Sales Tonnes	5754	5869	5986	6106	6228	4566	6671	7005	7355	7723	
Sales Realisation	15,064	15,365	15,671	15,986	16,305	11,954	17,465	18.339	19,255	20,219	
Raw Materials	1,575	1,603	1,635	1,668	1,702	1,247	1,823	1,914	2,009	2,110	
Electricity	3,250	3,250	3,250	3,250	3,250	2,816	4,096	4,096	4,096	4,096	
Heavy Oil(Furnace)	1,225	1,217	1,194	1,218	1,243	0,911	1,331	1,398	1,468	1,541	
Light Oil (Lehr/Dryer)	0.277	0.277	0.277	0.277	0.277	0.207	0.553	0.553	0.553	0.553	
Propane Gas(Fore)	0.441	0.441	0.441	0.441	0.441	0.318	0.882	0.882	0.882	0.882	
Water	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	
Packing Materials	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	
Selling & Distr.	0.075	0.077	0.078	0.080	0.081	0.060	0.087	0.092	0.096	0.101	
Salaries & Wages	2,350	2.350	2,350	2,350	2,350	2,350	2,350	2,350	2.350	2,350	
Variable Costs	9,393	9.415	9,425	9,484	9,544	8,109	11,322	11,485	11,654	11,833	
Moulds	0.083	0.165	0.165	0.165	0.165	0.248	0.248	0.248	0.248	0.248	
Rep./Maint.	0.774	0.774	0.774	0.774	0.774	0.774	0.774	0.774	0.774	0.774	
Plant Insurance	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258	
Training	0.125	0.063	0.063	-	-	-	-	-	-	-	
Tech. Asst.	2.664	1.648	1.648	1.150	1.380	0.469	0.469	0.469	0.469	0.469	
Admin. Costs	0.441	0.441	0.441	0.441	0.441	0.441	0.441	0.441	0.441	0.441	
Fixed Costs	4,345	3,349	3,349	2,788	3,018	2,190	2,190	2,190	2,190	2,190	
Profit/(Loss) before interest	1,326	2,601	2,897	3,714	3.743	1,655	3,953	4,664	5,411	6,196	36,160
Interest	0,875	0,875	0,830	0,651	0,473	0,569	0,665	0,487	0,308	0,129	(5,862)
Profit/(Loss) before depreciation	0,451	1,726	2,067	3,063	3,270	1,086	3,288	4.177	5,103	6,067	30,298
Deprec.(1)	1,804	1,845	1,884	1,925	1,884	1,437	1,469	1,502	1,533	1,565	(16,848)
Deprec.(11)	0,399	0,399	0,399	0,399	0,399	0,399	0,399	0,399	0,399	0,399	(3,990)
	2,203	2,244	2,283	2,024	2.283	1,836	1,868	1,901	1,932	1,964	(20,838)
Profit/(Loss) before tax	(1,752)	(0,518)	(0,216)	0.739	0.987	(0,750)	1,420	2,276	3,171	4,103	= 9,460

GUYANA GLASSWORKS LTD. APPENDIX 2

CONSTANT PROFIT AND LOSS ACCOUNT - 10 YEARS TO 1994 Values G$ million Ref: PL4(2/82)

	Year 1983	Year 1986	Year 1987	Year 1988	Year 1989	Year 1990	Year 1991	Year 1992	Year 1993	Year 1994
Gross Turnover	15,064	15,365	15. 71	15,986	16,305	11,954	17,465	18,339	19,255	20,219
Less:										
Inter factory sales within consolidated operating unit.										
Sub-Total:										
NET TURNOVER: within consolidated operating unit.										
Total:										
Inter company sales outside consolidated operating unit.										
Operating Profit	(0,877)	0.357	0.614	1,390	1,460	(0,181)	2,085	2,763	3,479	4,232
Interest payable (external)	(0,875)	(0,875)	(0,830)	(0,651)	(0,473)	(0,569)	(0,665)	(0,487)	(0,308)	(0,129)
Profit After Interest										
Sub-total:	(1,752)	(0,518)	(0,216)	0,739	0,987	(0.750)	1,420	2,276	3,171	4,103
Exceptional Items										
Profit Before Tax										
Sub-total:										
Taxation										
Profit After Tax										
Sub-Total:										
Extraordinary Items										
Profit after extraordinary items										
Sub-total:										
Inter company dividends payable										
Inter company dividends receivable										
Dividends payable to minorities: net										
RETAINED PROFITS										
Total:	(1,752)	(0,518)	(0.216)	0.739	[illegible]	(0.750)	1,420	2,276	3,171	4,103

GUYANA GLASSWORKS LTD.

FUNDS FLOW STATEMENT - 10 YEARS TO 1994 Values G$ million Ref: FF4(2/82)

	Year 1983	Year 1984	Year 1985	Year 1986	Year 1987	Year 1988	Year 1989	Year 1990	Year 1991	Year 1992	Year 1993	Year 1994
Items affecting reserves:												
Retained profits Profits on revaluations losses on exchange			(1,752)	(0,518)	(0,216)	0,739	0,987	(0,750)	,420	2,276	3.171	4,103
Capital Expenditure:												
On fixed assets including moulds On development Notional cost of leased assets Realisation of fixed assets (WDV)	(5,966)	(5,391)	(0,352)	(1,266)	(0,352)	(0,352)	(1,110)	(4,876)	(0,655)	(0,352)	(2,375)	(0,352)
Total:												
Depreciation:												
On fixed assets including moulds			1,804	1,845	1,884	1,925	1,884	1,437	1,469	1,502	1,533	1,565
Amortisation of development expenditure			.399	.399	.399	.399	.399	.399	.399	.399	.399	.399
Total:			2.203	2.244	2.283	2.324	2.283	1.836	1.868	1.901	1.932	1.964
Development Grants:												
Income												
Amortisation												
Total:												
Asset revaluations: increase in book value of fixed assets					-	-	-	-	-	-	-	-
Working Capital												
Finished goods and work in progress			(0.628)	(0.012)	(0.013)	(0.013)	(0.013)	0.181	(0.230)	(0.036)	(0.038)	(0.041)
Raw Materials			(0.393)	(0.008)	(0.008)	(0.008)	(0.009)	0.114	(0.144)	(0.023)	(0.023)	(0.026)
Stores			(0.569)	(0.013)	0.004	(0.005)	(0.004)	0.091	(0.240)	(0.012)	(0.012)	(0.013)
Trade Debtors			(1.511)	(0.050)	(0.051)	(0.052)	(0.054)	0.726	(0.919)	(0.146)	(0.152)	(0.161)
Trade Creditors			(1.128)	0.012	(0.003)	0.004	0.004	(0.163)	0.453	0.012	0.013	0.013
Total:			(3.033)	(0.071)	(0.071)	(0.074)	(0.076)	0.365	(0.635)	(0.205)	(0.212)	(0.228)
Inter company dividends:												
Accrued												
Paid												
Dividends payable to minorities:												
Accrued												
Paid												
Total:												
Deferred tax or future tax relief												
Carried Forward Sub-total:	(5,966)	(5,391)	(2,874)	0,389	1,644	2,637	2,084	(2.841)	1,553	3,620	2,516	5,487

APPENDIX 3

GUYANA GLASSWORKS LTD.

FUNDS FLOW STATEMENT - 10 YEARS TO 1994   Values G$ million   Ref: FF4A(2/82)

	Year 1983	Year 1984	Year 1985	Year 1986	Year 1987	Year 1988	Year 1989	Year 1990	Year 1991	Year 1992	Year 1993	Year 1994
Brought Forward / Sub-total:	(5.966)	(5.391)	(2.874)	0.389	1.644	2.637	2.084	(2.841)	1.553	3.620	2.516	5.487
Taxation:												
Accrued (excluding inter company tax)												
Paid (excluding inter company tax)												
Total:												
Trading Cash Flow:												
Investments/Acquisitions/ Disposal of subsidiaries												
Sub-total:	(5.966)	(5.391)	(2.874)	0.389	1.644	2.637	2.084	(2.841)	1.553	3.620	2.516	5.487
Total Cash Flow												
Financing: Loans												
External loans received	4.000	3.000						4.400				
External loans repaid					(1.430)	(1.430)	(1.430)	(1.430)	(1.430)	(1.430)	(1.430)	(1.390)
Internal loans received (including inter company tax).												
Internal loans repaid (including inter company tax).												
Hire purchase finance received												
Hire purchase finance repaid.												
Leasing finance received (notional cost)												
Total:	4.000	3.000	-	-	(1.430)	(1.430)	(1.430)	2.970	(1.430)	(1.430)	(1.430)	(1.390)
Financing: Share issues	3.800	3.800	-	-	-	-	-	-	-	-	-	-
Change in Bank balance												
Sub-total:	1.834	1.409	(2.874)	0.389	0.214	1.207	0.654	0.129	0.123	2.190	1.086	4.097
Opening Bank balance	-	1.834	3.243	0.369	0.758	0.972	2.179	2.833	2.962	3.085	5.275	6.361
Closing Bank balance Total:	1.834	3.243	0.369	0.758	0.972	2.179	2.833	2.962	3.085	5.275	6.361	10.458

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FORECAST ACCOUNTS BY PERIOD

	B/S at start (Audited) 1983/4	Funds Flow F/cast 1985	B/S F/cast 1985	Funds Flow F/cast 1986	B/S F/cast 1986	Funds Flow F/cast 1987	B/S F/cast 1987	Funds Flow F/cast 1988	B/S F/cast 1988	Funds Flow F/cast 1989	B/S F/cast 1989
Share Capital	9.688	-	9.688	-	9.688	-	9.683	-	9.688	-	9.688
Reserves	-	-	-	-	-	-	-	-	-	-	-
Retained Profits	-	(1.752)	(1.752)	(0.518)	(2.270)	(0.216)	(2.486)	0.739	(1.747)	0.987	(0.760)
Sub-total	9.688	(1.752)	7.916	(0.518)	7.398	(0.216)	7.182	0.739	7.921	0.987	8.908
Goodwill/investments in subsidiaries/ disposal of subsidiaries	-	-	-	-	-	-	-	-	-	-	-
Total	9.688	(1.752)	7.916	(0.518)	7.398	(0.216)	7.182	0.739	7.921	0.987	8.908
Borrowing:- over one year	7.000	-	7.000	-	7.000	(1.430)	5.570	(1.430)	4.140	(1.430)	2.710
overdrafts/bank balance	(3.243)	2.874	(0.369)	(0.389)	(0.758)	(0.214)	(0.972)	(1.207)	(2.179)	(0.654)	(2.833)
Total:	3.757	2.874	6.631	(0.389)	6.242	(1.644)	4.598	(2.637)	1.961	(2.084)	(0.123)
Deferred Liabilities											
Capital Employed Grand Total	13.425	1.122	14.547	(0.907)	13.640	(1.860)	11.780	(1.898)	9.882	(1.097)	8.785
Fixed Assets	13.425	1.851	11.574	0.978	10.596	1.931	8.665	1.972	6.693	1.173	5.520
Less: Capital expenditure leased this year	-	-	-	-	-	-	-	-	-	-	-
Total	13.425	1.851	11 574	0.978	10.596	1.931	8.665	1.972	6.693	1.173	5.520
Working Capital: Finished goods and work in progress	-	(0.628)	0.628	(0.012)	0.640	(0.012)	0.653	(0.013)	0.666	(0.013)	0.679
Raw Materials	-	(0.393)	0.393	(0.008)	0.401	(0.008)	0.409	(0.008)	0.417	(0.009)	0.426
Stores	-	(0.569)	0.569	(0.013)	0.582	0.004	0.578	(0.005)	0.583	(0.004)	0.587
Trade Debtors	-	(2.511)	2.511	(0.050)	2.561	(0.051)	2.612	(0.052)	2.664	(0.054)	2.718
Trade Creditors	-	1.128	(1.128)	0.012	(1.140)	(0.003)	(1.137)	0.004	(1.141)	0.004	(1.145)
Total	-	(2.973)	2.973	(0.071)	3.044	(0.071)	3.115	(0.074)	3.189	(0.076)	3.265
Dividends Payable	-	-	-	-	-	-	-	-	-	-	-
Capital Employed Grand Total	13.425	(1.122)	14.547	0.907	13.640	1.860	11.780	1.898	9.882	1.097	8.785

GUYANA GLASSWORKS LTD — APPENDIX 4

FORECAST ACCOUNTS BY PERIOD — Values G$ million — BALANCE SHEET — Ref: RM(2/82)

		B/S at start 1989	Funds Flow F/cast 1990	B/S F/cast 1990	Funds Flow F/cast 1991	B/S F/cast 1991	Funds Flow F/cast 1992	B/S F/cast 1992	Funds Flow F/cast 1993	B/S F/cast 1993	Funds Flow F/cast 1994	B/S F/cast 1994
Share Capital		9.668	-	9.668	-	9.668	-	9.668	-	9.668	-	9.668
Reserves		-	-	-	-	-	-	-	-	-	-	-
Retained Profits		(0.760)	(0.750)	(1.520)	1.420	(0.090)	2.276	2.186	3.171	5.357	4.103	9.460
Sub-total		8.908	(0.750)	8.158	1.420	9.578	2.276	11.854	3.171	15.025	4.103	19.128
Goodwill/investments in subsidiaries/ disposals of subsidiaries		-	-	-	-	-	-	-	-	-	-	-
Total		8.908	(0.750)	8.158	1.420	9.578	2.276	11.854	3.171	15.025	4.103	19.128
Borrowings: over one year		2.710	2.970	5.680	(1.430)	4.250	(1.430)	2.820	(1.430)	1.390	(1.390)	-
	overdrafts/bank balance	(2.833)	(0.129)	(2.962)	(0.123)	(3.085)	(2.190)	(5.275)	(1.086)	(6.361)	(4.097)	(10.458)
Total		(0.123)	2.841	2.718	(1.553)	1.165	(3.620)	(2.455)	(2.516)	(4.971)	(5.487)	(10.458)
Deferred Liabilities			-									
Capital Employed	Grand Total	8.785	2.091	10.876	(0.133)	10.743	(1.344)	9.399	0.655	10.054	(1.384)	8.670
Fixed Assets		5.520	(3.040)	8.560	1.213	7.347	1.549	5.798	(0.433)	6.241	1.612	4.629
Less: Capital expenditure leased this year		-	-	-	-	-	-	-	-	-	-	-
Total		5.520	(3.040)	8.560	1.213	7.347	1.549	5.798	(0.433)	6.241	1.612	4.629
Working Capital:	Finished Goods	0.679	0.[illegible]91	0.498	(0.230)	0.728	(0.036)	0.76[illegible]	(0.038)	0.802	(0.041)	0.843
	Raw Materials	0.426	0.114	0.312	(0.144)	0.456	(0.023)	0.479	(0.023)	0.502	(0.026)	0.528
	Stores	0.587	0.091	0.496	(0.240)	0.736	(0.012)	0.748	(0.012)	0.760	(0.013)	0.773
	Trade Debtors	2.718	0.726	1.992	(0.919)	2.911	(0.146)	3.057	(0.152)	3.209	(0.161)	3.370
	Trade Creditors	(1.145)	(0.163)	(0.982)	0.453	(1.435)	0.012	(1.447)	0.013	(1.460)	0.013	(1.473)
Total		3.265	0.949	2.316	(1.080)	3.396	(0.205)	3.601	(0.212)	3.813	(0.228)	4.041
Dividends Payable		-		-	-	-	-	-	-	-	-	-
Capital Employed	Grand Total	8.785	(2.091)	10.876	0.133	10.743	1.344	9.399	(0.655)	10.054	1.384	8.670

APPENDIX 5

GUYANA GLASSWORKS LTD.

RATE OF RETURN ON A DISCOUNTED CASH FLOW BASIS

Item	Year -1	Year 0	1985 Year 1	1986 Year 2	1987 Year 3	1988 Year 4	1989 Year 5	1990 Year 6	1991 Year 7	1992 Year 8	1993 Year 9	1994 Year 10	Year Total
Nett Profit b/tax	-	-	(1.752)	(0.518)	(0.216)	0.739	0.987	(0.750)	1.420	2.276	3.171	4.103	9.460
Depreciation	-	-	2.203	2.244	2.283	2.324	2.283	1.836	1.868	1.901	1.922	1.964	20.838
Interest on t/loan) Interest on o/drafts)	-	-	0.875	0.875	0.830	0.651	0.473	0.569	0.665	0.487	0.308	0.129	5.862
Total	-	-	1.326	2.601	2.897	3.714	3.743	1.655	3.953	4.664	5.401	6.196	36.160
Capital Expenditure	(8.034)	(5.391)	(352)	(1.266)	(0.352)	(0.352)	(1.110)	(4.876)	(0.655)	(0.352)	(2.375)	(0.352)	(25.467)
Residual Book Values	-	-	-	-	-	-	-	-	-	-	-	4.629	4.629
Gross Cash Flow	(8.034)	(5.391)	0.974	1.335	2.545	3.362	2.633	(3.221)	3.298	4.312	3.026	10.473	15.322
Discounted @ 7.84%	(8.664)	(5.391)	0.903	1.148	2.030	2.487	1.806	(5.067)	1.945	2.358	1.534	4.924	0.013

GUYANA GLASSWORKS LTD.

OPERATIONAL FOREIGN EXCHANGE OUTGOINGS REQUIREMENT (NOT INCLUDING CAPITAL PURCHASES) G$ millions

Calculated whether transacted through Guyana supplier or not	Year 1985	Year 1986	Year 1987	Year 1988	Year 1989	Year 1990	Year 1991	Year 1992	Year 1993	Year 1994
Raw Materials (less sand G$ 25,730)	1,4[illegible]	1,508	1,540	1,571	1,603	1,175	1,717	1,802	1,893	1,987
Electricity (self generated)	3,250	3,250	3,250	3,250	3,250	2,816	4,096	4,096	4,096	4,096
Heavy Oil	1,225	1,217	1,194	1,218	1,243	911	1,331	1,398	1,468	1,541
Light Oil	277	277	277	277	277	207	553	553	553	553
Propane Gas	441	441	441	441	441	318	882	882	882	882
Water (cost of pumping)	100	100	100	100	100	100	100	100	100	100
Moulds	83	165	165	165	165	165	248	248	248	248
Repairs/Maintenance	774	774	774	774	774	774	774	774	774	774
Training	123	63	63	-	-	-	-	-	-	-
Technical Assistance	2,66[illegible]	1,648	1,648	1,150	1,[illegible]0	469	469	469	469	469
Total Outgoings	10,420	9,443	9,452	8,946	9,233	6,935	10,170	10,322	10,482	10,650
Total Good Tonnes	5,754	5,869	5,986	6,106	6,228	4,566	6,071	7,005	7,355	7,723
Price per Tonne (G$)	1,810	1,609	1,594	1,465	1,483	1,519	1,525	1,474	1,425	1,379
Cost of Imports * 1 tonne = US$ 800 CIF @ G$ 3.00 = $1.00	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400
Savings per tonne (G$)	590	791	806	935	917	881	875	926	975	1,021
Savings per tonne (G$ 000's)	3,395	4,642	4,825	5,709	5,711	4,023	5,837	6,487	7,171	7,885

TOTAL: G$ 55,685,000

* Quoted by Guyana Glassworks, Imports currently from Mexico.