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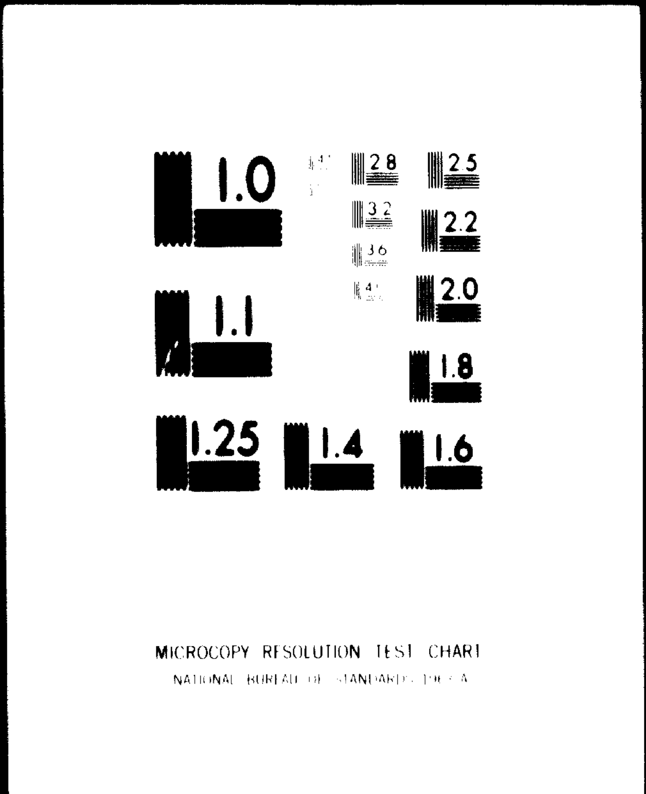

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JAMAICA SUGAR INDUSTRY SURVEY

PHASE ONE

PREPARED FOR THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

July 1971

SANDERSON & PORTER, INC.

New York, N. Y.

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PREFACE

The first phase - the fact finding mission of the Jamaican sugar industry - has been completed. This study, undertaken by Sanderson & Porter, Inc. for the United Nations Industrial Development Organization has resulted in a comprehensive plan of action together with concrete recommendations for program continuity.

Sanderson & Porter is pleased to have been a part of this most worthwhile endeavor.

INTRODUCTION

Previous studies undertaken by various Government appointed Commissions in 1959, 1962, 1964, and 1966 have reported the recent decline of sugar production in Jamaica. All have employed a common approach. They have been almost unanimous in attributing the decline either to the cost of production, to the decline in cane quality and tonnage per acre, to the reduction of skilled and unskilled workers available to the sugar industry, to the revenue realized from marketing of domestically consumed and exported sugar or to a combination of these factors. The most noteworthy undertaking was that of the Sugar Industry Enquiry Commission, more commonly known as the "Mordecai" Report, being named after the Chairman of the Committee which executed this study in 1966.

The report was very well presented, contains a great deal of information, and covers in detail the cross section of subjects just mentioned. As a result the problems of the Jamaica Sugar industry are well defined and formulated. However, the definitive action program to correct these conditions and to increase the sugar production to its former annual output is not offered by any of the published studies.

Implementation of a revitalization program for the sugar industry is a complicated task. An integrated approach must be offered: one that includes the fields of agriculture, of technology as applied to a modern "heavy" industry, and of human relations. Realizing this and in order to effect such a program for its sugar industry, the Jamaican Government requested the assistance of the United Nations Industrial Development Organization (UNIDO). The program developed by UNIDO and its original specifications have as the project goal improvement of the performance of the industry and/or reducing production costs. Also this document indicated that this was a two phase program:

Phase One: A fact-finding mission of two months duration in Jamaica. Findings gathered during this period would result in positive recommendations to the Jamaican Government for an action program to revitalize the national sugar industry.

Phase Two: This phase would last for an undetermined duration. The recommendations generated in the first phase would be implemented to ensure optimum operations.

The first phase of the Jamaica Sugar assistance program demanded a multi-disciplined approach. The range of talents included sugar technology, sugar chemistry, and mechanical engineering in terms of sugar processing equipment. All had to be coordinated and integrated to develop viable answers to this agri-industrial economic segment.

The team provided by Sanderson & Porter, Inc., to execute this assignment included:

R. L. Steere	Officer-in-charge
F. le Grand	Sugarcane Agronomist/Project Director
E. Delden	Sugar Technologist
D. Haggerty	Mechanical Engineer
K. J. Skoog	Coordinator/Editor

The team was augmented by the extensive technical and personnel resources of the home office. The combined efforts are presented in this report.

This report is organized in traditional divisions and generally in keeping with the suggested report outline of the United Nations. Since a tremendous amount of raw data was assembled it was felt that this would be the most concise and orderly manner in presenting our findings.

Throughout the report, we have used Jamaican dollars in all financial discussions. As a point of information $1.20 U. S. Dollars is equal to $1.00 Jamaican dollar. Also, English measures have been used as they are the standard in Jamaica.

ACKNOWLEDGMENTS

We would indeed be remiss if we did not gratefully acknowledge the tremendous cooperation we received from all sectors during the course of the assignment. Special thanks must be extended to:

Hon. Robert Lightbourne, O.J.M.P.	Minister of Trade and Industry
Mr. W. D. Roberts, C.D., J.P.	Chairman, The Sugar Industry Authority
Mr. Lloyd Perkins, LL.B (Lond.)	Secretary, The Sugar Industry Authority Board
Dr. Ian Sangster, B.S.C., Dr. RER, Nat.	Chief Sugar Technologist, The Sugar Industry Authority
Mrs. Cynthia Hunt	Secretary/Stenographer, The Sugar Industry Authority
Mr. R. D. C. Henriques	Vice Chairman, The Sugar Manufacturers' Association (of Jamaica) Ltd.
Mr. C. S. Roberts	Manager, The Sugar Manufacturers' Association (of Jamaica) Ltd.
Mr. T. Chinloy	Director, Research Department, The Sugar Manufacturers' Association (of Jamaica) Ltd.
Mr. R. P. Lord	Chairman, The All-Island Jamaica Cane Farmers' Association

Mr. Cecil Abrahams	Director of Productivity Centre Jamaica Industrial Development Corporation
Mrs. Pinkie Bowers	Administrative Officer, Productivity Centre, Jamaica Industrial Development Corporation
Mr. Warren Cornwell	United Nations Representative, Kingston, Jamaica

In addition, the study could not have been made without the support of the General Managers, the Factory Managers, the Engineers and the Chemists of every sugar factory in Jamaica. The total effort is appreciated as it facilitated the progress of the work and made it more meaningful and effective. This was a true team effort in that all parties involved were vitally concerned with "doing something for Jamaica".

GLOSSARY OF TERMS

A short Glossary of frequently used terms is provided for the convenience of the layman who is unfamiliar with sugar technology:

Bagasse: The fibrous residue from cane after juice extraction in the milling tandem, and utilized for steam generation which in turn is used for sugar processing.

Brix: Brix is the percentage by weight of solids in a pure sucrose solution as determined by the Brix hydrometer.

Cane: The part of the cane plant which is used for sugar production and consisting of the cane stalk with the tops removed. Adherent foreign matter such as soil, leaves and other non-millable cane matter is included in the gross weight of cane to be processed.

Centrifugals: The machinery to separate the sugar crystals from the massacuite. The resulting products from the centrifuging operation are therefore sugar and molasses.

Clarifier: The machinery to clarify the sucrose containing mixed juice which is obtained from cane after extraction by the milling tandem. Juice is clarified by application of heat and milk of lime; the resultant products from the clarification process are clarified juice and filter cake (mud).

Clarified Juice: One of the resulting intermediate products during sugar processing and obtained after the clarification process.

Evaporator: The machinery where evaporation takes place, a process for removal of water from a solution through the application of heat from steam.

Fiber: The dry water-insoluble matter in sugarcane.

Filter: The machinery for separation of the insoluble matter from the treated mixed juice after the clarification process.

Filtercake: Also called mud. The insoluble matter obtained by the filter from the treated mixed juice.

Juice Heaters: The machinery to heat sugar containing juice by an exchange of heat from steam through a system of piping filled with juice.

Massacuite: The concentrated syrup or molasses in which the sugar has been concentrated to a point where it will crystallize. Massacuites are designated by A, B, or C, indicating their relative purity or the number of crops of crystals of sugar which are to be removed.

Milling Tandem: The machinery used for the extraction of (mixed) juice from sugarcane. The tandem may contain one or more sets of knives, a shredder, a crusher and several three roller mills.

Mixed Juice: Also called diluted juice. The sucrose containing juice obtained from the milling tandem and conveyed into the rest of the factory for further processing.

Molasses: The residue left after the crystals have been separated from the mother liquors, the massacuites. Molasses are designated as A and B, corresponding with the massacuites. The final molasses is the liquid residue from which no more sugar can be removed economically.

Preevaporator: An evaporator vessel utilizing exhaust steam and any deficiciency of this type of steam augmented with live steam, and delivering vapor to the first vessel of the multiple evaporator.

Sucrose: Also called polarization (Pol). The pure chemical compound, also known as saccharose or cane sugar. The value is determined by direct or single polarization of the normal-weight solution in a saccharimeter.

Sugar: One of the products in crystalline form obtained from the sugar processing. Normally raw sugar, a brown product having 96 degrees polarization or higher is specified.

Syrup: The concentrated juice from the evaporators, before crystallization has removed any sugar.

Vacuum Pans: The machinery used for concentration of syrup or molasses to a point where sugar will crystallize and the crystal will grow.

Vapor Cell: An evaporator vessel utilizing exhaust steam and delivering vapor to heat exchangers or similar equipment other than the multiple evaporator. The purpose of this system is to secure a higher density for juice in a separate stage.

The foregoing glossary has been taken from the standardization of terms, definitions, calculations and control methods developed by the Committee on Uniformity of Reporting Factory Data of the International Society of Sugar Cane Technologists. These terms and definitions were published in "Sugar" under the title "System of Cane Sugar Control of the International Society of Sugar Cane Technologists." They have also been adapted from the "Cane Sugar Handbook" by Spencer and Meade.

SYNOPSIS

In recent years high production costs have plagued the Jamaican sugar industry. As a result, profits, at best, have been marginal. These high production costs are the result of many contributing factors at each level of the production cycle. To significantly reduce total production costs the efficiency at each of the various levels of production must be improved to the greatest extent possible. This report presents a comprehensive plan for accomplishing that end.

The first phase of the UNIDO assistance program revealed that a major portion of the equipment used by the various sugar factories in Jamaica has exceeded its economic life span, making maintenance costs, as well as time lost due to machinery failure during the crop season, high. In addition, due to the comparatively small size of many of the plants, economies of scale are not being realized. In order to benefit from large economies of scale, it has been recommended that many sugar factories be converted into syrup producing units. The syrup in turn would be processed into sugar by a new and large end-factory. This central crystallizing unit will be located at a deep water port to facilitate the shipment of sugar in large efficient bulk carrying vessels.

At the same time it has been proposed to increase the daily grinding capacity for most milling units in order to reduce the duration of the crop season. Shortening of the crop season will result in cane of a higher sucrose content than the cane now being processed. The increased milling rate and the higher annual production will optimize the utilization of arable land; a resource in short supply in heavily populated Jamaica.

It has been further recomme..ded, that in order to decrease the production costs of sugar, a centrally located production center for machinery be established. Its main task would be to repair and maintain the machinery used by all processing units. This production center would own, maintain and lease the major agricultural equipment needed for growing and transporting cane. At the same time it would be responsible for the training of factory and field workers as well as supervision personnel. Finally, the production center would centralize the stocking of spare parts in order to benefit from the price reduction through mass purchasing, minimize total capital tied up in inventories, and minimize parts outages and resultant downtime.

Many hours are lost during the crop due to inadequate supplies of cane to the mills. This lack of cane together with "stale cane" points up the poorly organized transportation system. Reorganization of the cane transportation system, together with an increase in the productivity of the cane cutter is vital to the future stability of the agricultural sector in Jamaica.

The execution of the second phase of the assistance program is essential. Only then can the recommended plan of action presented in Phase One be implemented and thus enable the Government of Jamaica to revitalize the sugar industry.

RECOMMENDED PLAN OF ACTION

The basic objectives of the program were to:

Maximize sugar output per acre to optimize the limited land resources.

Minimize cost of production so that Jamaica could compete with other sugar producing countries in the fulfillment of its quota granted by the International Sugar Agreement.

To attain these objectives some facts become evident:

Amalgamation of the sugar factories must be effected. This is to be done in such a manner that the mountainous terrain would not be a hindrance. Mere amalgamation by concentration of cane supply to one plant is unacceptable as the high costs of cane transportation greatly outweigh the decreased cost obtained from the larger processing plant.

Equipment stnadardization and training of workers must be promoted.

Savings resulting from modernization should be such that the investments needed would be self-liquidating.

A coordinated effort must be made by the industry to cut costs, especially in the importation of parts, thus keeping the Balance of Payments in check.

The profession of the sugar worker has to be upgraded.

Production of by-products from sugar such as animal feeds, electrical power and motor fuel, particle board, paper to name a few, should be studied. This could improve the public image of the sugar industry and also prove beneficial in monetary terms as well.

Amalgamation

In the developing countries, at present, factories processing 2,000 tons of cane per day are considered the smallest units capable of profitable operation. This, in contrast to 4000 tons in the developed countries. The major reason for this is the lower wage rates in the developing countries. As many of the factories in Jamaica are too small for economical operation, amalgamation to larger units is necessary.

Cane consists of approximately 20 per cent soluble solids and 15 per cent fiber. The balance is moisture. Accordingly cane is not an easily transportable commodity, even for moderate distances. Transportation costs, however, can be significantly reduced when the water content has been removed.

This recommendation was made only after careful consideration of several alternatives. One of these alternatives, and the more obvious one, would be to close a number of the smaller plants, and to increase the capacity of a single centrally located plant to process all the cane in an area. However, this alternative is not compatible with the topography of Jamaica where cane is often grown in specific valleys served by their own processing plant. Cane cannot be transported from these valleys to a centrally located processing plant in the large road trailer trucks required for economical transportation because adequate roadways do not exist for such vehicles. Accordingly, the recommendation calls for the production of syrup as an intermediate product by some of the existing smaller factories. This syrup would be transported in small tank trucks, suitable for the road conditions in Jamaica to a centrally located crystallizing unit.

Processing

In order to facilitate amalgamation, cane should be ground in the present processing plants. The juice obtained would be clarified and concentrated into syrup of 72 degrees Brix. The resultant product, with most water removed, would be transported to a new central end-factory. There it would undergo further crystallization, to be stored and finally bulk loaded for export. Stated differently, the crystallization process (pans and crystallizers) and the separation process (centrifuges) would be eliminated at several plants. These processes would be performed at the central plant, thus avoiding the transportation problems on mountainous and narrow roads, and reducing overall production costs. Also, as about 60 per cent of the total maintenance cost in the present factories is used to repair the milling, clarification, evaporation stations and the boiler plant, every factory participating in this new concept would benefit from a maintenance standpoint as well.

Crop Duration

In order to reduce production costs at each factory even further, the grinding capacity would be increased within the optimum time span of the crop period. Sugar production, or syrup production, per hour will increase substantially when the crop duration is shortened.

This should be done whether a specific plant is to remain a crystallizing unit or is to be converted into a syrup producing unit. This is because the volume of cane passed per crop season to a great extent determines the profitability of the processing plant. Consequently, the maximum cane tonnage possible should be processed by each plant. Thus shortening the crop season essentially by eliminating the rainy period will increase the sugar content and subsequently improve daily sugar production.

The sugar content of the cane processed should not be so low that the cost of processing plus the price of cane purchased from the farmer exceeds the anticipated export sale price. It must be kept in mind that the purchase cost of cane will decline as the average sugar content decreases. This sugar content level is essentially dictated by the length of the crop season; less sugar in a long season (and as a result partly during the rainy season) and conversely, more sugar during the short and correspondingly dry season. Accordingly, the period recommended to be eliminated is the rainy season. During this period large amounts of soil are admitted together with the cane for processing causing excessive abrasion and necessitating repairs to the grinding equipment. The shortening of the crop season will both increase the yearly output of sugar and reduce maintenance costs as well.

The average purchase price of sugarcane will decline with a lengthened crop season. However, as the cost of purchasing cane which, incidentally, is a one-time cost, is far greater than the cost of processing; a factory can still realize a profit per ton of cane processed during a farily prolonged grinding season.

Today, even the larger factories are growing only about half of their required annual cane supply. The balance is purchased from independent growers. From this it becomes evident that some break-even point exists for each factory. It would be unprofitable to extend the grinding season beyond this break-even point due to the already discussed decrease in the sugar content and the resultant inferior quality of cane. Also, the break-even point for the factory may not be consistent with the break-even point for the grower. Therefore, the optimum grinding season and sugar yield per acre should be determined according to the national interest with due regard given to the scarce land resources available.

It is to be emphasized that in order to increase the daily grinding capacity for each plant to the level suggested in this report, the full cooperation of the mill owners is essential. The level proposed reflects a short and reasonable grinding season within the climatic limitations of Jamaica. To begin implementing these recommendations, a comprehensive and meaningful dialogue should be held between the responsible leaders of the Government, the mill owners, and the cane growers so as to establish an acceptable crop season duration and to ensure reasonable profitability for all concerned. Naturally, a mill owner will not wish to reduce the crop season beyond his point of optimum profitability. However, if this becomes necessary, any investments made beyond this point should be regarded as a social cost, made in the national interest. Mill owners also should realize the benefits to be derived from shortening the crop season; namely, better scheduling of repairs and less wear and tear on machinery. Therefore a compromise agreement is necessary from all quarters in order to start revitalization of the industry.

Factory Employment

At present the sugar industry is a seasonal industry. With the modern technology and improving socio-economic conditions of the seventies, skilled workers will be averse to accepting seasonally oriented employment. By reducing the size of the operations at the small processing plants, the number of persons required to work in the factory during the season will be reduced. Later the same workers can be employed for repair and maintenance during the out-of-crop season. Pay scales for year round employment should be adjusted to be favorable to other industries. The sugar industry will then be able to retain its workers. Such a factory schedule, also, should have a minimal effect on agricultural employment as most of these workers attend to their own holdings during the early and final stages of the crop.

Central End-Factory

Similarly, the central end-factory will operate on a year round basis, i.e. ten months per year, allowing two months for general maintenance. This will permit permanent employment of the skilled work force.

The end-factory should be located at a port so that sugar can be loaded quickly and directly into the large ocean-going vessels now used for bulk transport. The present bulk loading facilities are inadequate for effective loading. Some installations are capable of handling only 600 tons of sugar per day. As such delays in port nearly equal actual transportation to the United States Market. By placing the bulk loading station for the central end-factory at a port, preferably Kingston, ocean transportation costs can be greatly reduced and the profitabiligy for growing sugar cane and sugar manufacturing can be augmented.

The cost of such a facility is estimated at about $4.4 million. In addition, in order to run the factory during the entire year, a tank storage installation should be included at a cost of $1.3 million. This would enable the sugar industry to provide more than just seasonal employment.

An alternative would be to process the syrup into crystal form by those units remaining crystallizing plants. Tanks could be erected at these crystallizing units to receive the syrup. This syrup would be processed after the crop has terminated. However, due to a longer processing period, time alloted for equipment maintenance will be even less than is the case at present. In addition, the sugar produced for export will still be located inland. An investment of about $1.3 million would be needed for tanks, with no other major capital investment required. Also, the larger factories will become oriented toward more permanent employment. The capital investment required for shortening the crop season may become more attractive to these crystallizing units and the expected bagasse excesses could be more readily utilized as fuel. In any event, it must be remembered that syrup is a perishable product. This alternate has a disadvantage in that all syrup must be stored and processed after the regular grinding period has ended. The original plan, that of constructing a central end-factory, involves less danger of syrup spoilage since crystallization would be on a year around basis.

Another alternative would be to increase the capacity of the end-factory. By the end-factory processing more syrup, the crystallizing units would receive lesser amounts and would be able to process the syrup during the regular crop season. This approach would reduce the need for syrup storage facilities and lessen the chances of spoilage. However, the capital investment for this scheme would be high and the sugar would still be produced inland, causing shipping problems.

Previously it was stated that in order for a plant in a developing country to be profitable the minimum processing capacity is 2,000 tons of cane per day. It should be added that those plants which are recommended for conversion into syrup production, process well below this daily minimum. To attain this goal nearly $6.0 million must be invested in the central end-factory and syrup storage tanks. Furthermore, at least half of the total amount designated for increasing the daily grinding capacity must be spent on the syrup producing units. Therefore, a total of aproximately $6.6 million must be expended to make the recommendations economically viable.

Transportation and Storage

The syrup produced by the processing plants will still have to be transported to the central end-factory for final processing. Although the weight of the syrup will be greater than the weight of sugar now transported, it will occupy the same volume as sugar. Also, it has the advantage of pump loading.

To receive and store the syrup, tanks must be erected at the present ports of shipment. Every day the production of the syrup factories will be shipped by tank truck to these storage facilities. The tanks would be emptied into a shallow draft vessel or barge fitted with tanks for transport to the central end-factory. This will take advantage of the existing waterways and will reduce transportation costs. This subject is fully covered under the chapter entitled "Storage Techniques and Transportation of Syrup."

Cane Supply/Mechanization

The conversion of the present factories into syrup producing units will be the most viable and economical plan to revitalize the Jamaican Sugar Industry However, such a plan can only succeed when a constant supply of sugarcane is furnished to these plants. An integrated coordination between the daily capacity of the factory, harvesting and loading, and transportation of the cane becomes essential to optimize sugar production. As a result it is also recommended that some simple form of mechanization be adapted. This would aim towards increasing the daily productivity of the cane cutter. A moderate investment for a harvesting machine, and the cane cutter working in conjunction with the machine, would both lighten the task of cane cutting and provide a constant flow of cane to the processing plants.

As just stated only a limited harvesting method is recommended at this time. This is because harvesting machines presently on the market have some limitations especially when working with recumbent cane, the type now found in Jamaica. Erect growing varieties of cane should be introduced in order to effectively utilize currently available machinery. However it may take years to replace the high yield recumbent cane for a similar erect growing variety.

This approach would also utilize the present transportation and loading equipment provided that some fundamental organizational concepts for these operations can be developed. Thus, from all indications, simple mechanization appears to be logical, and in the national interest for social as well as monetary reasons.

It should be mentioned that the idea of converting into syrup plants is not new. This development started during the past 20 years and has proven successful in other parts of the world, especially in the United States and Venezuela. In Jamaica, the plan is logical as it will integrate the present small sized processing units into an industry where costs can be kept in pace with the competitive price obtained for the output. At the same time, Jamaica will utilize its already available capital resources, namely, its cane crushing facilities to the fullest extent.

Finally, the factories which are considered the best possible choices for conversion to syrup plants are Bybrook, Gray's Inn, Hampden, Innswood, Jamaica Sugar Estates, Long Pond, Serge Island, and Worthy Park. Details of conversion costs are shown in the factory profiles.

Jamaica Machinery Cooperative

To eliminate the high costs associated with machine maintenance a central repair facility should be established. Such a step would reduce maintenance costs and benefit foreign exchange as well. The JMC would be represented by all corners of the industry. It would own, operate, maintain and lease all the major cane harvesting and transportation equipment. It would also operate the central repair facility for equipment.

As an adjunct to these areas of responsibility, the JMC would develop a comprehensive training program for factory, field and supervisory personnel.

The JMC would have solid jurisdiction over the purchase and stocking of spare parts and equipment required by the Industry. This would eliminate the duplicity and costly individual factory inventories that now exist.

Until this report is formally submitted by UNIDO to the Jamaican Government, we are unable to specifically query private factory owners with regard to accepting the proposed Jamaica Machinery Cooperative. However, we feel that they would be amenable to this plan.

Crop Diversification

The Government and the sugar industry should realize that for economic reasons the syrup producing plants eventually may have to close. Exported sugar will face intensified price compettitition from sugar produced in other nations. In the decades to come Jamaica may only retain a few large plants While annual production for domestic consumption may decrease, the balance, if it remains competitive, would be exported. However, at this point in time, a sound and conscientiously executed plan for diversification into crops other than sugar should be considered. Such a program conceivably may solve the problems of Jamaica's agricultural sector in the years to come.

An interesting footnote to the above is the case of Barbados. For many years it has depended on a single crop, sugar, as the key to its economy. As a result overall prosperity has not been achieved. Although Barbados does get preferential prices from Britain, as Jamaica gets from Canada and the Dominican Republic and Puerto Rico get from the United States, the seasonal nature of the crop, the decline of world prices and the advent of mechanization are combining to cause unemployment. The Barbadian Government, in an effort to boost the economy, has sponsored some public works programs and urged small farmers to experiment with truck crops. In 1970 for example, onions were grown commercially for the first time. This is the possible beginning of successful agricultural diversification.

It must be remembered that diversification into crops other than sugarcane and its derivative products is not easy. These commodities, being perishable by nature, require an intensive marketing and transportation system in order to prevent a total crop loss. A start in this direction has been made by the formation of the Agricultural Marketing Corporation, which is responsible for local collection, storage and distribution of vegetables. This operation has proven successful in that vegetables are now in plentiful supply at the major consumption centers of Jamaica. The company, however, sustained a deficit during the initial three years of its operation since export of its produce was nearly non-existent. Export and quality of product is essential to profitable operations, as are sophisticated skills, a commodity that is scarce in a developing country.

Similar problems face the small citrus industry. Only a small quantity of production is canned as fruit slices for export. The major portion of the crop filters to an already saturated local market.

Poultry production has nearly reached self sufficiency. Export is difficult because of the relatively high prices paid for feed grains and protein based ingredients which must be imported.

Beef, as well as dairy production is increasing. However, the present return per acre from these commodities is lower than the present return per acre from sugarcane. Thus the replacement of sugarcane by livestock would lower the national income from the agricultural sector; a factor which can be ill afforded.

Worthy Park Estates is currently experimenting with crops such as mahogany, coffee and cacao but without any apparent economic success. Diversification is failing partly from the lack of expertise but mainly from the difficulty to secure overseas markets at reasonable prices. These crops must be exported as the local market can only absorb a fraction of the production.

For these and other reasons, and based on this experience, a plan to integrate Jamaica's agricultural sector into the changing economy of tourism and mining should be considered. Diversification should concentrate on crops which can be exported as well as on crops which can be utilized by the tourist industry. The latter could replace the heavy imports of commodities now needed to sustain this industry.

The approach to crop diversification might not only cover the agricultural education and extension services, but also could include the details for marketing, quality control, and the establishingof the necessary agro-industrial complexes to service both a modern tourist trade and the export of produce with high quality standards.

This plan may take several man years to develop and would cover numerous disciplines. Successful application of the program may take decades. The sugar industry development, recommended in this report, presents not only a viable end in itself, but also a sound interim approach leading to such a diversification program. Implementation should effect a smooth and gradual transition into a diversified economy during the years to come.

AGRICULTURAL ASPECTS

The future existence of the Jamaican sugar industry will depend heavily on its ability to supply a constant annual production of sugarcane containing as high a sugar content as is possible. This sugar content and cane tonnage per acre only will be realized through the proper application of modern agricultural technology.

The Jamaica Sugar Manufacturers Association was cognizant of the need for agricultural research several decades ago. As a result, their research activity has gained international recognition. The institution is well staffed with dedicated scientists versed in all fields of modern agricultural research including soils, fertilizers, chemistry, pathology, entomology, variety selection and agricultural engineering. In addition, by providing financial support, Jamaica is participating in an extensive regional cane breeding experimentation program that is being conducted in Barbados. The benefits Jamaica has received from this research have been high cane tonnages per acre and a high sugar content in cane. This no doubt will continue in the future. Therefore, the sugar yield per acre, now favorable when compared with other sugar producing areas in the Caribbean, can be expected to remain competitive.

Future profitability will also depend on the ability to mechanize the necessary field operations other than cane harvesting. During the past few years the Estates have begun to level the cane fields and relocate field drains. Longer rows in larger acreages will facilitate the efficient working of the mechanical equipment. This land conversion process is continuing. In the near future it is anticipated that the major part of the cane acreage will have been converted and will be able to accept mechanized equipment.

The production of the total land suitable for the cultivation of crops is limited. The Agricultural Census/Survey of 1960-61 by the Department of Statistics indicates:

Total Land Area	2.8 million acres
Land in Farms	1.7 million acres
Cultivated Area	545,300 acres
Grassland	495,200 acres
Ruinate	355,000 acres

It is impossible to obtain an accurate estimate of the total area of land occupied by the cane farmers and sugar estates. The Cane Farmers Association estimated that the total acreage held by its members is about 78,000 acres. The estimate is not reliable in that it was based on random samples of larger farms only. The total sugar cane planted by the estates is estimated at approximately 90,000 acres, and their aggregate holdings over 200,000 acres.

Tangible data regarding capability and usage of estate lands has been prepared by the Research Department of the Sugar Manufacturers Association. The survey covers 13 estates including the larger ones. It provides a useful overview of estate land usage patterns and trends. This data shows that:

> the total area of the 13 estates is 172,000 acres of which only 94,000 acres are arable;
>
> approximately 80 per cent of the arable land is allocated for cane cultivation.

From the foregoing and from our own investigation it is evident that sugar production occupies an appreciable proportion of the good arable land available on the island. There is no evidence of any area of suitable land that is not put to productive use. On the contrary some of the land under cane is too steep or too poor for other cultivation -- particularly with tractors -- and might be retired to pasture or some other use.

It should also be added that some of the estates and large farms are reclaiming salt marshes and other lands to add to the area under sugar.

Drainage of some land is poor, especially in a large section of St. Elizabeth parish. This land is swampy, and used only to a limited extent for sugarcane production. The balance is used for cattle raising. This section may be utilized for general agriculture, including sugarcane production, after a reclamation program is undertaken.

This point is covered later under the Holland factory profile.

Irrigation facilities are limited to overhead apparatus which draws water from the major rivers. The system is rather costly and is of doubtful economic value in other than level cane growing areas. The natural rainfall and its distribution pattern, however, is adequate to produce a sugar yield which compares favorably with that of other major sugar producing areas in the Caribbean.

This all suggests that the factories are able to pay reasonable prices to the cane growers, a price that, essentially, is based on the sugar content in the cane. This, in turn, is dependent upon the price ultimately received by the processor for sugar and molasses.

Thus, it becomes apparent that the sugar yield per acre is favorable enough to provide an adequate return to the grower. This, of course, is based on the premise that the present markets offering preferential sugar prices will continue and, indeed, will increase in the future so that the average price received for the entire crop will improve accordingly.

Jamaica proposes to average a yearly sugar production of 500,000 tons or more. This is not an impossible goal. To reach this plateau, certain sloping areas now under cane cultivation may have to be abandoned when full field mechanization will be in effect. The higher sugar yield per acre, however, which can be expected from improved technology as well as from the introduction of better yielding varieties, should compensate for the loss in sugarcane acreage in the future.

As Jamaica is rather small, the present processing facilities are fairly centrally located within each cane growing area. On the average, most of the fields are located within a ten-mile radius from the factory. Although the distance between the cane growing areas and the processing locations affects the efficiency of cane transportation, the mountainous terrain forms an additional natural limitation. Cane that is grown in the valleys having their own processing facilities is separated from the Island's road system by fairly steep mountain ranges. It can be said that transportation of cane from these areas to a centrally located processing plant is at best difficult.

Transportation

Cane transport is one of the major problems and expenses in cane production. The factories are invariably centrally located with respect to the estate lands. The individual farmers occupy the outer fringes of the area. As just mentioned on the larger holdings it is possible for a farmer's cane to be as much as ten miles from the factory making transportation costs prohibitive. The situation worsens when a farmer must employ an outside transporter if he himself has inadequate vehicles.

Much of the problem is due to the fact that in recent years it has been decided that only the factory would constitute the point of delivery of cane. Prior to this some factories had established delivery out-stations, where the cane was accepted. This both reduced haulage and minimized congestion.

Compounding the problem is that farmer transport costs have risen due to slower turn-round of vehicles at the factory. At some factories it has been physically impossible to improve delivery facilities leading to delays in the factory yard and increased charges by transporters.

Transportation problems often result in stale cane. This is a problem that gives the sugar manufacturer cause for concern. It becomes more acute as the number of individuals involved in producing the crop increases. In general the problem stems from three main causes:

delays in loading cut cane in the field,

irregularity of transport, and

delays at the factory.

Stale cane is harmful to both grower and manufacturer in that quality is affected and efforts to eliminate any cause for delay between cutting and processing, must be of primary importance. As Jamaican sugar has a good reputation, nothing should be tolerated which will jeopardize the good quality of the sugar produced. Thus the first step to avoid stale cane is to effect close co-ordination of harvesting and transport operations. This applies equally to estate and farmer

In short, the present sugar content in cane, and the cane tonnage, per acre, are adequate for successful competition with other major producing areas. Also, sugarcane growing operations are fairly well organized. Subsequent operations such as harvesting, cane transportation, processing, and especially the delay between cane curning and grinding, cause measurable sugar content losses. For a harvesting procedure which employs burning, rapid and well planned handling of the cane from burning to processing is essential to preserve the sugar content. The recommendations of the report take this into account.

TECHNOLOGICAL ASPECTS

Examining factory weekly and crop reports it is evident that Jamaica's technological expertise in sugar processing is at a par with other major sugar producing areas of the world. The percentage of undetermined losses is within an acceptable range. The material balances provided in each factory profile do not reveal any major shortcomings in processing skills by the factory staffs.

The measure of factory control is based on the sugar content present in cane at the time of processing. It does not take into account the possible sugar losses that occur between burning and processing. It accounts only for the chemical and mechanical losses of sugar during processing and for the division in the form of crystalline sugar or sugar in the form of blackstrap.

Crystal recovery, in the form of Boiling House Efficiency, is sometimes low. This is especially true in the smaller factories. Similarly, sugar extraction by the milling tandem at the customary low linear speed of the rollers needs some improvement. This is indicative of equipment inefficiencies that exist especially in the back part of the factories.

Annually, the Research Department of the Jamaica Sugar Manufacturers Association publishes factory control data for each processing plant. This information provides comparisons between existing plants and suggests additional improvements for sugar recovery. This organization also provides some assistance when special difficulties in chemical control may occur.

The training and expertise of the factory staffs employed can be regarded as being high. The College of Tropical Agriculture in Trinidad, which later merged with the University of the West Indies, has provided exclusive training for sugar technologists. The College itself has been heavily engaged in cane processing and by-product utilization research and is well suited for such educational curricula.

The Jamaican Government also has recognized the need for an agency having broad powers, being able to oversee all aspects of sugar production. This entity, the Sugar Industry Authority, conducts processing research as one of its functions. The laboratory is headed by a Ph. D. in carbohydrate chemistry. The fundamental principle of this laboratory is to design standards of cane acceptance by the processor and to improve cane quality by reducing the time between cane burning and processing. The latter, actually, is a management concept, and as previously discussed, is reliant on the available transportation system. However, the laboratory may succeed in improving management controls by establishing accurate standards for cane quality. Also, the work already initiated by the laboratory will be augmented by adopting the recommendations regarding improvement of the cane transportation system.

At some future date the laboratory will assist the individual processors in various phases of cane processing and in the investigation of possible applications of sugarcane by-products. As such it will supplement the Research Department of the Jamaican Sugar Manufacturers Association which is already making great strides forward in this sector.

Finally, it should be noted the Sugar Industry Authority recently has created and staffed an Economics and Statistics Section. This was necessary since neither the Research Department of the Jamaica Sugar Manufacturing Association nor its own processing laboratory were capable of providing any meaningful information in this field. Thus, the industry, now, has the proper tools to project economic trends and pricing structures.

CURRENT STATE OF THE INDUSTRY

Economics

Domestic agriculture, as well as agriculture for export, is an important function of the social sector as well as in the monetary field. Exhibit A compares the contribution of exportable agricultural commodities to other sectors of the Jamaican Gross Domestic Product. Sugar and bananas are the principal agricultural commodities exported. The total output of each has been reduced drastically over recent years explaining the decline in the percentage contribution to the Gross Domestic Product for this sector.

The drop in annual sugar production is shown in Exhibit B. Sugar exports fell from 424,000 tons of sugar valued at $31,266,000 in 1965 to 302,000 tons valued at $28,584,000 in 1969; a moderate monetary loss considering the large decline in tonnage produced. This is illustrated in Exhibit C, which shows the average export price for sugar dropping sharply after 1964 but increasing from 1968 to 1969. The principal price increase affected sugar exported to the United States. This rose $24.00 per ton during the 1967-1969 period.

Jamaica, under the new International Sugar Agreement should have obtained a larger share of the sugar quota for the United States at this favorable price. However, it was unable to take advantage of this increased market potential due to a lack of available sugar. A quota of 180,000 tons was allotted to the West Indies by the United States. Jamaica, historically the largest sugar producer in this region, was able to provide only 60,778 tons. Had sugar production not declined more than 20 per cent from 1968 to 1969, Jamaica would have been able to export at least its average tonnage of the previous years. Thus, taking advantage of the increased export price of $120.50 per ton, Jamaica could have profited by more than $3.5 million in foreign exchange.

The decline in sugar output and the failure to capitalize on the improved price structure for export sugar reflects on the utilization of the Island's available resources. This is especially true as Jamaica shows an increasing deficit in its Balance of Payments (Exhibit D). Not only did reduced sugar production have an influence on widening the deficit in the Balance of Payments, but also on the gross domestic product in the rural areas.

The large majority of workers are employed in the field as cane cutters and loaders and are remunerated by task performed. Therefore, the earnings of this group are closely related to the amount of cane available for harvesting. As no data about agricultural employment is available, it is assumed that 30,000 cane cutters and loaders are employed during the crop season Again assumed, they contribute up to four times as much to the Gross Domestic Product as the some 6,000 factory workers employed by the industry itself. Decline in sugar production would have caused a resultant decline in the consumption of basic commodities in the rural areas of Jamaica lowering the standard of living in this region.

In summary, the continued decline cannot be attributed to natural causes. However, such factors as: migration of the population from rural to urban areas; human relations; wages; cost and methods for harvesting and loading of cane; and cost and type of equipment employed for sugar processing are most often mentioned by the knowledgeable people of the industry as being the causes for the continued reduced sugar production.

Each of these factors will be discussed in greater detail on the following pages.

<u>The Rural Population</u>

Jamaica has only limited land resources, a total of 28 million acres. It already has a large population, one which is increasing at a high annual rate. The Island's topography, with its large mountain ranges, reduces the amount of arable land to 1.7 million acres. This is less than one acre per capita. As a result, it is essential that the maximum monetary yield be obtained from the land.

Jamaica has been growing sugarcane for centuries. The rural population is familiar with this crop, and is assisted by a privately sponsored research station. Sugarcane and bananas are the only crops which are produced on a large scale and for which agricultural technology is on a par with other countries. Agricultural technology is presently very limited for other crops. Therefore, sugar production cannot be allowed to collapse completely as the effect on the development of the country would be disastrous.

Sugarcane is furnished by three main suppliers: the Estates which also own the sugar manufacturing plants, the independent large cane holdings, which do not own grinding facilities but who employ a varying number of agricultural laborers; and small independent farmers who deliver only a very meager amount of cane every year. About half of all cane is produced by the sugar manufacturing companies. Seventy-five per cent of the farmers produce only 25 per cent of the total cane crop. Among this group is a large number who produce cane from very small acreage. These holdings generally are located on the steep mountain sites where growing conditions are difficult and transportation to the processing site cumbersome. These farmers rely mainly on manual labor for their production. The commodity of time is plentiful as he has no other employment available to make his free time productive. The small remuneration received from growing cane on this marginal type of arable and otherwise unproductive land means a positive, although very small contribution to the Jamaican economy. Even the small amount of cane produced means a small disposable income to this farmer.

Therefore, the growing of cane by the small farmers must be allowed to continue as it makes use of the most marginal land resources, and it provides some income to a large segment of the population. Furthermore, the small farmer can increase his income by working for the Estates during the season. Cane farming ties the small grower to the location where the major portion of sugarcane is produced. As a result, the growing of cane by the small farmer is actually beneficial to the sugar industry in general.

Training/Wages

To attract the needed factory workers, the industry itself has initiated what is known as a "helpers" system for on-the-job training.

During the training period, the helpers receive practical instructions in the basic factory skills. No form of specialization is introduced nor are any promotion steps offered for an apprentice to proceed through a specific range of job training. The result is that the apprentice receives instruction in the basic skills only. The training necessary to maintain the more sophisticated machinery which has been installed during recent years is not available.

The present level of basic training and the resulting lack of incentive wage rates causes migration to other industries where such incentives do exist. As a result, the other industries do not even provide the basic training; finding it cheaper to hire a person having these fundamental skills from the sugar industry and then providing the specialized training at higher wage rates. This migration is extremely costly to the sugar industry.

The need for specialized technical training becomes evident when studying the cause of machinery break-downs. (Exhibit E). One factory, Worthy Park, has an outstanding record as compared to the other factories. This can be explained by the fact that Worthy Park has very unsophisticated machinery and is only moderately electrified. The level of training needed to repair and keep the machinery operational is lower than at other factories where more modern equipment has been installed during recent years. It also suggests that although the present training for maintenance of machinery that is 30 or 40 years old is adequate, the training for repairing and effectively maintaining the modern and more sophisticated machinery now in use is inadequate.

The difference in wage rates between the sugar industry and the other industries must also be regarded as a reason for worker migration. Exhibit F illustrates the wage rates for the other industries while Exhibit G shows the wage structure for comparative skills in the sugar industry. Upon comparison, it is not surprising that persons with mechanical skills leave their employ with the sugar industry.

The sugar industry has maintained that any significant changes in the wage structure for factory employees would be impossible due to the average price received for sugar. With the present system, containing numerous production units, this may be true. But with larger (and thus fewer factories) the cost factor for workers per ton of sugar would change substantially and allow wages comparable to other industries.

Comparative wages are not only important in the factories, they are as important to the man in the field, especially the cane cutter. The average age of a cane cutter is just under 50, making it evident that there is no influx of youth to this profession. The reasons are twofold: either the wage rates are unfavorable or some social aspects make the job unattractive

As the processing facilities can function properly and profitably only when a regular supply of cane is guaranteed, adequate manpower able and willing to cut cane is necessary to supply these factories.

There appears to be a "stigma" attached to the profession of cane cutting in Jamaica. It is regarded by the young population as an undesirable occupation. Cane cutting is a difficult task requiring skill. A cane cutter must maintain an adequate output in order to make a worthwhile income. Without skill output is unsatisfactory since a worker is paid on a task basis If his output is poor his daily take-home payment can be low. In contrast, a tractor driver has an easier task to perform. His work is light, rather clean, and his skill requirements are not much greater than a good cane cutter. Yet the tractor driver receives a wage far superior to the cane cutter.

Both tasks are essential for sugar production. Failure in either section will automatically signal a failure in sugarcane supply to the factories. Processing time lost due to failure in the cane supply sector is dramatically shown below.

Name of Factory	Out of Cane Hours	Total Crop Time Hours
Monymusk	348	5,496
New Yarmouth	435	5,006
Appleton	1,236	4,311
Jamaica Sugar Estate	581	4,793
Bernard Lodge	208	5,257
Frome 1	458	4,411
Frome 2	361	4,435
Worthy Park	427	3,973
Gray's Inn	935	4,473
Sevens	618	5,806
Long Pond	865	5,488
Innswood	185	5,309
Hampden	620	4,934
Serge Island	854	3,430
Bybrook	590	5,427
Holland	722	4,833
Total	9,443	77,382

Source: Time Account 1970 Crop
Sugar Producers Association of Jamaica, Ltd. 1970.

The lack of enthusiasm for cane cutting in Jamaica is contradicted by the fact that Jamaican cane cutters are willing to and do perform well when engaged in this activity outside of their country. For example, about 8,000 Jamaican agricultural workers, essentially cane cutters, migrate to Florida at the beginning of each crop season. These workers cut an average of seven tons of cane per working day. In contrast his counterpart in Jamaica cuts an average of 3-1/2 to three tons per day. Of course the average age of the cane cutter in Florida is lower than the cutter in Jamaica. This may explain the discrepancy in daily output per worker. However, each cane cutter in Florida is interested only in his output, and as a result his daily earnings.

The important role performed by the cane cutter should be promoted in the national interest. Jamaica's population, already 20 per cent unemployed, does not warrant the replacement of manpower. Ways and means must be sought to advance cane cutting to a position that is both honorable and rewarding. Many cane cutters are small farmers but cut cane to supplement their income. When the rainy season starts, however, this same individual will leave his employment to tend his farm. Toward this end some form of mechanization would be useful.

Countries with higher standards of living completely mechanize their cane harvesting due to the lack of available labor. True, mechanical harvesting is often more expensive than manual harvesting. The cane cutter can sever precisely the top of the stalk at the right height and cut the cane exactly at soil level The machine, however, has to be set for cutting the top at an average height and cutting the stalk at about soil level. The amount of extraneous matter, which has an adverse effect on sugar recovery, is mugh higher for mechanically harvested cane than for manually harvested cane. Ideally, the cane cutter should work in conjunction with the machine. Cane topping should be performed manually while the severing of the stalk at soil level, and loading of the cane, may be performed mechanically. Employing the joint operation will lighten the task of the cane cutter and will increase his productivity considerably. At the same time it secures the optimum sugar production from scarce land resources.

Cost of Spare Parts and Equipment Repairs

A great variety of field as well as processing equipment is available to and used by the sugar industry. The Jamaica Sugar Industry is presently comprised of 15 processing plants. With the exception of five, each has a production capacity that is only marginal for economic survival. Each plant has its own individuality. Due to this great selection of machinery, stocking of spare parts becomes expensive and presents real problems as Jamaica is fairly isolated from the United Kingdom and the United States. However, it receives the majority of the necessary spare parts from these nations. The result is a large inventory of parts kept separately at each mill, and most important, they are not always interchangeable. Even the most standard items, such as valves, are stocked in great quantities at each mill in order to be available when needed. The result is a high priced spare parts inventory, possibly exceeding $100,000, for a factory producing 17,000 tons of sugar and represents a capital investment of six per cent for spare parts on the value of sales. Even then, all the spare parts cannot be stocked due to physical limitations of plant size, and have to be ordered separately when needed. This causes delays in repair and maintenance schedules.

In addition, the industry has almost completed a change from manual to mechanical cane loading without regard to standardization. Many types of tractors and several types of loaders are used. This also will eventually generate a similar spare part problem. As standardization of equipment is essential, future modifications or expansion programs should keep this in mind

A side effect of the variety of machinery is the high cost of repairs and maintenance during the out-of-crop season. Workers are trained to maintain only one piece of equipment and cannot easily be moved from factory to factory. Moreover, the specialized training required, and discussed earlier, to effect repair of a specific piece of equipment, is not available.

The high cost of repairs in the factories has been discussed at length in the Mordecai report. They can be attributed to the small economies of size of some plants, their individualistic approach in purchasing machinery and parts, and the marginal skills of the workers. As there are more sugarcane estates than sugar processing factories, the non-standardization of equipment may increase repair costs even further in the future.

Condition of Machinery

As stated previously, there are at present 15 operational sugar factories in Jamaica. Three others recently have been shut down and the equipment sold. The existing factories can be graded as passing, fair and good.

The age of the equipment ranges anywhere from the early 1900's to the 1970's. A few of the factories, particularly Moneymusk, Frome, Bernard Lodge, New Yarmouth, Appleton and Sevens have pursued vigorous modernization programs. However, at times the programs were delayed due to lack of funds. Others have made a small attempt at modernizing while some have made no attempt whatsoever. The latter group has replaced equipment only when forced to by the failure of the original equipment.

For ease of identification we have divided the factories into three groups: A, B, and C. Ratings for each group shall be A-good, B-fair, and C-poor.

In grouping the 15 factories, we find: three factories having an "A" or "good" rating; three factories having a "B" or "fair" rating; and nine factories having a "C" or "poor" rating. Thus, 60 per cent of the factories are considered to be in poor condition. This, then, is indicative of the existing state of the Jamaican sugar industry.

Each factory was visited and a complete survey made to determine the mechanical condition of the equipment. Since the factories were visited during the off-crop season, the equipment was not running. Therefore, the assessment of the condition of the machinery was solely dependent upon the experience of the members of the Team.

To check further on the validity of this assessment, an investigation was made of the lost time during the crop for mechanical, electrical and steam difficulties as this lost time is a valuable yardstick in evaluating the condition of the equipment. In Florida and Louisiana the maximum allowance for mechanical, electrical and steam difficulties is three per cent. Taking into consideration the age of the equipment and the lack of skilled labor it was agreed that an extra allowance of two per cent be made for these conditions raising the maximum allowance to five per cent for Jamaica. Using this figure as a point of reference, and estimating the lost time as a percentage of the net grinding time, (i. e. days of crop minus lost time for weather, labor disputes, out of cane, holidays, end of run, and other miscellaneous causes), the grouping of the factories was established as follows:

2 Factories	0-5 per cent lost time
6 Factories	5-10 per cent lost time
7 Factories	10-17 per cent lost time

Therefore, 87 per cent of the factories exceeded the maximum allowable downtime. Even raising the allowance to ten per cent shows that 47 per cent of the factories still fail to meet even this limit.

Statistics at times can be misleading and possibly it is unfair to judge the different factories on the above basis. The fact remains, however, that there is an ultimate point in material fatigue for any piece of equipment. The oldest piece of equipment observed was built in 1911. Thus, it has been in operation 59 years. No records have been maintained but if someone had taken the time to keep such records on the costs of repair and maintenance, both labor and parts, the total amount spent on keeping certain pieces of machinery operational could prove staggering.

Causes of Machinery Failure

Just after World War II, marketing for Jamaican sugar was normalized by long term agreements with the United Kingdom for quantity and price. These agreements, amended from time to time, have promoted the growing of sugarcane. The price paid for sugar favored production in large plants. Jamaica had more than 30 operational plants at that time.

Normally, the factories which have closed down continued to grow cane. The crop is transported to the operating plants. Rather than installing larger sized machinery to augment the daily grinding capacity, these factories instead increased the length of the grinding period in order to process the larger cane supply with the existing equipment.

During the early sixties, cane growing was encouraged by the Government. The resulting increase in cane supply was supported by a sudden spurt in the sugar price. As this increase in the cane supply could have been considered temporary, it was understandable that the factory management was hesitant to install additional equipment.

Subsequently, and dating from this time, extensive prolongation of the crop period has been practiced. Instead of using the machinery four months per year, and devoting the balance to reconditioning, management is faced with grinding periods often in excess of seven months. Wear and tear of machinery during such a prolonged crop period is heavier than for a grinding of normal duration. The short time now allotted for reconditioning of machinery further aggravates the repair situation. Due to these and other facts the quality of repair has worsened rapidly.

Expansion of the crop season occurred in the periods marked by rainfall. Normally, when cane was loaded manually, the wet weather did not have a very significant effect on the amount of extraneous matter adherent to the cane.

This situation has changed during the past few years.

Cane burning prior to harvesting has recently been initiated. Now the workers are able to harvest more cane per day and as a result, increase their daily remuneration. Also, mechanical cane loading by means of grabs has been introduced. This has augmented the cane cutting force with the workers formerly employed for manual loading.

Burned cane now harvested during the wet periods of the prolonged crop season often is left for several days in the field before being processed. This increases the tons cane per ton of sugar ratio; the indicator for cane quality. Furthermore, the mechanical loading of cane during these wet periods causes heavy amounts of extraneous matter to adhere to the cane and to enter the factory. Soil, especially, has a very abrasive action and causes significant increases in the wear and tear of machinery until the clarification process is complete. Carrier chains and sprockets, juice pumps and mill rolls wear much more quickly than before. Soil also reduces the combustion quality of bagasse and results in difficulty in maintaining steam pressure and forcing an increase in utilization of fuel oil; an expensive commodity in Jamaica.

Thus, an already tight repair schedule has become even more strained in recent years. Subsequently, the cost of repairs has skyrocketed and machine parts have to be replaced at ever increasing rates.

The grinding season must be reduced in order to stabilize the Jamaican sugar industry in the future. The shortening of the duration for the crop season will, to a great extent, achieve the following:

Promote better machinery repair schedules.

Significantly reduce the abrasive wear of machinery by soil.

Prolong the life expectancy of equipment and parts, lowering the production cost at the same time.

Shortening of the crop season will also:

Eliminate cane processing during the wet periods when supply of cane cutters is at its lowest level.

Shorten the delay in time between cane burning and processing, thus increasing the cane quality.

Limit cane processing to the period when cane has as optimum ripeness as possible, again increasing cane quality.

Make more effective use of the cane transportation equipment and cause fewer breakdowns. The efficiency of this equipment is greatly reduced when used during wet season.

For the reasons just stated, shortening of the grinding season to a more normal time span is essential to the future of the industry.

Assessment of the Outside Repair Facilities

There is only one independent repair facility on the Island equipped to handle the heavy equipment of the sugar industry. Located in Kingston, the Kingston Iron Works (K. I. W.) houses its offices, workshops and foundry in one central location. The shops are equipped with most of the machines and tools necessary to repair the factory equipment as well as to fabricate new equipment, such as vacuum pans, evaporators, juice heaters, and clarifiers. It cannot manufacture power units or allied equipment.

In addition to serving the sugar industry K. I. W. serves the bauxite and the other industries on the Island. The work for the sugar industry represents a small portion of its annual income with the bauxite industry contributing the major portion. It also manufactures and ships finished products to many of the sugar producing nations in the Caribbean, Central and South America. K.I.W. intends to pursue a major rehabilitation program aimed at modernizing the foundry, machine, and fabrication shops in an effort to improve its efficiency and reduce costs.

There are a few smaller repair facilities that serve the sugar industry specializing in boiler repairs, electrical repairs and instrument calibration and repair. None of these is capable of or attempts to undertake the major foundry or machine shop work.

The quality of the work of K.I.W. is classified as fair to good. As in every industry, complains of inconsistent quality of both materials and workmanship are common but despite these difficulties the industry relies heavily on K.I.W.

Of common concern is the high cost of repair and material. Lower prices can be obtained abroad but import restrictions do not allow the factory operators to take advantage of them. An excellent example of lower off-island costs is that some factories have imported new mill rollers from Barbados, made possible through the CARIFTA agreement, at a lower cost than the same roller supplied by K.I.W. Even though there is shipping cost involved the Barbados price is still much cheaper. However, and not withstanding the CARIFTA agreement, if K.I.W. is unable to fill an order the factory in question generally is issued an import permit for the material or work required.

It is extremely doubtful, even after modernization, that K.I.W. will be able to stabilize or lower their prices. The higher cost of new machinery today may force further increases in price. In addition, since the other industries constitute the major portion of K.I.W.'s annual income, it is understandable that they would cater to these industries as sugar mill repair work is only seasonal in nature.

There are two options to circumvent the existing high prices. One is relaxation of the import restrictions on the sugar industry, thereby allowing the factory operator to obtain services, material or parts anywhere in the world at attractive prices. The second is to form the Jamaica Machinery Cooperative that will be allowed both import relaxation and include a central repair facility solely for the sugar industry.

FACTORY PROFILES

The profiles and discussions for each factory which follow are based on detailed technical information provided by the Chief Engineer and Fabrication Superintendent of the factories and on the personal observations and impressions of the Team members visiting the plants.

An example of methods used for the evaluation of each plant is included only in the discussion of the Innswood Plant. For all other plants a diagram indicating the optimum duration for the grinding season based on sugar content in cane during the 1970 crop is included. Incidentally, this crop was one of the wettest in history but the short duration of the project prevented calculation for the optimum duration of a grinding period based on the average of the past five crop seasons and the correlation with rainfall during these years.

The average yield per acre was fairly low for 1970 when compared with previous years, especially the fifties. During the latter period cane was harvested and loaded manually. This resulted in a minimum amount of extraneous matter. The 1970 values for yield were selected as the most recently available date and reflect the losses which are suffered from mechanical operations in the growing and harvesting process. The values experienced for 1970 will reflect future production performance more realistically than the adaptation of such values from the prevailing earlier years.

In addition, a table indicating present capacity of each piece of major machinery is incl·ded for each factory, as a·e tables and figures indicating the material balance, heat balance and steam requirements. These are shown to substantiate the recommendations for each plant.

During the investigation, it was found that, on the whole, the laboratories are well equipped for performing the routine analyses needed for an effective factory control. Large factories have more and more modern equipment than the smaller ones Each factory spends about the same amount per ton of sugar produced for laboratory equipment.

All factory technical personnel possess degrees either from the University of the West Indies, which offers a bachelors degree in sugar chemistry and technology, the older D. I. C. T. A. degree from the Imperial College of Tropical Agriculture, which was the forerunner of the University of the West Indies, or a technical degree from England.

Sugar analyses, intermediate product analyses and their reporting are performed according to the standards set by the International Society of Sugar Technologists.

In addition, in our discussion of each plant capacity changes are mentioned only for those items of machinery that require replacement or modification. For example, boiler capacities to convert to syrup production are considered adequate unless specifically mentioned. (Note the case of Worthy Park which calls for a new boiler to reach its projected capacity.

The location of each factory has been determined historically; not by any modern plant location analysis. Years ago several small animal driven factories were located in each valley. Ruins of some still exist. With the advent of the steam engine, and for subsequent economic reasons these factories were amalgamated with one factory remaining in a valley. Where the land was relatively flat, these factories further amalgamated into larger units (Monymusk and Frome). In other areas, the topography prevented this concentration as the mountain ranges and the relatively poor road system prevented effective cane transportation. Accordingly the location of the present facilities has been governed by the prevailing topography. The existing factories and their ownerships follow:

Owner	Factory
Jamaica Sugar Estates Ltd.	Jamaica Sugar Estates
Seaforth Sugar & Rum Ltd.	Serge Island
Gray's Inn (Ja.) Central Factory Ltd.	Gray's Inn
Trelawny Estates Ltd.	Long Pond
Hampden Estates Ltd.	Hampden
J. Wray & Nephew Ltd.	Appleton
Holland Estate Ltd.	Holland
The West Indies Sugar Co. Ltd.	Frome
The West Indies Sugar Co. Ltd.	Monymusk
Sevns Ltd.	Sevens
New Yarmouth Ltd.	New Yarmouth
Worthy Park (Factory) Ltd.	Worthy Park
Innswood Estate Ltd.	Innswood
Bernard Lodge Sugar Company	Bernard Lodge
United Estates Ltd.	Bybrook

It would have been improper for us to discuss our specific recommendations with the owners during the course of the study. However, it is our opinion that our recommendations will be accepted by the vast majority -- if not all -- of the owners.

APPLETON
Saint Elizbeth Parish

Appleton

The recommendations for Appleton are interrelated with those for the Holland Plant. Appleton and Holland both could be converted into syrup producing units, or the Holland factory would be closed down; its cane supply being sent to Appleton for processing. If Holland closes, then Appleton would remain a sugar unit at least for the present.

Should Appleton become a syrup unit, the present hourly grinding rate should be reduced from 67.5 to 60 T.C.H. or 1,440 T.C.D. Permitting a 25 per cent lost time factor for all purposes, the new grinding rate will effect a reduction of the crop duration to 134 days. The above recommendations were based on evaluation of the data on the following pages.

To suggest this grinding rate of 60 T.C.H. the following was considered.

The mills, juice heaters, filters, vacuum pans, C crystallizers and the high and low grade centrifugals all are of sufficient capacity to obtain the proposed grinding rate. The clarifier, though, is too small to adequately increase its capacity, and small polycell clarifier should be added. The enlargement of the clarification station will improve the quality of sugar, lessen its ash content, increase polarization, and render a better color than is presently obtained.

The capacity of the syrup supply tanks is also too small. At least 500 cubic feet of capacity should be added. The estimated cost for improvements needed to attain 60 T.C.H. efficiently either as a crystallizing or a syrup producing unit is $12,000 ($10,000 and $2,000 for clarifier and syrup tanks, respectively).

Although the above offers a solution for Appleton, it is not the optimum avenue to follow in that the problems facing the Holland factory have to be resolved simultaneously.

To keep the Holland facility in operation will involve continual and increasing government subsidization. At the same time, the nearby modern plant at Appleton will lose financially in that it will have an insufficient cane supply to operate profitably due to high depreciation factors.

Accordingly, it is recommended that the Holland Plant be closed.

The cane now harvested by Holland should be transported to Appleton. The topography of this area is fairly flat so cane transportation will be neither difficult nor costly. The merger of cane from Holland together with cane for Appleton will ensure delivery of about 230,000 tons per season (based on the deliveries for the 1970 crop) for Appleton.

The grinding period should be 140 days in order to pass the combined quantity of cane from Holland and Appleton. This means that the grinding capacity for Appleton be increased to 91.2 T.C.H. or 2,200 T.C.D.

To simply add cane supplies to be processed by the present mechanical facilities of Appleton, without the upgrading of the factory, would be unrealistic and would be contrary to the national interest. Just adding the cane supply from Holland will extend the crop duration far into the rainy season. The resulting decrease of sucrose content will eliminate any advantages from the large economy of size for the facility.

Upgrading Appleton easily can be effected by using the equipment presently available at Holland. The mechanical requirements for the proposed increase in grinding capacity for Appleton will be as follows:

Milling: The milling tandem has adequate capacity to attain the proposed grinding rate.

Juice Heaters: The juice heaters also are of sufficient capacity.

Clarification: The clarification station must be enlarged by installing the 16' diameter "Dorr" clarifier, now at Holland. Filter capacity is large enough to attain the proposed grinding rate.

Evaporators: The capacity of the evaporation station must be enlarged. The easiest solution would be to add the #2 vessel (2,500 square feet heating surface), now at Holland and designate this vessel as the last vessel in the Appleton station. The original #1 and #2 vessels at Appleton would be utilized as a double effect pre-evaporator, followed by a quadruple effect, with each vessel having 2,500 square feet of heating surface. This solution would be the cheapest alternative. However, further calculations have to be performed to determine the pressures and types of steam to be used and whether the preevaporator should be coupled in parallel or if each vessel should work separately. Finally, the types and amount of vapor which should be removed from the preevaporators to be used for the juice heaters and the new quadruple effect would have to be determined.

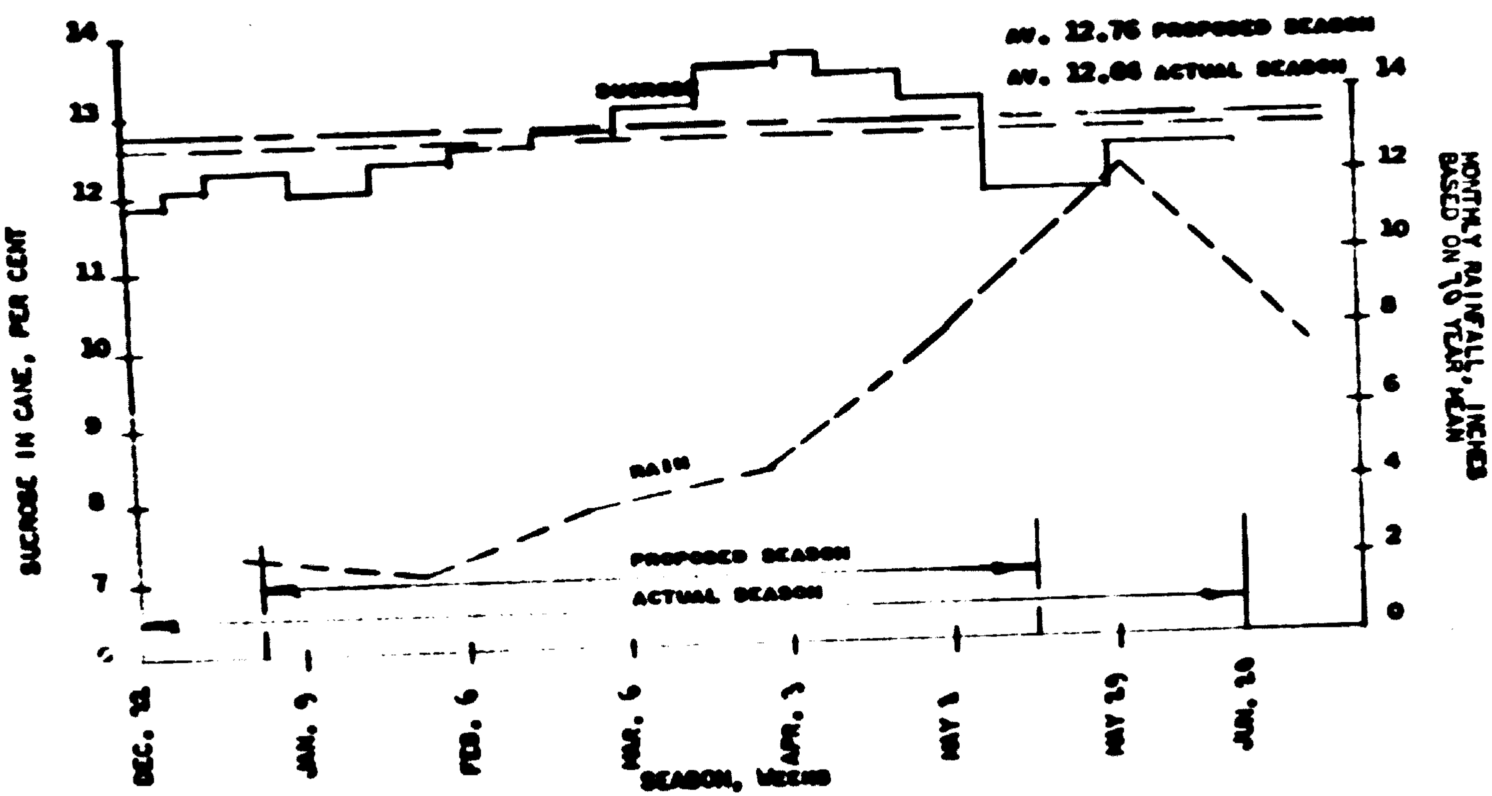
Vacuum Pans: The addition of Holland's pan #3 (600 cubic feet capacity and 1,000 square feet heating surface) should be adequate to increase Appleton to the proposed grinding rate. However, the capacity for the syrup and molasses holding tanks have to be increased.

Centrifugals: The addition of the single "Western States" fully automatic machine now at Holland will bring Appleton to the required capacity. In addition, the low grade continuous "Western States" centrifugal presently at Holland must be added to the capacity of the station at Appleton.

Aside from the question of ownership of equipment, it is estimated that $50,000 would be required to disassemble the designated equipment at Holland and reinstall it at Appleton.

APPLETON:
DISTRIBUTION OF PER CENT SUCROSE IN CANE DURING 1970 CROP

ACTUAL DURATION OF GRINDING SEASON-DEC. 12-JUN. 20 OR 191 DAYS
PROPOSED " " " JAN. 2-MAY 15 OR 134 DAYS



SANDERSON & PORTER, INC.

APPLETON: MATERIAL BALANCE SHOWING QUANTITIES OF INTERMEDIATE AND FINAL PRODUCTS PER TIME UNIT DURING THE 1970 CROP SEASON
PURITY MIXED JUICE: 84.49

Material	Per Cent Cane	Pounds/ Cubic Feet	Per Minute Pounds	Per Minute Cubic Feet	Per Minute Gallon	Per Hour Pounds	Per Hour Tons
Cane	100.00	25.00	2,521	101.0	-	151,222	67.51
Bagasse	31.61	5.00	797	160.0	-	47,801	21.34
Imbibition	22.12	62.00	558	9.0	67	33,450	14.93
Mixed Juice	90.51	66.18	2,282	34.5	258	136,871	61.10
Milk of Lime	0.50	67.00	12.6	0.2	1.5	756	0.34
Lime Juice	91.01	66.18	2,294	34.6	259	137,627	61.44
Mud to Filter	15.50	66.54	391	5.9	44	23,4[illegible]9	10.46
Mud	2.03	69.25	51	0.7	5	3,069	1.37
Wash Water	3.00	62.00	76	1.2	9	4,536	2.03
Filtrate	16.47	65.40	416	6.4	48	24,906	11.12
Clarified Juice	75.51	66.08	1,907	28.9	216	114,188	50.98
Juice to Evaporator	91.98	66.23	2,319	35.0	262	139,094	62.10
Syrup	21.85	82.41	552	6.7	50	33,040	14.75
Evaporation	70.13	62.00	1,768	28.5	213	106,054	47.35
MCA	12.75	93.21	322	4,967 cu. ft/ day		19,293	8.61
Sugar A	7.09	53.00	179	3.4	-	10,724	4.79
Molasses A	5.72	88.90	144	1.6	12	8,658	3.86
Dil. Mol. A	6.70	84.04	169	2.0	15	10,142	4.53
MCB	9.30	93.65	235	3,607 cu. ft/ day		14,075	6.28
Sugar B	3.83	53.00	97	1.8	-	5,800	2.59
Molasses B	5.70	90.17	144	1.6	12	8,623	3.85
Dil. Mol. B	6.92	84.04	175	2.1	16	10,471	4.67
MCC	5.84	94.55	148	2,245 cu. ft/ day		8,845	3.95
Sugar C	2.67	54.00	67	1.2	-	4,043	1.80
Magma	3.61	92.33	91	1.0	8	5,463	2.44
Final Molasses	3.26	92.16	82.2	0.9	7	4,930	2.20

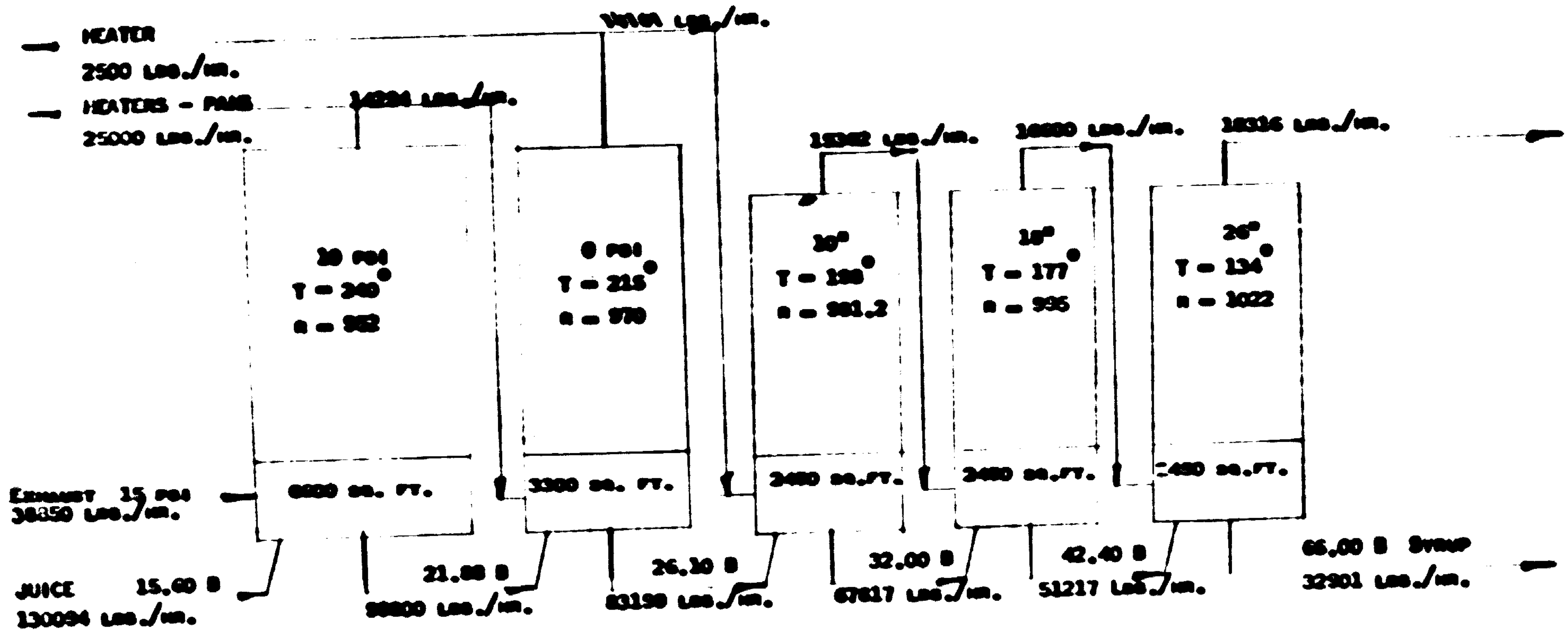
APPLETON: ACTUAL CAPACITY IN TONS CANE PER DAY FOR MAIN EQUIPMENT IN EACH PROCESSING STATION

Station	Average T. C. D.
Mills	2,208
Juice heaters	3,970
Clarifiers	1,050
Filters	2,268
Evaporators	1,610
Vacuum pans	1,780
Syrup supply tanks	960
A and B molasses supply tanks	2,304
C crystallizers	2,160
High grade centrifugals	1,875
Low grade centrifugals	2,160

APPLETON: HEAT BALANCE FOR THE EVAPORATION, STATION SHOWING THE STEAM CONSUMPTION IN B. T. U. NEEDED TO OBTAIN PRESENT DEGREE OF EVAPORATION IN EACH VESSEL

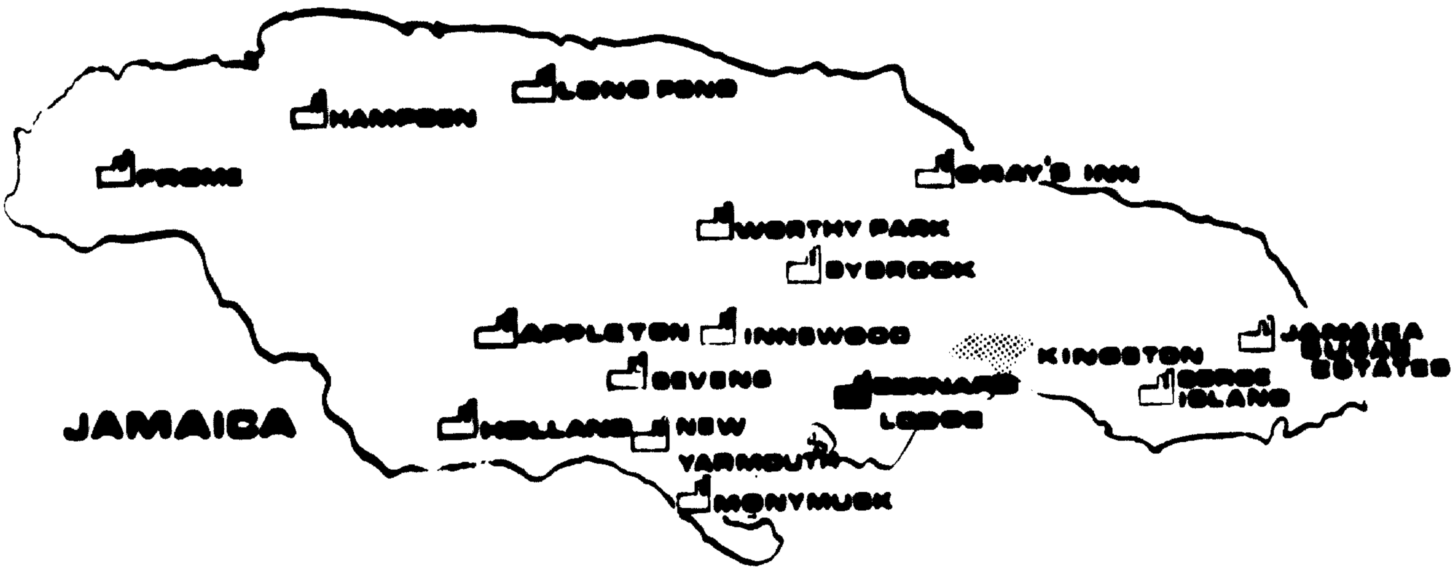
Calculation for Flow of Heat	Heat Content B. T. U.	Evaporation Pounds per Hour	Juice Per Cent Brix
1 Juice to Evaporator 10 psi		139,094	15.63
Exhaust to # 1 38,850 x 945	36,713,250		
Add Flash from heaters 139,094 (245-240)	695,470		
Available for Evaporation	37,408,720		
Evaporation 37,408,720 -:-952		39,294	
Transfer to # 2		99.80	21.78
2 Vapor from # 1 0 psi	37,408,720		
To heaters & pans 25,000 x 952	23,800,000		
Balance	13,608,720		
Add Flash 99,800 (240-215)	2,495,000		
Available for Evaporation	16,103,720		
Evaporation 16,103,720 -:-970		16,601	
Transfer to # 3		83,199	26.13
3 Vapor from # 2	16,103,720		
To heaters 2,500 x 970 10"	2,425,000		
Balance	13,673,720		
Add Flash 83,199 (215-198)	1,414,383		
Available for Evaporation	15,093,103		
Evaporation 15,093,103 -:- 981.2		15,382	
Transfer to # 4		67,817	32.05
# 4 Vapor from # 3 18"	15,093,103		
Add Flash 67,817, (198-177)	1,424,157		
Available for Evaporation	16,517,260		
Evaporation 16,517,260 -:- 995		16,600	
Transfer to # 5		51,217	42.44
# 5 Vapor from # 4 26"	16,517,260		
Add Flash 51,217 (177-134)	2,202,331		
Available for Evaporation	18,719,591		
Evaporation 18,719,591 -:- 1,022		18,316	
Leaving # 5 as Syrup		32,901	66.07

APPLETON: HEAT BALANCE DIAGRAM SHOWING INPUT AND OUTPUT OF STEAM, JUICE, VAPOR AND SYRUP BASED ON HEAT BALANCE CALCULATIONS



EVAPORATION RATE #1 = 5.95 LBS./SQ.FT./HR.
#2 = 5.03 " " "
#3 = 6.17 " " "
#4 = 6.66 " " "
#5 = 7.35 " " "
OVERALL = 6.11 " " "

BERNARD LODGE
Saint Catherine Parish



Bernard Lodge

From evaluation of the technical data contained on the following pages, and according to the quality of cane, Bernard Lodge should remain a crystallizing unit. The crop duration should be shortened to 135 days to optimize sugar production. The cane grinding rate should be increased from 134 to 178 tons per hour resulting in an increase of 3,200 to 4,275 tons of cane per day.

The factors which will enable Bernard Lodge to attain the proposed grinding rate are as follows:

Milling: The present mill tandem is capable of attaining the prescribed daily cane grinding capacity.

Juice Heaters: The heating arrangement is inadequate. The present low juice velocity in the heaters is partially responsible for the poor performance in this station. Also, the design of the juice heaters is unsuitable to operate on the vapor (at 5 p.s.i.) from the first vessel of the evaporators.

Adopting the higher daily cane grinding rate, the juice velocity in the heaters would be increased to a satisfactory rate. Concurrently, the heat transmission coefficient would be improved considerably when utilizing exhaust steam of 10 p.s.i. The heater station would have adequate capacity to accommodate the increased grinding rate, provided the steam source for heating is changed.

Clarification: The present "Bach" clarifier is too small and is capable of only handling 2,000 tons of cane per day. Also, the high number of compartments in the clarifier causes a heat loss resulting in decreased efficiency in juice clarification. It would not be advisable to convert the present clarifier capacity to accommodate the prescribed cane grinding rate. A 12-foot diameter polycell type clarifier should be purchased instead.

The filter also is insufficient. A second unit of the same size should be installed.

Evaporation: The performance of the installed equipment is efficient but is too small for even the present grinding capacity. The most economical solution would be to utilize the present first vessel with a 10,000 square foot heating surface as a preevaporator. At the same time the exhaust steam pressure should be increased to 15 p.s.i. so that the preevaporator can bleed vapor of about 10 p.s.i. to the heaters. A new first vessel with a 6,500 square foot heating surface should be installed to complete the station. The new combination would provide 38,600 square feet of heating surface to service the expected flow of 340,000 pounds of juice per hour. This allows an evaporation rate of 6.2 pounds per square foot per hour.

Pans: The pans are capable of handling the increased grinding capacity but it would be advisable to add a few molasses holding tanks. These can be fabricated locally.

Crystallizers: The capacity of the C crystallizers is adequate, provided that they are operated in a continuous arrangement. This means that all crystallizers would be interconnected, alternatively in front and rear, and top and bottom with an overflow. The last crystallizer would overflow continuously into the pugmill of the centrifugals. To accommodate such a system a new strike receiver would be needed to receive the pan load. This receiver would have 1,200 cubic feet of capacity with a mechanical stirring device (not water cooled) and would discharge continuously into the first crystallizer.

Centrifugals: The capacity for the A and B sugar is sufficient to accommodate the new grinding rate. The capacity of the low grade sugar station may be considered adequate as each machine can exceed the 60 cubic feet of massacuite per hour capacity; the value used for the calculation. Depending on the screen type used, the continuous centrifugals may reach a capacity as high as 120 cubic feet of C massacuite per hour.

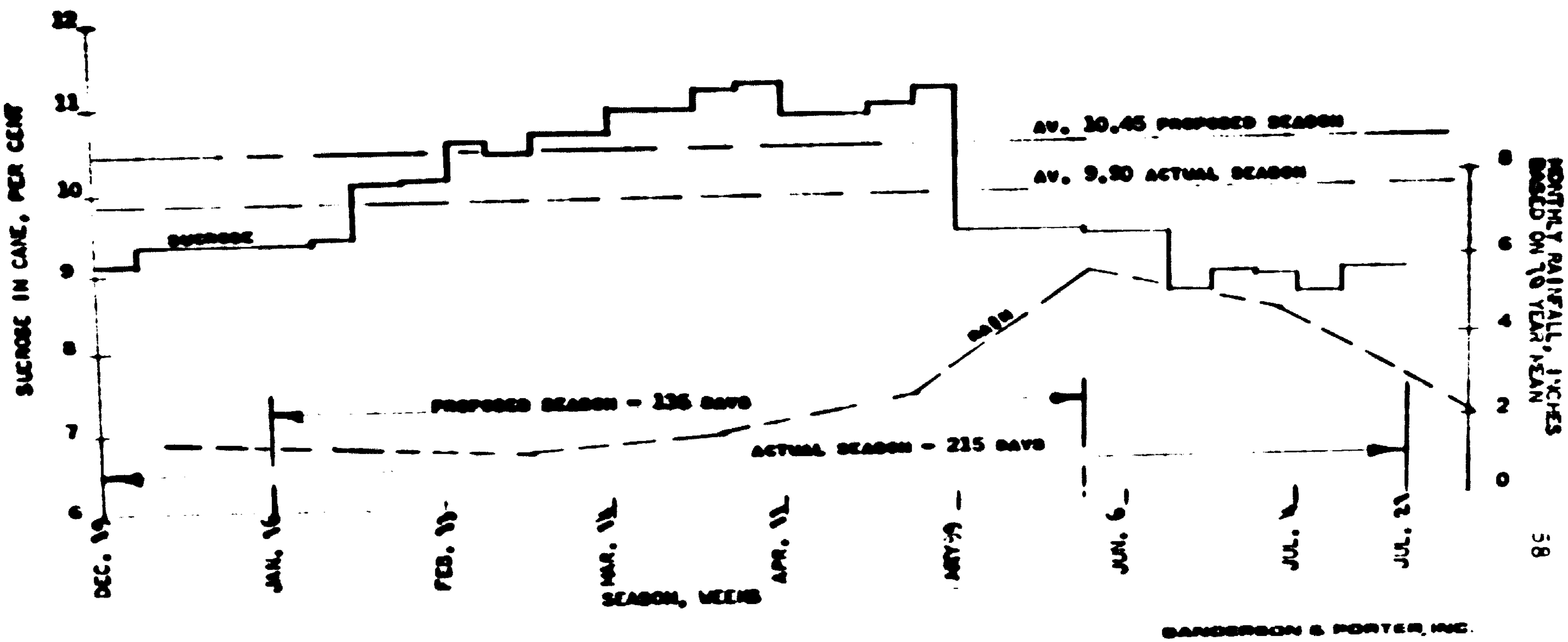
<u>Capital Cost:</u> Capital investments estimated to achieve the mentioned grinding rate are:

Clarification	$ 20,000
Filter	40,000
Evaporator	35,000
Crystallizer	5,000
Total	$100,000

BERNARD LODGE:

DISTRIBUTION OF PER CENT SUCROSE IN CANE DURING 1970 CROP

ACTUAL DURATION OF GRINDING SEASON-DEC. 19-JUL. 21
PROPOSED " " " " JAN. 16- MAY 30



BERNARD LODGE: MATERIAL BALANCE SHOWING QUANTITIES OF INTERMEDIATE AND FINAL PRODUCTS MANUFACTURED PER TIME UNIT DURING THE 1970 CROP SEASON
PURITY MIXED JUICE: 78.60

Material	Per Cent Cane	Pounds/ Cubic Feet	Per Minute Pounds	Per Minute Cubic Feet	Per Minute Gallons	Per Hour Pounds	Per Hour Tons
Cane	100.00	25.00	4,988	200.00	-	299,242	133.59
Bagasse	33.89	5.00	1,690	338.00	-	101,413	45.27
Imbibition	18.10	62.00	903	14.60	109	54,163	24.18
Mixed Juice	84.21	65.66	4,200	63.90	478	251,992	112.50
Milk of Lime	.50	67.00	25	0.37	27	1,496	.67
Limed Juice	84.71	65.65	4,226	64.30	481	253,488	113.16
Mud to Filter	15.50	66.00	773	11.70	88	46,383	20.71
Mud	2.39	80.00	119	1.48	11	7,152	3.19
Wash Water	3.0	62.00	150	2.41	18	8,977	4.01
Filtrate	16.11	63.60	804	12.64	95	48,208	21.52
Clarified Juice	69.21	65.57	3,452	52.64	394	207,105	92.46
Juice to Evaporator	85.32	65.60	4,256	64.90	485	255,313	113.97
Syrup	20.46	78.69	1,021	13.00	97	61,225	27.33
Evaporation	64.86	62.00	3,235	52.20	390	194,088	86.64
MCA	9.69	92.96	483	7,487 cu. ft /day		29,000	12.95
Sugar A	4.62	53.00	231	4.35	-	13,828	6.17
Molasses A	5.07	90.00	253	2.80	21	15,172	6.77
Dil. Mol. A	6.13	84.04	306	3.64	27	18,335	8.18
MCB	8.13	93.48	405	6,244 cu. ft /day		24,319	10.86
Sugar B	3.08	53.00	154	2.90	-	9,220	4.12
Molasses B	5.05	91.75	252	2.74	20	15,099	6.74
Dil. Mol. B	6.39	84.04	319	3.79	28	19,132	8.54
MCC	6.22	94.14	311	4,758 cu. ft /day		18,662	8.33
Sugar C	2.55	54.00	127	2.35	-	7,622	3.40
Magma	3.18	92.30	159	1.72	13	9,510	4.24
Final Molasses	3.96	90.10	198	2.19	16.4	11,854	5.29

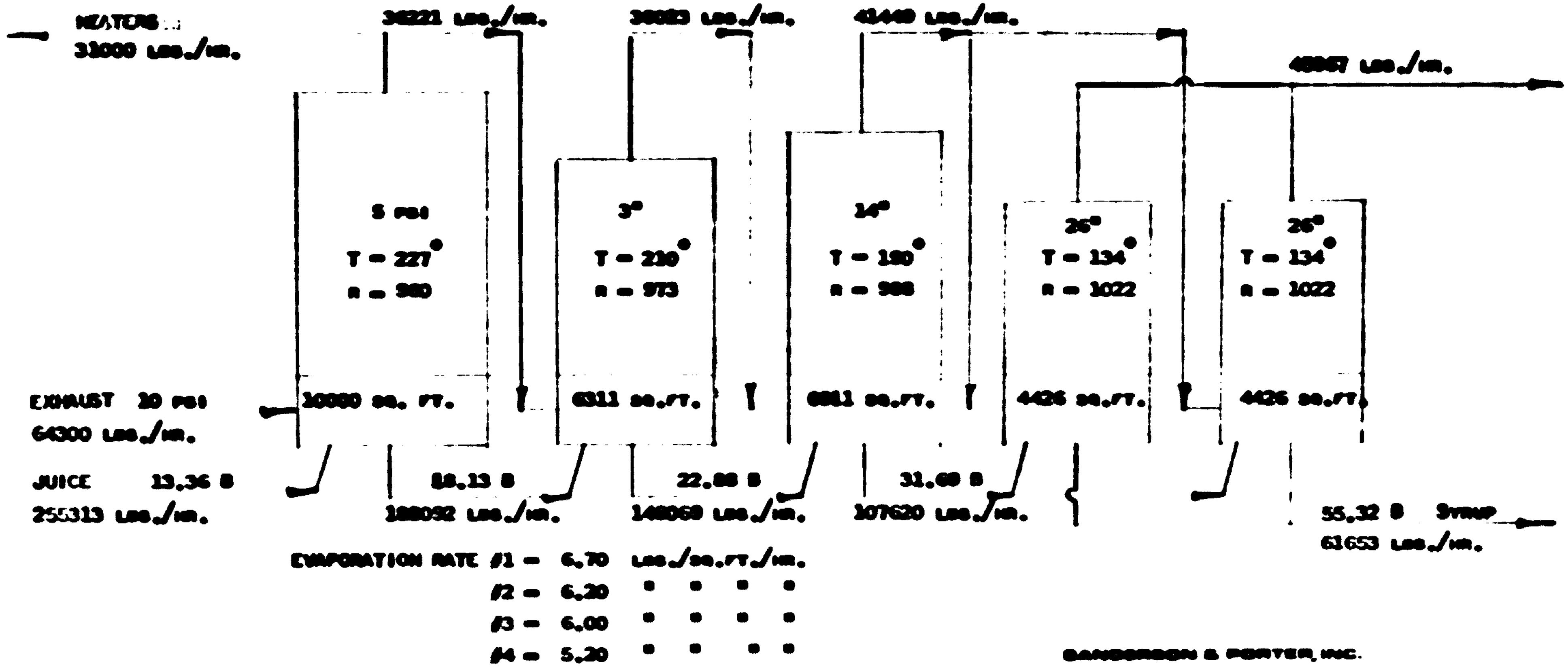
BERNARD LODGE: ACTUAL CAPACITY IN TONS CANE PER DAY FOR MAIN EQUIPMENT IN EACH PROCESSING STATION

Station	Average T. C. D.
Mills	5,040
Juice heaters	2,475
Clarifiers	2,880
Filters	2,650
Evaporators	3,200
Vacuum pans	4,000
Syrup supply tanks	4,000
A and B molasses tanks	3,600
C crystallizers	3,860
High grade centrifugals	4,320
Low grade centrifugals	3,900

BERNARD LODGE - HEAT BALANCE FOR EVAPORATION STATION SHOWING THE STEAM CONSUMPTION IN B. T. U., NEEDED TO OBTAIN THE PRESENT DEGREE OF EVAPORATION IN EACH VESSEL

Calculation for Flow of Heat	Heat Content B. T. U.	Evaporation Pounds per Hour	Juice Per Cent Brix
# 1 Juice to # 1		255, 313	13. 36
Exhaust to # 1 (10 psi) 64, 300 x 952	61,213,600		
Add Flash from preheater 255, 313 x (240-227)	3, 319, 069+		
Available for Evaporation	64, 532, 669		
Evaporation 64, 532, 669 -:- 960		67, 221	
Transfer to # 2		188, 092	18. 13
# 2 Vapor from # 1	64, 532, 669		
To heaters 31, 000 x 960	29, 760, 000-		
Balance	34, 772, 669		
Add Flash 188, 092 (227-210)	3, 197, 564+		
Available for Evaporation	37, 970, 233		
Evaporation 37, 970, 233 -:- 973		39, 023	
Transfer to # 3		149, 069	22. 83
# 3 Vapor from # 2	37, 970, 233		
Add Flash 149, 069 (210-190)	2, 981, 380+		
Available for Evaporation	40. 951, 613		
Evaporation 40, 951, 613 -:-988		41. 449-	
Transfer to # 4		107, 620	31. 60
# 4 Vapor from # 3	40, 951, 613		
Add Flash 107, 620 (190-134)	6, 026, 720+		
Available for Evaporation	46, 978, 333		
Evaporation 46, 978, 333 -:- 1022		45, 967-	
Leaving Syrup from # 4		61, 653	55. 32

BERNARD LODGE: HEAT BALANCE DIAGRAM SHOWING EVAPORATOR INPUT AND OUTPUT OF STEAM, JUICE, VAPOR AND SYRUP, BASED ON HEAT BALANCE CALCULATIONS



BYBROOK
Saint Catherine Parish

Bybrook

Bybrook should be converted to a syrup producing unit. At the same time, the crop duration should be shortened from 226 to 184 days per season in order to optimize production with the existing equipment. A grinding rate of 1,680 T.C.D. or 70 T.C.H. is projected.

Limiting factors are:

Milling: The present tandem has a maximum capacity of 62 T.C.H. for cane having 15.6 per cent fiber. This fiber content was very high during 1970. It is felt that the tandem could achieve 70 T.C.H., providing the fiber content will return to its normal average of 13.8 per cent. Whether the fiber content will actually return to the normal average is debatable. Mechanically loaded cane will contain more extraneous matter than the hand loaded cane. Therefore, 13.8 per cent fiber may not be attained. In this event the milling tandem will be too small. For this reason, the milling tandem should be replaced by a diffusion plant. For the present, the grinding rate can be adjusted to 70 T.C.H. for cane having 15.6 per cent fiber. This action will result in a slightly higher than normal loss of sugar in the bagasse.

Juice Heaters: Capacity is ample to achieve the increased grinding rate.

Clarification: The capacity of the present clarifier is inadequate. This can be increased by adding some polycell trees to the existing ones. The filter is of ample capacity for the increased grinding rate.

Evaporation: The evaporator's capacity is too small to accommodate the projected grinding rate. The present quintuple effect performs very efficiently. It provides an overall evaporation of 6.55 pounds per square foot per hour, producing a syrup with 61 degrees Brix density or higher.

Keeping in mind the likely high fiber content in cane for the future, the most practical solution to increase the evaporation station would be to add one new vessel. In this manner the evaporation station could function as two triple effects as compared with the quintuple effect now in operation.

The following arrangement is suggested to accommodate the 13, 340 square feet of total heating surface:

Stage #1 - One existing vessel with 3, 170 square feet heating surface.

One new vessel with 2, 000 square feet heating surface.

Total for first stage 5, 170 square feet heating surface.

Stage #2 - One existing vessel with 2, 500 square feet heating surface.

One existing vessel with 2, 000 square feet heating surface.

Total for second stage 4, 500 square feet heating surface.

Stage #3 - One existing vessel with 1, 835 square feet heating surface.

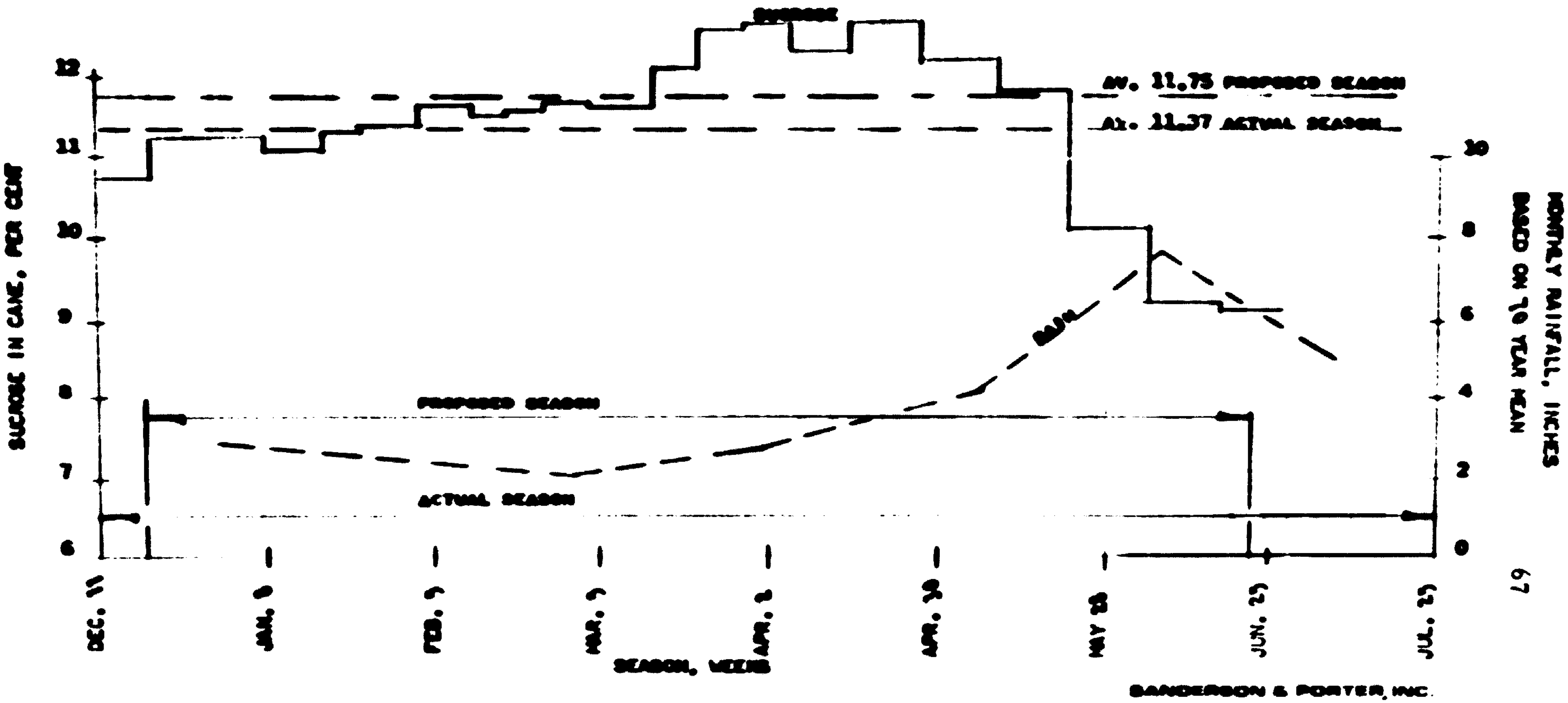
One existing vessel with 1, 835 square feet heating surface.

Total for third stage 3, 670 square feet heating surface.

Capital Costs: Capital costs to convert Bybrook into a syrup unit are estimated at about $18, 000 for the evaporator vessel ($12, 000 for the vessel and $6, 000 for change of piping arrangement). To remain a crystallizing unit and still grind 70 T. C. H. for optimum sugar production, an additional $45,000 will be needed to purchase pan supply tanks, high grade and low grade centrifugals ($2,000, $25,000, and $18,000 respectively).

BYBROOK:
DISTRIBUTION OF PER CENT SUCROSE IN CANE DURING 1970 CROP SEASON.

ACTUAL DURATION OF GRINDING SEASON DEC. 11-JULY 25 OR 226 DAYS
PROPOSED " " " DEC. 20-JUNE 22 OR 184 DAYS



BYBROOK: MATERIAL BALANCE SHOWING QUANTITIES OF INTERMEDIATE AND FINAL PRODUCTS MANUFACTURED PER TIME UNIT DURING THE 1970 CROP SEASON

Material	Per Cent Cane	Pounds / Cubic Feet	Per Minute Pounds	Per Minute Cubic Feet	Per Minute Gallons	Per Hour Pounds	Per Hour Tons
Cane	100.00	25.00	1,990	79	-	119,482	53.34
Bagasse	30.43	5.00	610	1,212	-	36,358	16.23
Imbibition	20.70	62.00	410	16.5	123	24,733	11.04
Mixed Juice	87.81	66.10	1,750	26.5	198	104,917	46.83
Milk of Lime	0.50	67.00	10.5	.15	1.1	603	.27
Limed Juice	88.30	66.10	1,760	26.7	200	105,510	47.10
Mud to Filter	15.5	68.00	310	4.53	34	18,520	8.27
Mud	2.28	85.00	45.5	.53	4	2,724	1.21
Wash Water	3.0	62.00	59.5	.98	7	3,584	1.60
Filtrate	16.27	64.80	324	5	37	19,440	8.67
Clarified Juice	72.80	66.10	1,450	22	165	86,983	38.83
Juice to Evaporator	89.07	65.60	1,774	27	202	106,423	47.51
Syrup	19.36	80.60	385	4.78	36	23,134	10.32
Evaporation	69.71	62.00	1,388	22.39	167	83,289	37.18
MCA	6.61	92.82	132	2.042 cu. ft/ day		7,898	3.52
Sugar A	2.94	53.00	59	1.1	-	3,516	1.56
Molasses A	3.71	86.60	74	0.85	6.4	4,439	1.98
Dil. Mol A	4.05	84.00	80.7	0.96	7.2	4,842	2.16
MCB	15.61	93.70	319	4,781 cu. ft/ day		18,656	8.32
Sugar B	6.43	53.00	128	2.4	-	7,686	3.43
Molasses B	9.18	87.40	183	2.1	16	10,970	4.89
Dil, Mol. B	10.27	84.00	205	2.4	18	12,272	5.[illegible]7
MCC	7.52	94.80	150	2.274 cu. ft/ day		8,988	4.01
Sugar C	3.23	54.00	65	1.2	9	3,865	1.72
Magma	4.50	91.50	90	1	7.3	5,382	2.40
Final Molasses	4.29	91.40	85.3	.93	7	5,123	2.29

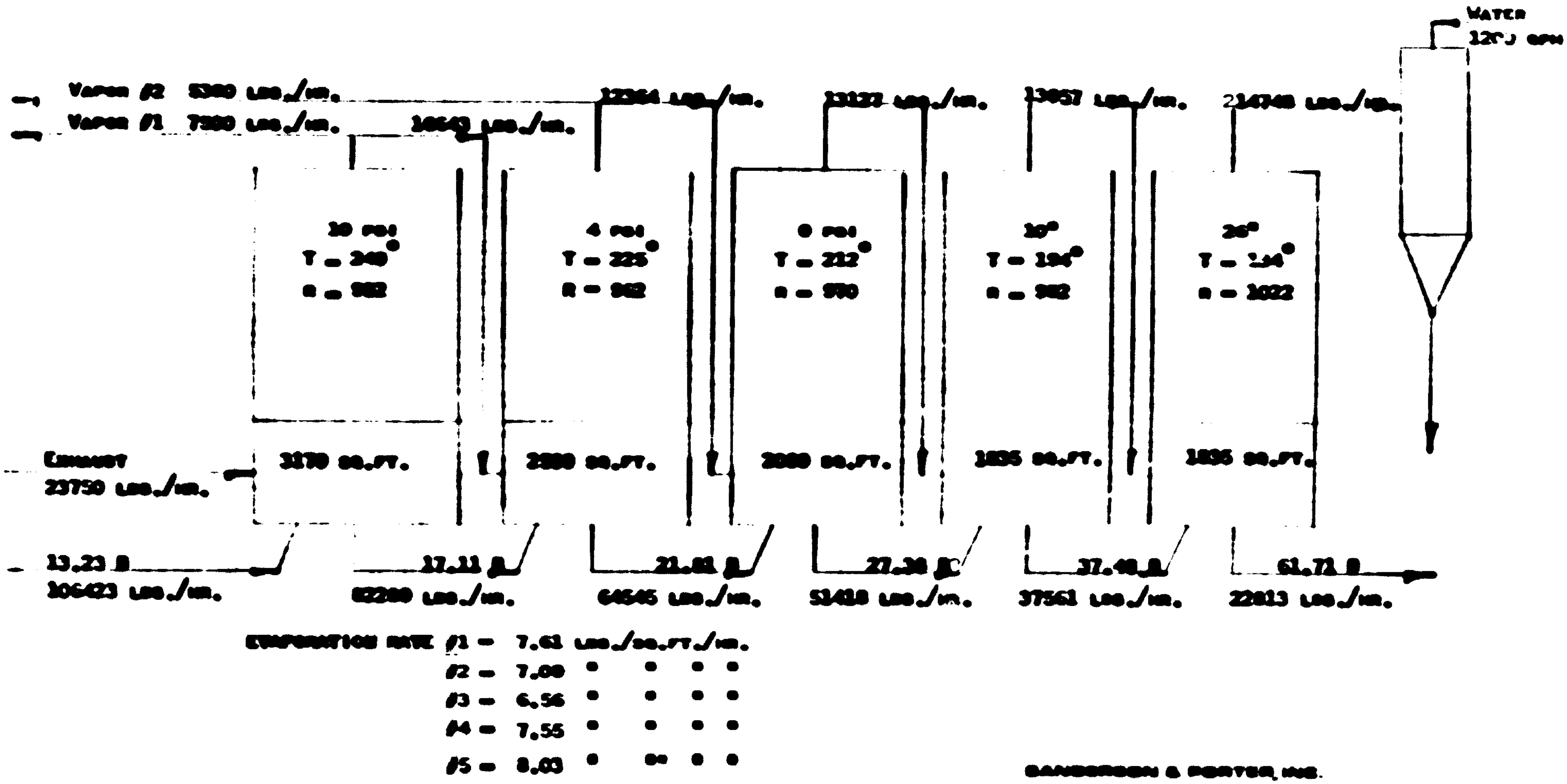
BYBROOK: ACTUAL CAPACITY IN TONS CANE PER DAY FOR MAIN EQUIPMENT IN EACH PROCESSING STATION

Station	Average T. C. D.
Milling tandems	1,488
Juice heaters	1,670
Clarifiers	1,320
Filters	2,040
Evaporators	1,280
Vacuum pans	1,420
Supply tanks, syrup	700
Supply tanks, molasses	1,200
C crystallizers	1,952
High grade centrifugals	1,416
Low grade centrifugals	1,356

BYBROOK: HEAT BALANCE FOR THE EVAPORATION STATION SHOWING THE STEAM CONSUMPTION IN B.T.U. NEEDED TO OBTAIN THE PRESENT DEGREE OF EVAPORATION IN EACH VESSEL

Calculation for Flow of Heat	Heat Content B.T.U.	Evaporation Pounds per Hour	Juice Per Cent Brix
#1 Juice to No. 1 10 psi		106.423	13.23
Exhaust to # 1 (15 psi) 23750			
x 945	22,443,750		
Add Flash from pre-heater	532,115		
Available for Evaporation	22,975,865		
Evaporation 22975865 -:- 952		24,134	
Transfer to #2		82,289	17.11
#2 Vapor from # 1 4 psi	22,975,865		
To Heaters 7500 x 952	7,140,000		
Balance	15,835,865		
Add Flash 82289 (240 x 225)	1,234,335		
Available for Evaporation	17,070,200		
Evaporation 17070200 -:- 962		17,744	
Transfer to # 3		64,545	21.81
#3 Vapor from # 2 0 psi	17,070,200		
To Heaters 5380 x 9621	5,175,560		
Balance	11,894,640		
Add Flash	839,085		
Available for Evaporation	12,733,725		
Evaporation 12733725-:- 970		13,127	
Transfer to # 4		51,418	27.38
#4 Vapor from # 3 10"	12,733,725		
Add Flash 51418 (212-195)	874,105		
Available for Evaporation	13,607,830		
Evaporation 13607830 -:- 982		13,857	
Transfer to # 5		37,561	37.48
#5 Vapor from # 4 26"	13,607,830		
Add Flash 37561 (195-134)			
8° BPR	1,464,880		
Available for Evaporation	15,072,710		
Evaporation 15072710 -:- 1022		14,748	
Leaving # 5 as Syrup		22,813	61.71

BYBROOK: HEAT BALANCE DIAGRAM SHOWING EVAPORATOR INPUT AND OUTPUT OF STEAM, JUICE, VAPOR AND SYRUP, BASED ON HEAT BALANCE CALCULATIONS



FROME
Westmorland Parish

Frome

The Frome factory is a well balanced processing unit. To optimize sugar production the crop season should considerably be shortened. A grinding rate of 312 T.C.H. or about 7,500 tons of cane per day should be established. Also, the factory should remain a crystallizing unit. To obtain the proposed grinding rate, the following factors are to be considered:

Milling: The two tandems now in operation do not need major modifications.

Juice Heaters: The higher juice velocity in the heaters will cause an increase in the heat transmission coefficient due to a decrease in scale formation on the tubes. The juice velocity, however, is already quite high for the present grinding rate. The station's capacity, especially the juice pumps, will definitely be too small to accommodate the proposed rate. Two new juice heaters, one for each tandem, each having 1,600 square feet of heating surface and provided with stainless steel tubes, should be installed.

Clarification: The clarifier capacity will become too small. The multi-feed 22 foot diameter "Dorr" can be converted easily to a five compartment unit thus adding one tray.

The present filters have an adequate capacity for the increased grinding rate.

Evaporation and Pans: No changes or additions are indicated except possibly for syrup and molasses storage. An additional row of tanks may be installed above the existing tanks. Syrup and molasses would require additional tank capacities of 5,000 cubic feet each in order to avoid stagnation in the operation of the pan floor.

Crystallisers: Capacity is ample to facilitate the increased grinding rate.

Centrifugals: Presently, the capacity for A sugar curing is too low to reach the target of 312 T.C.H., especially when considering 20 hours of curing per day. The installation of an additional machine must be considered but it is not necessary immediately.

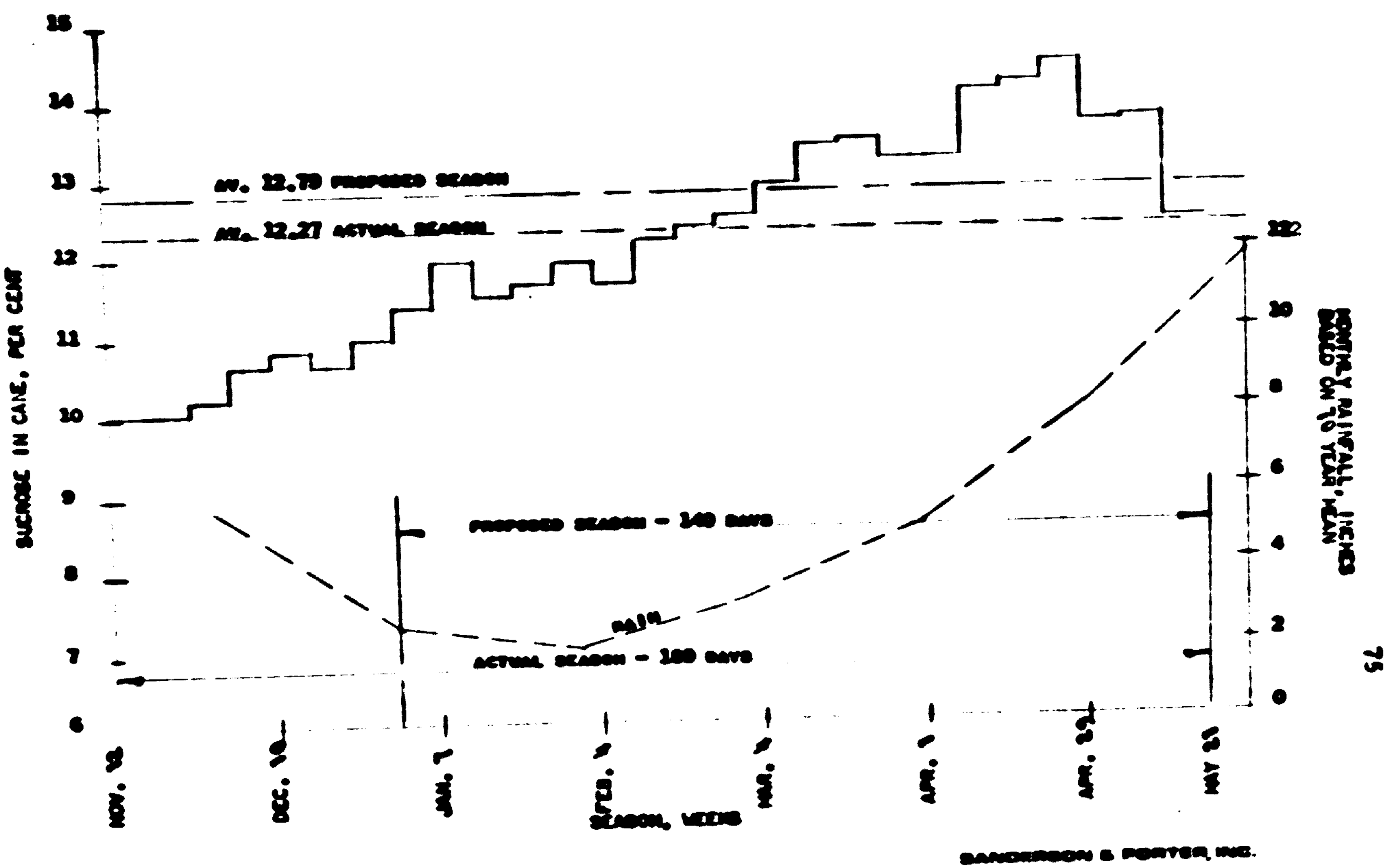
The present capacity is adequate for the low grade sugar curing.

Capital Cost: The necessary investment to reach the 312 T.C.H. grinding operation is estimated as follows:

Juice Heaters	$20,000
Conversion of Clarifier	5,000
Supply Tanks for Syrup and Molasses	6,000
Total	$31,000

FROME:
DISTRIBUTION OF PER CENT SUCROSE IN CANE DURING 1970 CROP

ACTUAL DURATION OF GRINDING SEASON-NOV. 12-MAY21
PROPOSED " " " " DEC. 3-MAY 21



FROME: MATERIAL BALANCE SHOWING QUANTITIES OF INTERMEDIATE AND FINAL PRODUCTS PER TIME UNIT DURING THE 1970 CROP SEASON
PURITY MIXED JUICE: 81.24

Material	Per Cent Cane	Pounds/ Cubic Feet	Per Minute Pounds	Per Minute Cubic Feet	Per Minute Gallon	Per Hour Pounds	Per Hour Tons
Cane	100.00	25.00	9,442	375.0	-	566,429	252.87
Bagasse	32.15	5.00	3,036	607.0	-	182,112	81.30
Imbibition	20.66	62.00	1,950	31.4	235	117,018	52.24
Mixed Juice	88.51	66.19	8,357	126.0	942	501,335	223.82
Milk of Lime	.50	67.00	47	.7	5.2	2,832	1.26
Limed Juice	89.01	66.20	8,404	127.0	950	504,167	225.31
Mud to Filter	15.50	67.00	1,463	22.0	165	87,786	39.19
Mud	2.17	82.80	205	2.5	19	12,298	5.49
Wash Water	3.00	62.00	283	4.6	34	17,002	7.59
Filtrate	16.33	45.34	1,542	24.0	180	93,390	41.29
Clarified Juice	73.51	66.25	6,940	105.0	785	416,381	185.88
Juice to Evaporator	89.84	45.71	8,482	129.0	965	509,771	227.17
Syrup	22.10	79.42	2,087	26.2	196	125,210	55.89
Evaporation	67.74	62.00	6,395	103.0	770	384,561	171.29
MCA	12.75	93.16	1,204	18,611 cu. ft. /day		72,241	32.25
Sugar A	5.29	53.00	499	9.4	-	29,947	13.37
Molasses A	7.46	90.87	705	7.7	58	42,294	18.88
Diluted Molasses A	9.24	84.04	873	10.4	78	52,347	23.37
MCB	11.04	93.92	1,043	15,982 cu. ft. /day		62,543	27.92
Sugar B	4.76	53.00	449	8.5	-	26,956	12.03
Molasses B	6.28	92.00	593	6.4	48	35,587	15.89
Diluted Molasses B	8.01	84.04	757	9.0	67	45,388	20.26
MCC	6.50	94.87	614	9,323 cu. ft. /day		36,852	16.45
Sugar C	3.25	54.00	307	5.7	-	18,426	8.23
Magma	4.16	92.32	393	4.2	32	23,564	10.52
Final Molasses	3.25	90.46	307	3.4	25	18,426	8.22

FROME: ACTUAL CAPACITY IN TONS CANE PER DAY FOR MAIN EQUIPMENT IN EACH PROCESSING STATION

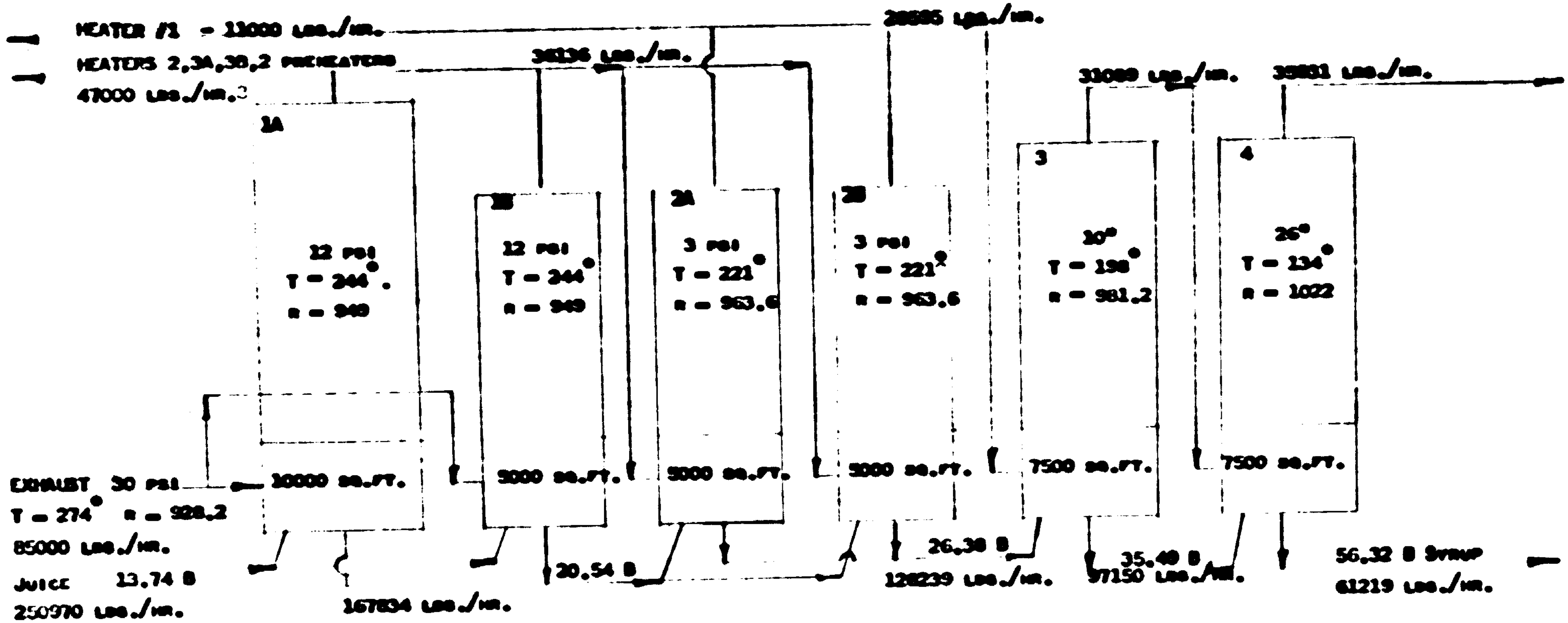
Station	Average T. C. D.
Milling tandems	9,840
Juice heaters	6,985
Clarifiers	6,800
Filters	10,600
Evaporators	7,680
Vacuum pans	8,665
Supply tanks, syrup	2,400/3,600*
Supply tanks, molasses	3,600/4,320*
C crystallizers	10,464
High grade centrifugals	6,720
Low grade centrifugals	7,560

* One tank can either be utilized for syrup or molasses

FROME: HEAT BALANCE FOR EVAPORATION STATION #1, SHOWING THE STEAM CONSUMPTION IN B.T.U., NEEDED TO OBTAIN THE PRESENT DEGREE OF EVAPORATION IN EACH VESSEL

Calculation for Flow of Heat	Heat Content B.T.U.	Evaporation Pounds per Hour	Juice, Per Cent Brix
#1 Juice to #1		250,970	13.74
Exhaust to #1 (30 psi) 85,000x928.2	78,897,000		
Available for Evaporation	78,897,000		
Evaporation 78,897,000 ÷ 949		38,136	
Transfer to No. 2		167,834	20.54
#2 Vapor from #1 (12 psi)	78,897,000		
To Heaters 47,000x949	44,603,000		
Balance	34,294,000		
Add Flash 167,834 (244-221)	3,860,182		
Available for Evaporation	38,154,182		
Evaporation 38,154,182 ÷ 963.6		39,595	
Transfer to #3		128,239	26.88
#3 Vapor from #2 (3 psi)	38,154,182		
To heaters 11,000x963.6	10,599,600		
Balance	27,554,582		
Add Flash 128,239 (221-198)	2,949,970		
Available for Evaporation	30,504,552		
Evaporation 30,504,552 ÷ 981.2		31,089	
Transfer to #4		97,150	35.49
#4 Vapor from #3 (10" vacuum)	30,504,552		
Add Flash 97,150 (198-134)	6,217,600		
Available for Evaporation	36,722,152		
Evaporation 36,722,152 ÷ 1,022		35,931	
Leaving #4 as Syrup		61,219	56.32

FROME: HEAT BALANCE DIAGRAM SHOWING EVAPORATOR INPUT AND OUTPUT OF STEAM, JUICE, VAPOR AND SYRUP, BASED ON HEAT BALANCE CALCULATIONS FOR EVAPORATOR # 1



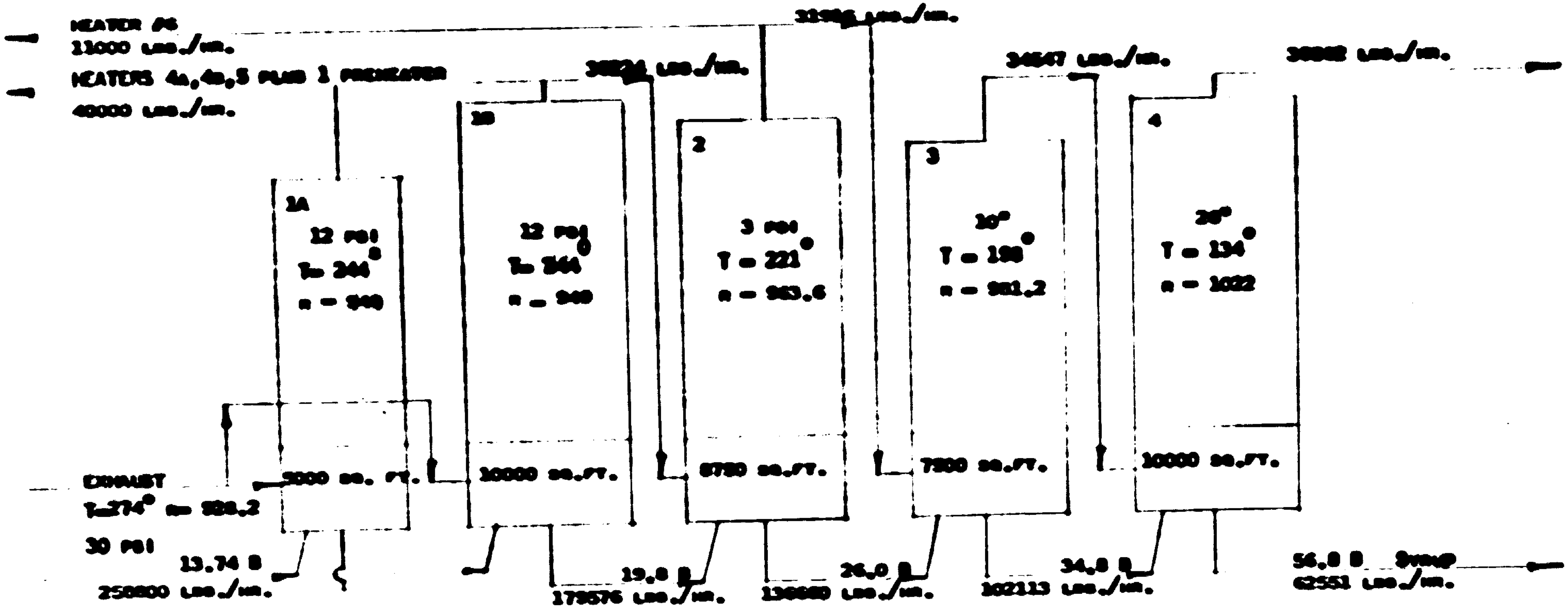
EVAPORATION RATE #1 = 5.54. LBS./SQ.FT./HR.
#2 = 3.96 " " " "
#3 = 4.14 " " " "
#4 = 4.79 " " " "
OVERALL = 4.74 " " " "

SANDERSON & PORTER, INC.

FROME: HEAT BALANCE FOR EVAPORATION STATION # 2 SHOWING THE STEAM CONSUMPTION IN B. T. U. NEEDED TO OBTAIN THE PRESENT DEGREE OF EVAPORATION IN EACH VESSEL

	Calculation for Flow of Heat	Heat Content B. T. U.	Evaporation Pounds per Hour	Juice Per Cent Brix
# 1	Juice to # 1		258,800	13.74
	Exhaust to #1 (30 psi) 81000 x 928.2	75,184,200		
	Available for Evaporation	75,184,200		
	Evaporation 75184200-:- 949		79,224	
	Transfer to # 2		179,576	19.80
# 2	Vapor from # 1 (12 psi)	75,184,200		
	To Heaters 40,000 x 949	37,960,000		
	Balance	37,224,000		
	Add Flash 179,576 (244-221	4,130,248		
	Available for Evaporation	41,354,448		
	Evaporation 41354448 -:- 963.6		42,916	
	Transfer to # 3		136,660	26.02
# 3	Vapor from # 2 (3 psi)	41,354,448		
	To heaters 11,000 x 963.6	10,599,600		
	Balance	30,754,848		
	Add Flash 136,660 (221-198)	3,143,180		
	Available for Evaporation	33,898,028		
	Evaporation 33898028 -:- 981.2		34,547	
	Transfer to # 4		102,113	34.82
# 4	Vapor from # 3 (10" vac)	33,898,028		
	Add Flash 102,113 (198-134)	6,535,232		
	Available for Evaporation	40,433,260		
	Evaporation 40433260 -:- 1022		39,562	
	Leaving # 4 as Syrup		62,551	56.84

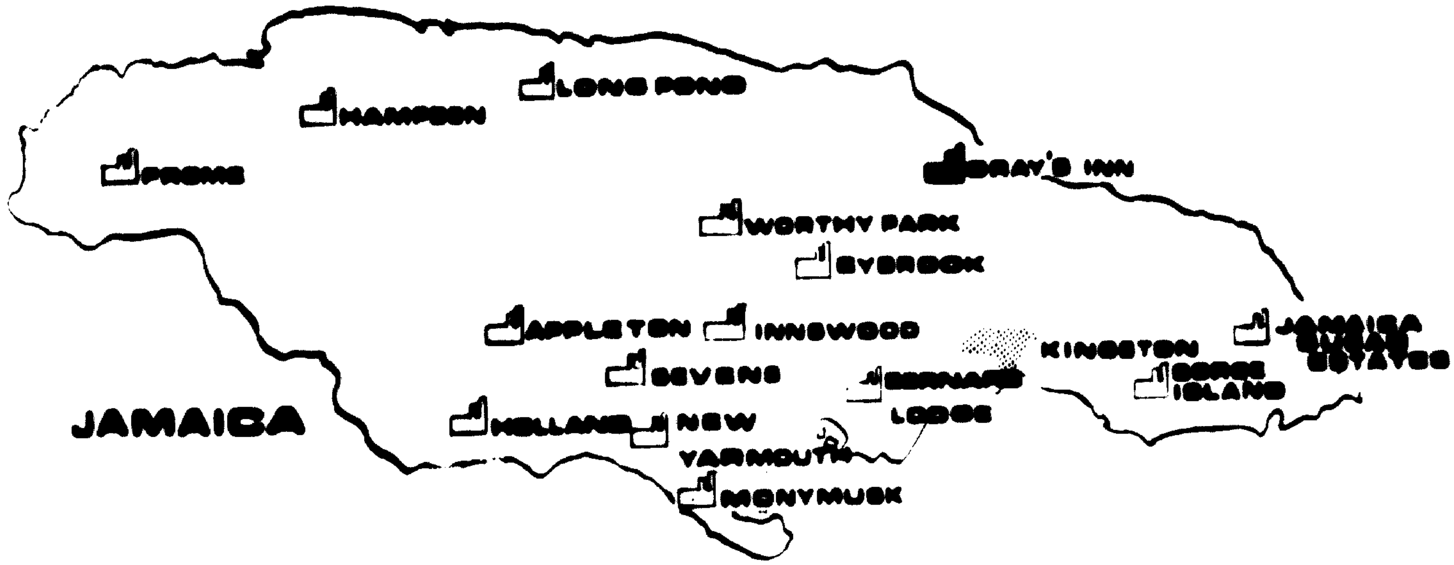
FROME: HEAT BALANCE DIAGRAM SHOWING EVAPORATOR INPUT AND OUTPUT OF STEAM, JUICE, VAPOR AND SYRUP, BASED ON HEAT BALANCE CALCULATIONS FOR EVAPORATOR # 2



EVAPORATION RATE #1 = 5.28 LBS./SQ.FT./HR.
#2 = 4.90 " " " "
#3 = 4.60 " " " "
#4 = 3.96 " " " "
OVERALL = 4.75 " " " "

SANDERSON & PORTER, INC.

GRAY'S INN
Saint Mary Parish



Gray's Inn

It is recommended that Gray's Inn be converted to a syrup producing unit. At the same time the crop season should be of 95 days duration. In order to optimize sugar production the grinding rate should remain at 56 T. C. H. To process this hourly grinding rate, the following limitations are apparent:

Milling: Sufficient capacity available.

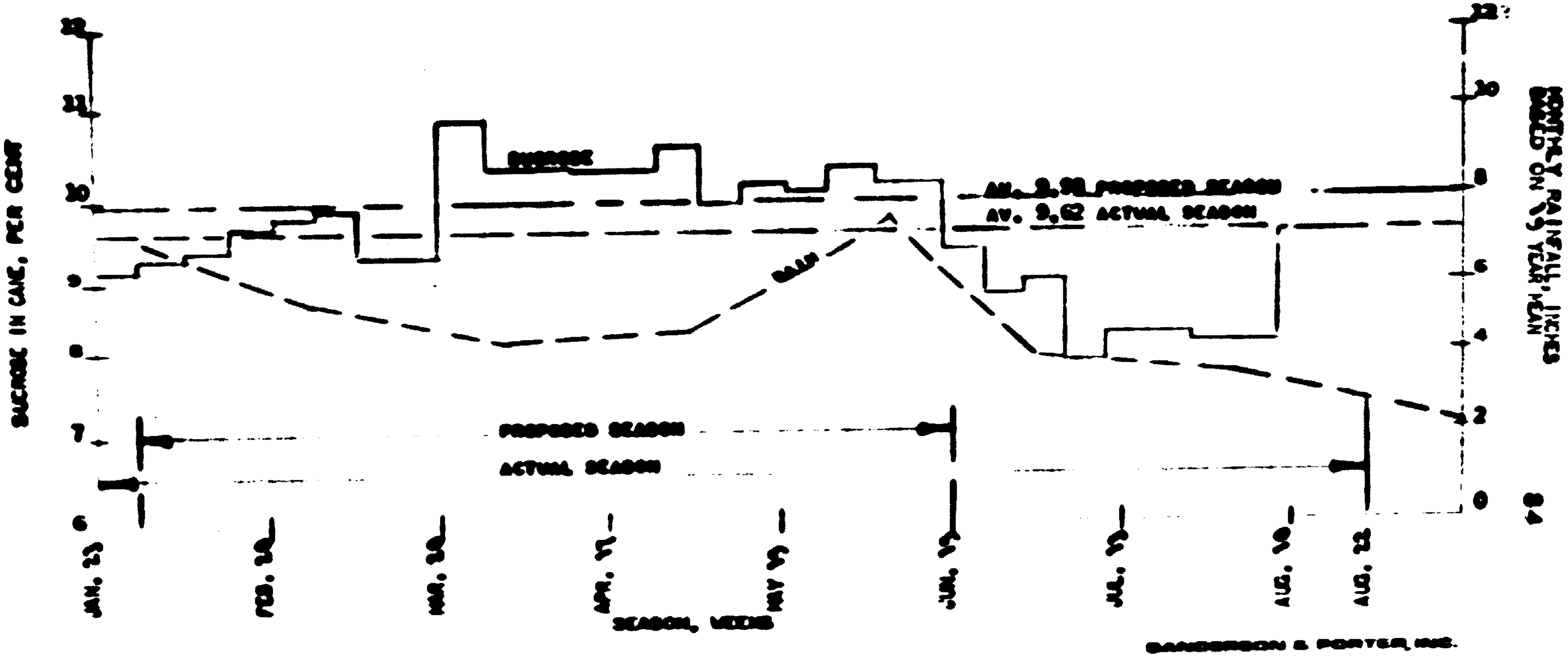
Juice Heaters: Sufficient capacity available.

Clarification: The capacity of the present clarifier is insufficient and a polycell clarifier, having 12' diameter should be installed. This new equipment should be able to service the cane grinding capacity, while the other clarifier can serve as an alternate or it can be sold.. The filtration station is of sufficient capacity to service the grinding rate.

Capital Cost: An estimated $10,000 will be needed to enact the changes needed in the clarification station.

GRAY'S INN:
DISTRIBUTION OF PER CENT SUCROSE IN CANE DURING 1970 CROP

ACTUAL DURATION OF GRINDING SEASON JAN. 23-AUG. 22 OR 212 DAYS
PROPOSED " " " " JAN. 30-JUN. 15 OR 137 DAYS



GRAY'S INN: MATERIAL BALANCE SHOWING QUANTITIES OF INTERMEDIATE AND FINAL PRODUCTS MANUFACTURED PER TIME UNIT DURING THE 1970 CROP SEASON

PURITY MIXED JUICE: 79.17

Material	Per Cent Cane	Pounds/ Cubic Feet	Per Minute Pounds	Per Minute Cubic Feet	Per Minute Gallons	Per Hour Pounds	Per Hour Tons
Cane	100.00	25.00	2,087	83.48	-	125,216	55.90
Bagasse	36.39	5.00	760	152.00	-	45,566	20.34
Imbibition	18.10	62.00	378	6.09	45	22,664	10.12
Mixed Juice	81.71	65.59	1,706	26.01	195	102,314	45.68
Milk of Lime	.50	67.00	10	0.14	1	626	.28
Limed Juice	82.21	65.59	1,716	26.16	196	102,940	45.96
Mud to Filter	15.5	66.00	324	4.90	37	19,408	8.66
Mud	2.85	85.00	59	0.69	-	3,569	1.59
Wash Water	3.00	62.00	63	1.00	7	3,756	1.68
Filtrate	15.65	65.91	327	4.96	37	19,596	8.75
Clarified Juice	66.71	65.64	1,392	21.20	159	83,532	37.29
Juice to Evaporator	82.36	65.69	1,719	26.16	196	103,128	46.04
Syrup	19.49	79.37	407	5.12	38	24.409	10.89
Evaporation	62.87	62.00	1,312	21.16	158	78,719	35.15
MCA	8.08	93.37	169	2,601 cu. ft/ day		10,120	4.52
Sugar A	4.20	53.00	88	1.66	-	5,259	2.35
Molasses A	3.88	90.16	81	0.90	7	4,861	2.17
Dil. Mol. A	4.77	84.04	98	1.16	9	5,901	2.63
MCB	7.84	94.10	164	2,505 cu. ft/ day		9,821	4.38
Sugar B	3.23	53.00	67	1,26	-	4,041	1.80
Molasses B	4.61	92.51	97	1.04	8	5,780	2.58
Dil. Mol. B	5,96	84.04	124	1.47	11	7,467	3.33
MCB	6.77	95.45	137	2,065 cu. ft/day		8,216	3.67
Sugar C	3.24	54.00	68	1.25	-	4,065	1.81
Magma	4.59	92.33	96	1.03	8	5,712	2.56
Final Molasses	3.53	91.98	69	0.75	5.5	4,151	1.85

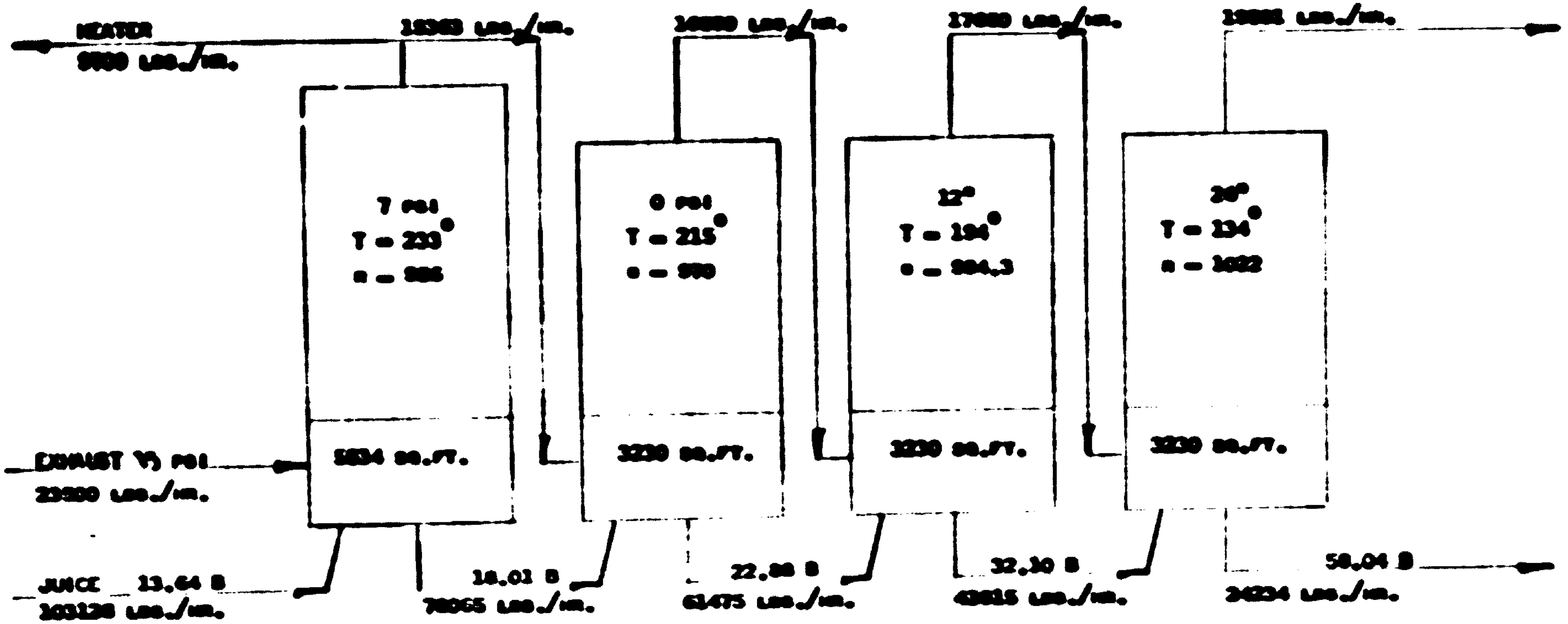
GRAY'S INN: ACTUAL CAPACITY IN TONS CANE PER DAY FOR MAIN EQUIPMENT IN EACH PROCESSING STATION

Station	Average T. C. D.
Mill tandems	1,680
Juice heaters	1,462
Clarifiers	765
Filters	1,878
Evaporation	1,560
Vacuum pans	2,230
Syrup supply tanks	1,500
A and B molasses supply tanks	1,500
C crystallizers	1,450
High grade centrifugals	3,480
Low grade centrifugals	2,012

GRAY'S INN: HEAT BALANCE FOR EVAPORATION STATION SHOWING THE STEAM CONSUMPTION IN B. T. U., NEEDED TO OBTAIN THE PRESENT DEGREE OF EVAPORATION IN EACH VESSEL

Calculation for Flow of Heat		Heat Content B. T. U.	Evaporation Pounds per Hour	Juice Per Cent Brix
#1 Juice to #1	7 psi		103,128	13.64
Exhaust Steam to #1 (15 psi) 23,500 x 945		22,207,500		
Add Flash from Juice Heater 103,128 (250-233)		1,753,176		
Available for Evaporation		23,960,676		
Evaporation 23,960,676 -:- 956			25,063	
Transfer to #2			78,065	18.01
#2 Vapor from #1	0 psi	23,960,676		
To Juice Heater 9,700 x 956		9,273,200		
Balance		14,687,476		
Add Flash. 78,065 (233-215)		1,405,170		
Available for Evaporation		16,092,646		
Evaporation 16,092,646 -:- 970			16,590	
Transfer to #3			61,475	22.88
#3 Vapor from #2	12"	16,092,646		
Add Flash 61,475 (215-194)		1,290,975		
Available for Evaporation		17,383,621		
Evaporation 17,383,621 -:-934.3			17,660	
Transfer to #4			43,815	32.10
#4 Vapor from #3	26"	17,383,621		
Add Flash 43,815 (194-134)		2,628,900		
Available for Evaporation		20,012,521		
Evaporation 20,012,521 -:- 1022			19,581	
Syrup Leaving #4			24,234	58.04

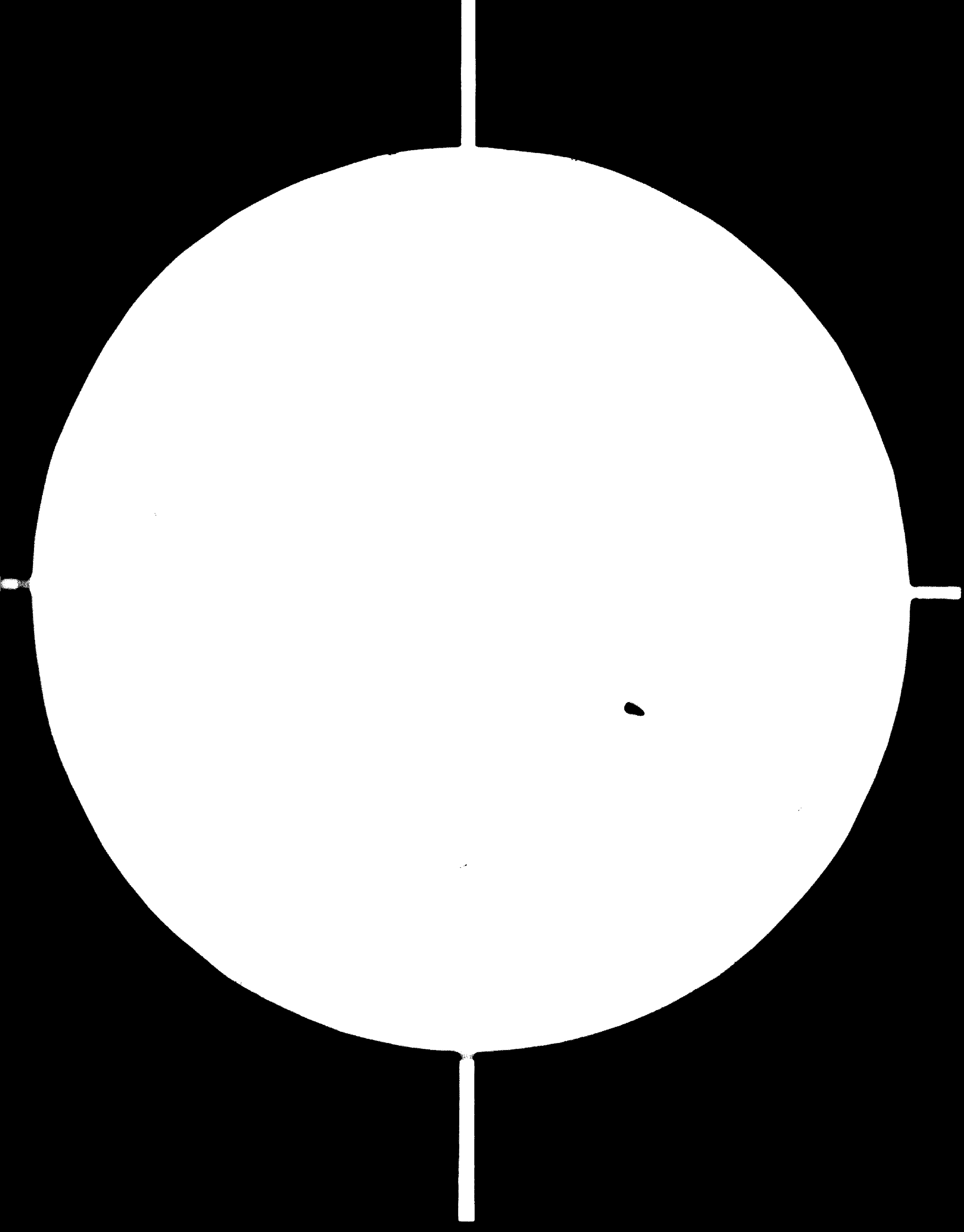
GRAY'S INN: HEAT BALANCE DIAGRAM SHOWING EVAPORATOR INPUT AND OUTPUT OF STEAM, JUICE, VAPOR AND SYRUP, BASED ON HEAT BALANCE CALCULATIONS



EVAPORATION RATE #1 = 4.52 LBS./SQ.FT./HR.
#2 = 5.13 " " " "
#3 = 5.46 " " " "
#4 = 6.06 " " " "
OVERALL = 5.18 " " " "

B-369

80.12.09



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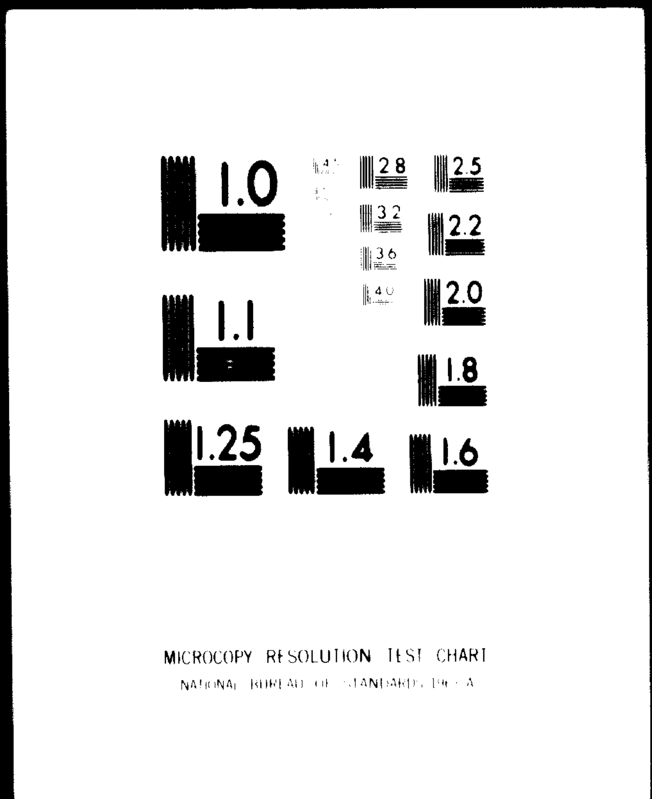

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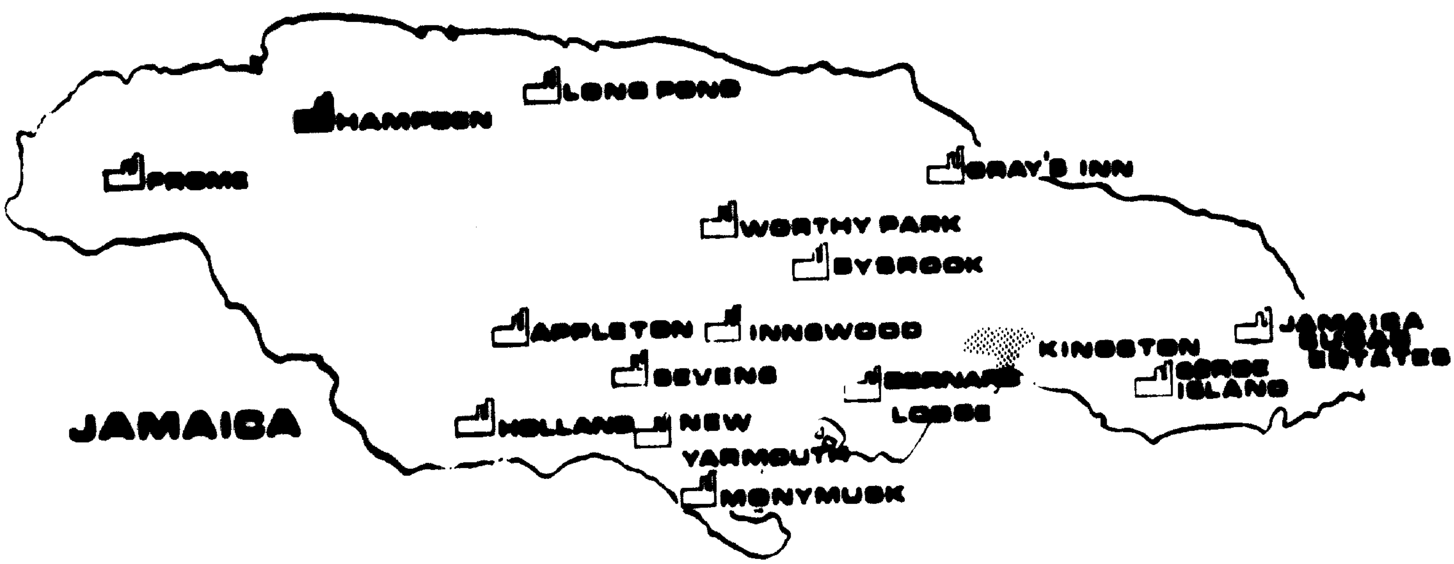
HAMPDEN
Saint James Parish



Hampden

It is recommended that the crop season be reduced to 136 days, based on the per cent sucrose distribution in cane in order to optimize production. Thus, a grinding rate of 83 T.C.H. or 2,000 T.C.D. must be obtained. It is further proposed that Hampden be converted into a syrup producing unit. Also, as Hampden is prominent in rum production its bagasse surplus may actually prove more beneficial. Presently, a large volume of fuel oil is used to produce steam for sugar as well as rum manufacturing. The elimination of the pan-boiling and centrifugal stations more than likely will allow adequate steam production for both operations, using the surplus bagasse rather than fuel oil. In addition, the clarification and evaporation stations will still be in operation after the conversion, thus continuing to serve the raw material needed for Hampden's strongly flavored rum production.

In order to attain the proposed grinding rate the following are to be considered:

Milling: The milling tandem itself is capable of producing 2,000 T.C.D., assuming 15 per cent fiber in cane. A speed of 48 f.p.m. is required to obtain the proposed rate. At this speed only the first two mills are slightly underpowered. By adjusting the mill roller setting it would be possible to produce 2,000 T.C.D. under the present conditions and without need for a major change in the milling equipment. A slightly higher sucrose loss may be expected in the bagasse but this easily could be eliminated with a moderate increase in imbibition water up to 25 per cent of weight on cane.

Juice Heaters: Presently, the juice velocity in the heaters is too low, resulting in a low heat transmission rate. With the increased grinding rate, the juice velocity will increase to about 5 f.p.s. The present low heat transmission rate will then be automatically corrected resulting in increased steam consumption for this station.

Clarification: The present capacity of the clarifier is adequate to meet the increased cane grinding rate. The filter now is able to handle slightly below 2,000 T.C.D., but it can be expected to meet the small overload without creating any serious problems.

Evaporation: The present capacity of this station is definitely too small to service the proposed grinding rate. The accumulated data did not indicate whether vapor is taken from the first vessel for servicing the juice heaters. If not, it should, as the heating surfaces of vessels #1 and #2 allow an extraction of 6,000 pounds of vapor per hour.

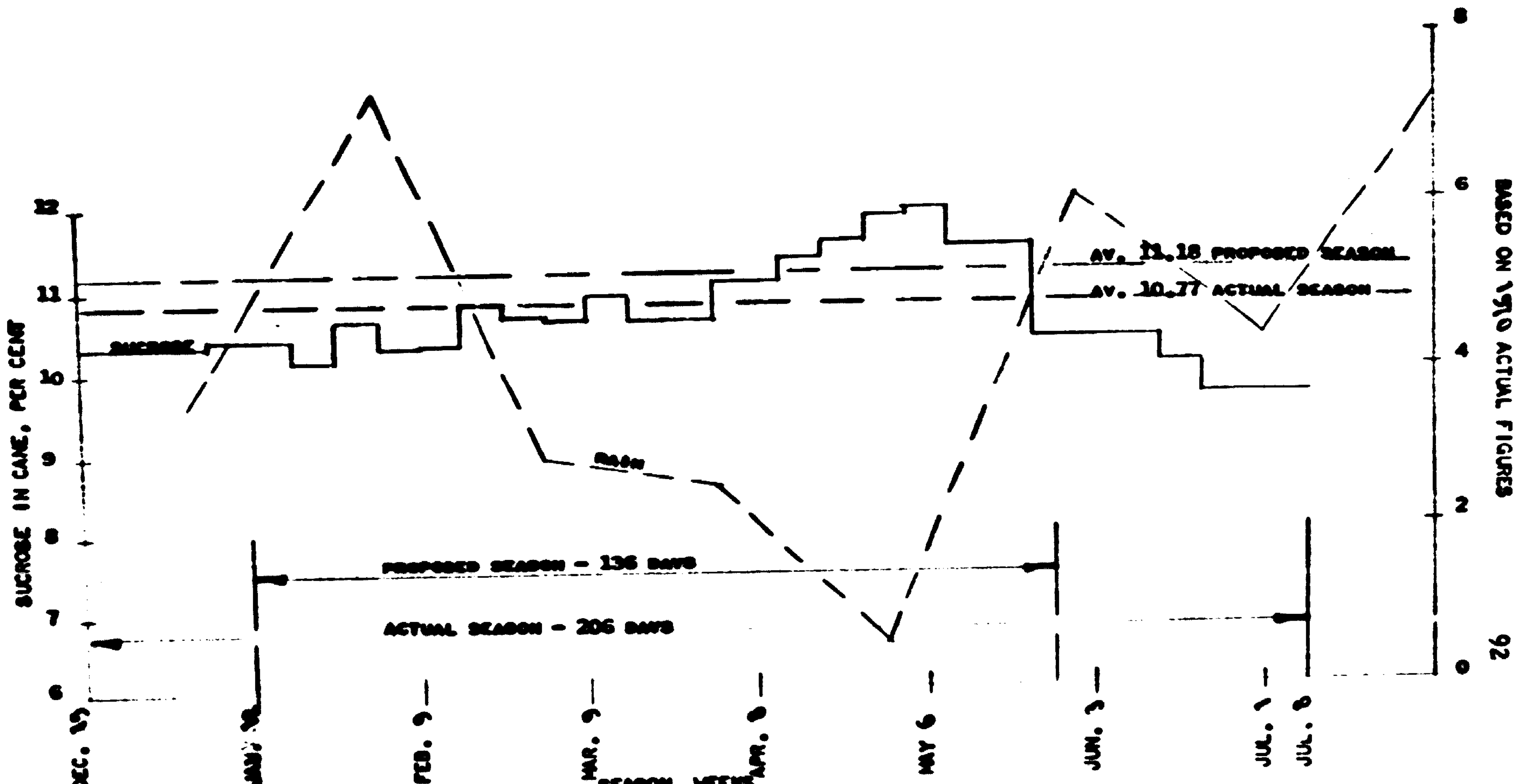
Without adequate bleeding of vapor, these vessels will perform inefficiently; 24,700 pounds per hour of exhaust steam are admitted to vessel #1 for evaporation of only 19,997 pounds per hour of water. This poor performance is also illustrated by the low average evaporation rate of 5.0 pounds per square foot per hour for the first vessel.

In the future a "dead ended" preevaporator should be installed and heated by exhaust steam with the vapor bleeding only to the juice heaters. The advantage of the proposed system is that the juice now entering the quadruple already has high density and the evaporation load per square foot of heating surface can be relatively small. The new vessel must evaporate 20,000-23,000 pounds of water per hour to obtain a satisfactory density for the syrup. Therefore, the vessel should contain about 2,500 square feet of heating surface.

Capital Costs: The cost for the new evaporator is estimated at $12,500.

HAMPDEN:
DISTRIBUTION OF PER CENT SUCROSE IN CANE DURING 1970 CROP

ACTUAL DURATION OF GRINDING SEASON - DEC. 15-JUL. 8
PROPOSED " " " " JAN. 12-MAY 27



SANDERSON & PORTER, INC.

HAMPDEN: MATERIAL BALANCE SHOWING QUANTITIES OF INTERMEDIATE AND FINAL PRODUCTS PER TIME UNIT DURING THE 1970 CROP SEASON
PURITY MIXED JUICE: 79.44

Material	Per Cent Cane	Pounds/ Cubic Feet	Per Minute Pounds	Per Minute Cubic Feet	Per Minute Gallons	Per Hour Pounds	Per Hour Tons
Cane	100.00	25.00	2,364	95.00	-	141,814	63.31
Bagasse	37.36	5.00	884	177.00	-	52,984	23.65
Imbibition	23.05	62.00	545	9.00	67	32,682	14.59
Mixed Juice	85.69	65.84	2,025	30.70	230	121,520	54.25
Milk of Lime	0.50	67.00	12	0.18		710	0.32
Limed Juice	86.19	65.84	2,037	30.90	231	122,230	54.56
Mud to Filter	15.50	66.00	363	5.50	41	21,974	9.81
Mud	2.48	85.00	59	0.70	5	3,517	1.57
Wash Water	3.00	62.00	71	1.10	8	4,256	1.90
Filtrate	16.02	64.75	379	5.90	44	22,719	10.26
Clarified Juice	70.69	65.11	1,671	25.70	192	100,248	44.75
Juice to Evaporator	86.71	65.77	2,050	31.20	233	122,967	54.89
Syrup	21.94	78.53	519	6.60	49	31,120	13.89
Evaporation	64.77	62.00	1,531	24.70	185	91,847	41.00
MCA	11.07	92.80	262	4,061 cu. ft/ day		15,703	7.01
Sugar A	5.55	53.00	131	2.50	19	7,871	3.51
Molasses A	5.52	88.35	131	1.50	11	7,832	3.50
Dil. Mol. A	6.37	84.04	151	1.80	13	9,031	4.03
MCB	8.42	93.80	199	3,056 cu. ft/ day		11,943	5.33
Sugar B	3.03	53.00	72	1.35	10	4,291	1.92
Molasses B	5.40	89.20	128	1.40	10	7,652	3.42
Dil. Mol. B	6.38	84.04	151	1.80	13	9,043	4.04
MCC	6.39	93.65	152	2,324 cu. ft/ day		9,068	4.05
Sugar C	2.70	54.00	63	1.20	9	3,826	1.71
Magma	3.74	92.32	88	0.95	7	5,302	2.37
Final Molasses	3.69	91.75	87	0.95	7	5,242	2.34

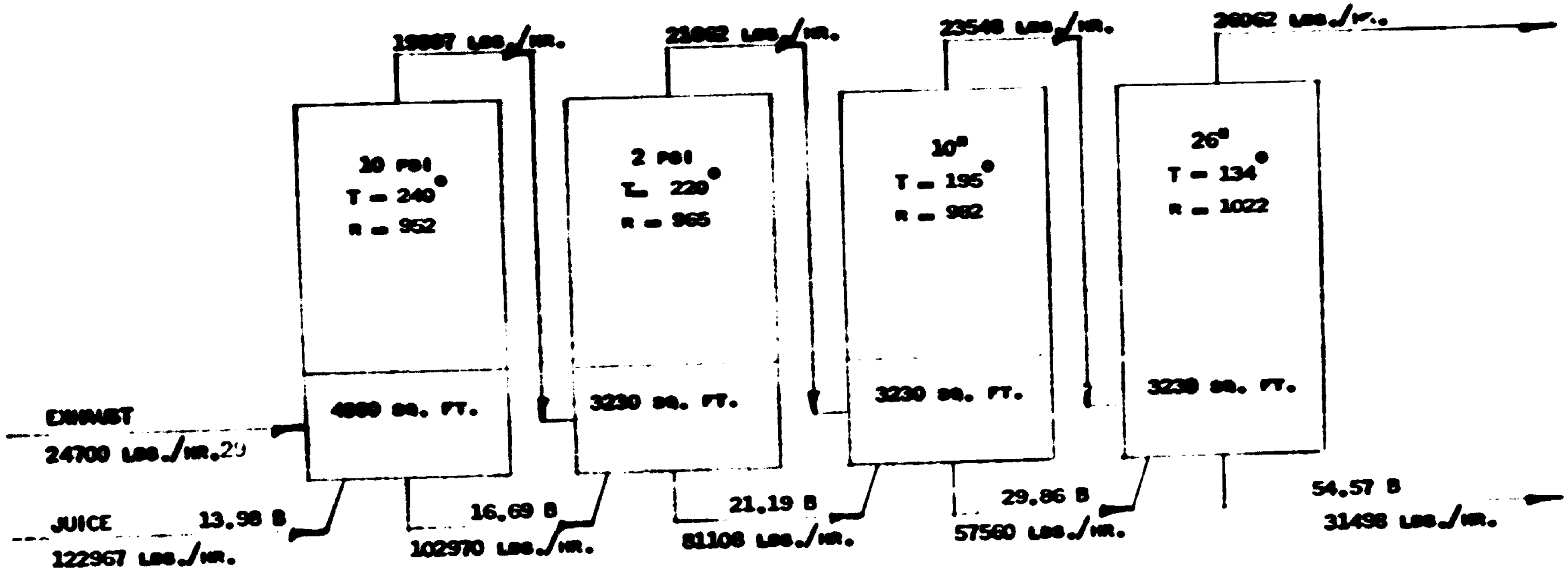
HAMPDEN: ACTUAL CAPACITY IN TONS CANE PER DAY FOR MAIN EQUIPMENT IN EACH PROCESSING STATION

Station	Average T. C. D.
Mills	1,632
Juice heaters	1,380
Clarifiers	2,220
Filters	1,884
Evaporation	1,353
Vacuum pans	1,920
Syrup supply tanks	1,392
A and B molasses tanks	2,740
C crystallizers	1,200
High grade centrifugals	1,079
Low grade centrifugals	2,127

HAMPDEN: HEAT BALANCE FOR THE EVAPORATION STATION SHOWING THE STEAM CONSUMPTION IN B. T. U. NEEDED TO OBTAIN THE PRESENT DEGREE OF EVAPORATION IN EACH VESSEL

Calculation for Flow of Heat		Heat Content B. T. U.	Evaporation Pounds per Hour	Juice Per Cent Brix
#1 Juice to #1	10 psi		122,967	13.98
Exhaust to #1 (15 psi) 24,700 x 945		23,341,500		
Deduct for Heating Juice 122,967 (240-205)		4,303,845		
Available for Evaporation 1		19,037,655		
Evaporation 19,037,655 -:-952			19,997	
Transfer to #2			102,970	16.69
#2 Vapor from #1	2 psi	19,037,655		
Add Flash. 102,970 (240-220)		2,059,400		
Available for Evaporation		21,097,055		
Evaporation 21,097,055 -:- 965			21,862	
Transfer to #3			81,108	21.19
#3 Vapor from #2	10"	21,097,055		
Add Flash. 81,108 (220-195)		2,027,700		
Available for Evaporation		23,124,755		
Evaporation 23,124,755 -:- 982			23,548	
Transfer to #4			57,560	29.86
#4 Vapor from #3	26"	23,124,755		
Add Flash. 57,560 (195-134)		3,511,160		
Available for Evaporation		26,635,915		
Evaporation 26,635,915 -:- 1,022			26,062	
Leaving #4 as Syrup			31,498	54.57

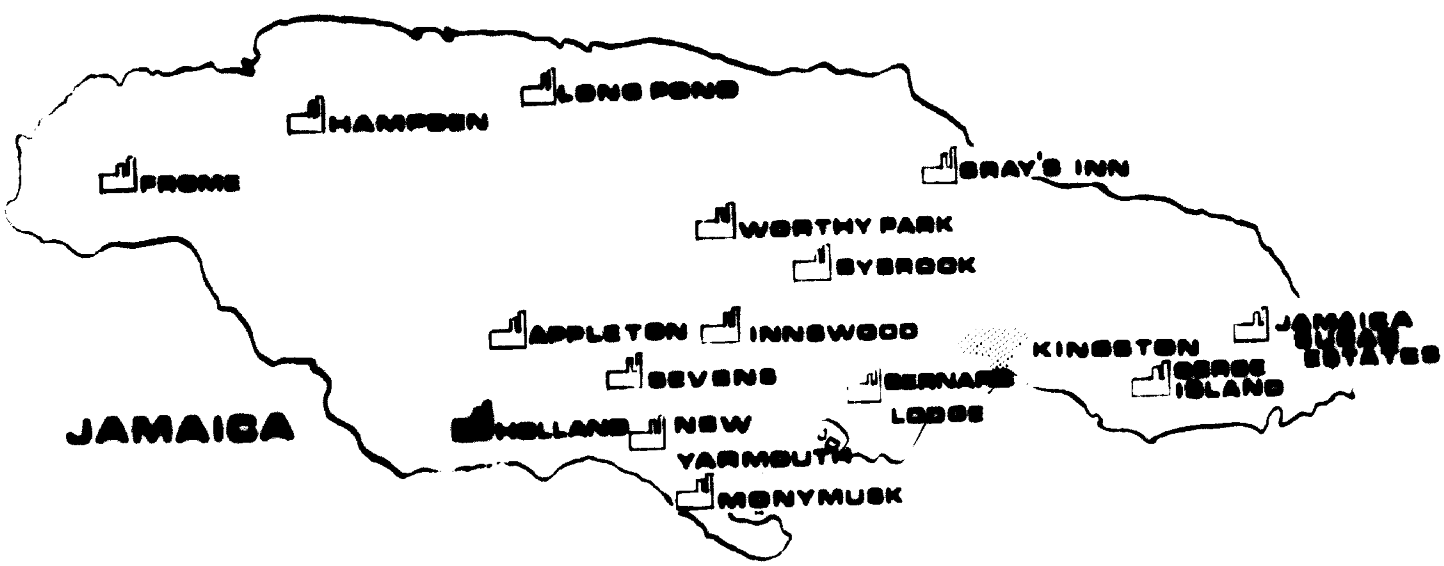
HAMPDEN: HEAT BALANCE DIAGRAM SHOWING EVAPORATOR INPUT AND OUTPUT OF STEAM, JUICE, VAPOR AND SYRUP, BASED ON HEAT BALANCE CALCULATIONS



EVAPORATION RATE #1 = 5.00 LBS./SQ.FT./HR.
#2 = 6.76 " " "
#3 = 71.30 " " "
#4 = 8.06 " " "
OVERALL = 6.68 " " "

SANDERSON & PORTER, INC.

HOLLAND
Saint Elizabeth Parish



Holland

As stated under the Appleton factory profile, the cane supply to Holland and Appleton is too small to service both factories economically. With Appleton being the more efficient factory, it is felt that the cane supply presently utilized by Holland should be transferred to Appleton and that Holland be closed. Some of the equipment now in Holland could be utilized by Appleton to increase its cane grinding capacity and to maximize the cane supply now processed in both factories.

In order for Holland to optimize its sugar production, the grinding period would have to be reduced from 180 to 134 days. Allowing for 25 per cent lost time, 45 T.C.H. will be reduced to 35 T.C.H. or 840 T.C.D. This hardly can be regarded as favorable. For this reason and because of the inadequate cane supplies, the closure of Holland is economically practical.

If, however, it is decided to keep Holland operational, the following factors, and based on the proposed grinding rate, must be considered:

> Milling: The milling tandem has adequate capacity to meet the grinding rate.
>
> Juice Heaters: The capacity for the juice heaters also is adequate.
>
> Clarification: The present clarifier has the exact capacity to handle the projected cane grinding rate. The present 8' x 6' filter is of insufficient capacity. The filter should be replaced by a new 8' x 10' unit for reasons of future maintenance.
>
> Evaporators: The capacity of this station is regarded as adequate.
>
> Vacuum Pans: This station has adequate capacity.
>
> Pan Supply Tanks: This station has adequate capacity.

C Crystallizers: This station has adequate capacity.

Centrifugals: Although the high grade centrifugal is of adequate capacity, the operation of this station is very delicate as only one machine is available. The installation of a second unit is recommended to eliminate the chance of total failure.

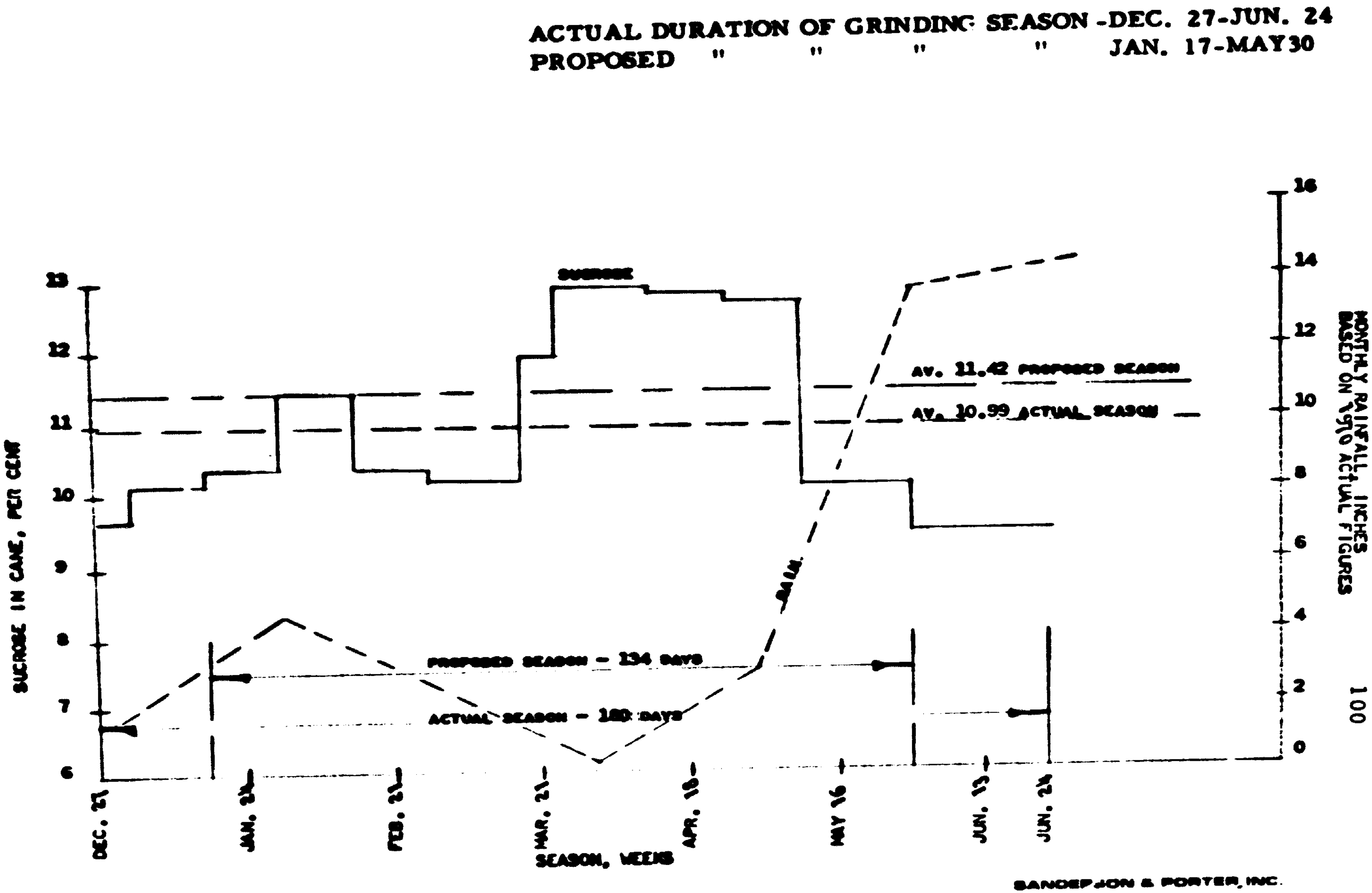
The low grade centrifugals are of adequate capacity to meet the proposed grinding rate.

Capital Costs: Total capital cost needed for the continuation of Holland, at the proposed grinding rate, is estimated at $68, 000 ($35, 000 and $33, 000 for filter and centrifugals, respectively).

As stated previously, the closure of Holland is recommended. This recommendation has taken into account the projected future potential of Saint Elizabeth Parish for sugar production especially when mechanization is introduced.

The possibility of planting 10-15, 000 acres of cane in the area served by two syrup units processing 4, 000 T. C. D. must be visualized. These units should house diffusion plants instead of the conventional milling tandems. This because the price of a diffusion plant is less, and its yearly maintenance costs are lower. Finally, while a modern and well-equipped milling tandem might reach 94 per cent of sucrose extraction, a diffusion plant can easily obtain 97 per cent extraction. The 3 per cent difference may yield an extra 1, 200 tons of sugar from the proposed acreage. This should have a value of more than $100, 000 annually.

In summary, the price of Jamaican sugar must remain competitive with the price of sugar produced in other areas. The present status of equipment at Holland, however, is inadequate to make a positive contribution to the future expansion of sugar production in the area. This future production will be better served by new processing units using the diffusion method rather than juice extraction by the milling tandem of Holland.


ACTUAL DURATION OF GRINDING SEASON - DEC. 27-JUN. 24
PROPOSED " " " " JAN. 17-MAY 30
SUCROSE
RAIN
AV. 11.42 PROPOSED SEASON
AV. 10.99 ACTUAL SEASON
PROPOSED SEASON – 134 DAYS
ACTUAL SEASON – 180 DAYS
SUCROSE IN CANE, PER CENT
MONTHLY RAINFALL, INCHES
BASED ON 1970 ACTUAL FIGURES
SEASON, WEEKS
DEC. 27
JAN. 24
FEB. 21
MAR. 21
APR. 18
MAY 16
JUN. 13
JUN. 24
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SANDERSON & PORTER, INC.

HOLLAND: MATERIAL BALANCE SHOWING QUANTITIES OF INTERMEDIATE AND FINAL PRODUCTS MANUFACTURED PER TIME UNIT DURING THE 1970 CROP SEASON

PURITY MIXED JUICE: 77.58

Material	Per Cent Cane	Pounds/ Cubic Feet	Per Minute Pounds	Per Minute Cubic Feet	Per Minute Gallons	Per Hour Pounds	Per Hour Tons
Cane	100.00	25.00	1,649	65.96	-	98,941	44.17
Bagasse	33.44	5.00	525	105,00	-	33,086	14.77
Imbibition	30.37	62.00	501	8.08	60	30,048	13.41
Mixed Juice	96.93	65.60	1,601	24.40	183	95.904	42.81
Milk of Lime	0.50	67.00	8	0.11	1	494	0.22
Limed Juice	97.43	65.60	1,607	24.49	183	96,398	43.03
Mud to Filter	15.50	65.90	256	3.88	29	15,336	6.85
Mud	3.41	68.56	56	0.81	-	3,374	1.51
Wash Water	3.00	62.00	49	0.79	6	2,968	1.33
Filtrate	15.09	64.80	249	3.84	29	14,930	6.67
Clarified Juice	81.93	65.57	1,353	20.63	154	81,062	36.19
Juice to Evaporator	97.02	62.00	1,600	25.80	193	95,992	42.85
Syrup	22.09	78.77	365	4.63	35	21,861	9.76
Evaporation	74.93	62.00	1,235	19.91	149	74,131	33.09
MCA	10.16	93.21	168	2,590 cu. ft/day		10,061	4.49
Sugar A	4.24	53.00	70	1.32	-	4,200	1.87
Molasses A	5.97	90.64	99	1.10	8	5,911	2.64
Dil. Mol. A	7.35	84.04	121	1.43	11	7,272	3.25
MCB	10.48	93.65	173	2,658 cu. ft/day		10,373	4.63
Sugar B	3.93	53.00	65	1.22	-	3,891	1.74
Molasses B	6.64	91.50	109	1.19	9	6,571	2.93
Dil.Mol. B	8.36	84.04	138	1.64	12	8,268	3.69
MCC	7.97	94.55	131	2,001 cu. ft/day		7,887	3.52
Sugar C	3.89	54.00	64	1.18	-	3,847	1.72
Magma	4.64	92.33	76	0.82	6	4,588	2.05
Final Molasses	4.24	91.59	70	0.76	6	4,195	1.87

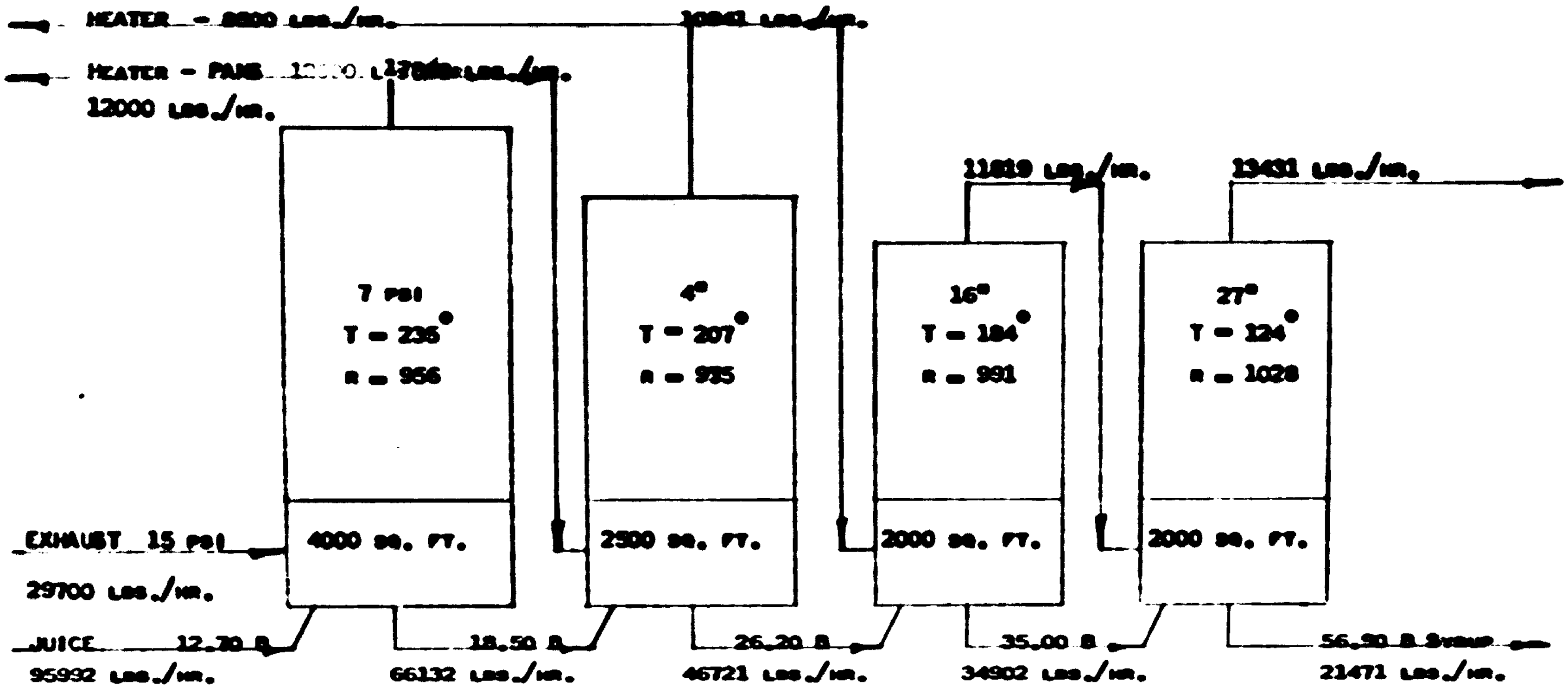
HOLLAND: ACTUAL CAPACITY IN TONS CANE PER DAY FOR MAIN EQUIPMENT IN EACH PROCESSING STATION

Station	Capacity T. C. D.
Mills	1,368
Juice heaters	3,816
Clarifiers	768
Filters	678
Evaporators	900
Vacuum pans	1,540
Syrup supply tanks	1.000
A and B molasses tanks	1.020
C crystallizers	1.415
High grade centrifugals	1,100
Low grade centrifugals	1.825

HOLLAND: HEAT BALANCE FOR THE EVAPORATION STATION SHOWING THE STEAM CONSUMPTION IN B.T.U. NEEDED TO OBTAIN THE PRESENT DEGREE OF EVAPORATION IN EACH VESSEL.

	Calculation for Flow of Heat	Heat Content B.T.U.	Evaporation Pounds per Hour	Juice Per Cent Brix
#1	Juice to #1		95,992	12.74
	Exhaust to #1 29,700 x 945	28,066,500		
	Add flash from heater 95,992 (240-235)	479,960		
	Available for Evaporation	28,546,460		
	Evaporation 28,546,460 -:- 956		29,860	
	Transfer to # 2		66,132	18.49
# 2	Vapor from #1	28,546,460		
	To heaters and pans 12,000x956	11,472,000		
	Balance	17,074,460		
	Add flash 66,132 (235-207)	1,851,696		
	Available for Evaporation	18,926,156		
	Evaporation 18,926,156 -:- 975		19,411	
	Transfer to # 3		46,721	26.17
#3	Vapor from # 2	18,926,156		
	To heaters 8,500 x 975	8,287,500		
	Balance	10,638,656		
	Add flash 46,721 (207-184)	1,074,583		
	Available for Evaporation	11,713,239		
	Evaporation 11,713,239 -:- 991		11,819	
	Transfer to #4		34,902	35.03
#4	Vapor from # 3	11,713,239		
	Add flash 34,902 (184-124)	2,094,120		
	Available for Evaporation	13,807,359		
	Evaporation 13,807,359 -:- 1.028		13,431	
	Leaving # 4 as Syrup		21,471	56.95

HOLLAND: HEAT BALANCE DIAGRAM, SHOWING INPUT AND OUTPUT OF STEAM, JUICE, VAPOR AND SYRUP BASED ON HEAT BALANCE CALCULATIONS



EVAPORATION RATE	#1 =	7.46	LBS./SQ.FT./HR.
	#2 =	7.76	" " " "
	#3 =	5.90	" " " "
	#4 =	6.71	" " " "
OVERALL	=	7.09	" " " "

SANDERSON & PORTER, INC.

INNSWOOD
Saint Catherine Parish

Innswood

Based on the accumulated technical data on the existing cane quality, and on the actual sugar production, Innswood should be converted to a syrup producing unit. At the same time, the crop duration should be shortened to 118 days per year lasting from February 1 to May 29. Shortening of the season will increase sucrose in cane from 10.01 to 10.84 per cent. It is estimated that 0.89 per cent of this additional sucrose will be available for sugar production, or an additional 1,590 tons of sugar valued at $150,000 will be realized.

To attain this goal the hourly grinding rate must be increased while the lost time is reduced. The lost time factor may be decreased significantly simply by shortening the crop season. Additionally, the time reduction for machinery operation would result in better maintenance schedules for the plant. These reductions and savings would effect a total production of 220,700 tons of cane during the proposed crop period, or 93 T.C.H.

In order for Innswood to produce its projected T.C.H. rate, the following factors must be considered:

Milling: The milling plant is able to produce effectively with the existing power.

Juice Heaters: Juice velocity through the heaters is low. The increased capacity will increase the juice velocity from 4.55 to 6.96 f.p.s., an ideal condition for this station.

Clarifier: By continuing the use of a coagulant and by changing the Oliver filter to a Rapifloc system, the filtered juice could be sent directly to the evaporator. This arrangement provides adequate clarification capacity during average rainfall years. An additional polycell clarifier should be installed in the future.

Evaporation: The capacity must be increased by adding a preevaporator vessel in front of the present quadruple effect. With a proper cleaning schedule, the evaporation rate could be increased from the present 4.75 to 6.00 pounds per square foot per hour which would accommodate 1,970 tons of cane per day. To reach 2,400 T.C.D. a preevaporator with about 3,500 square feet of heating surface should be added.

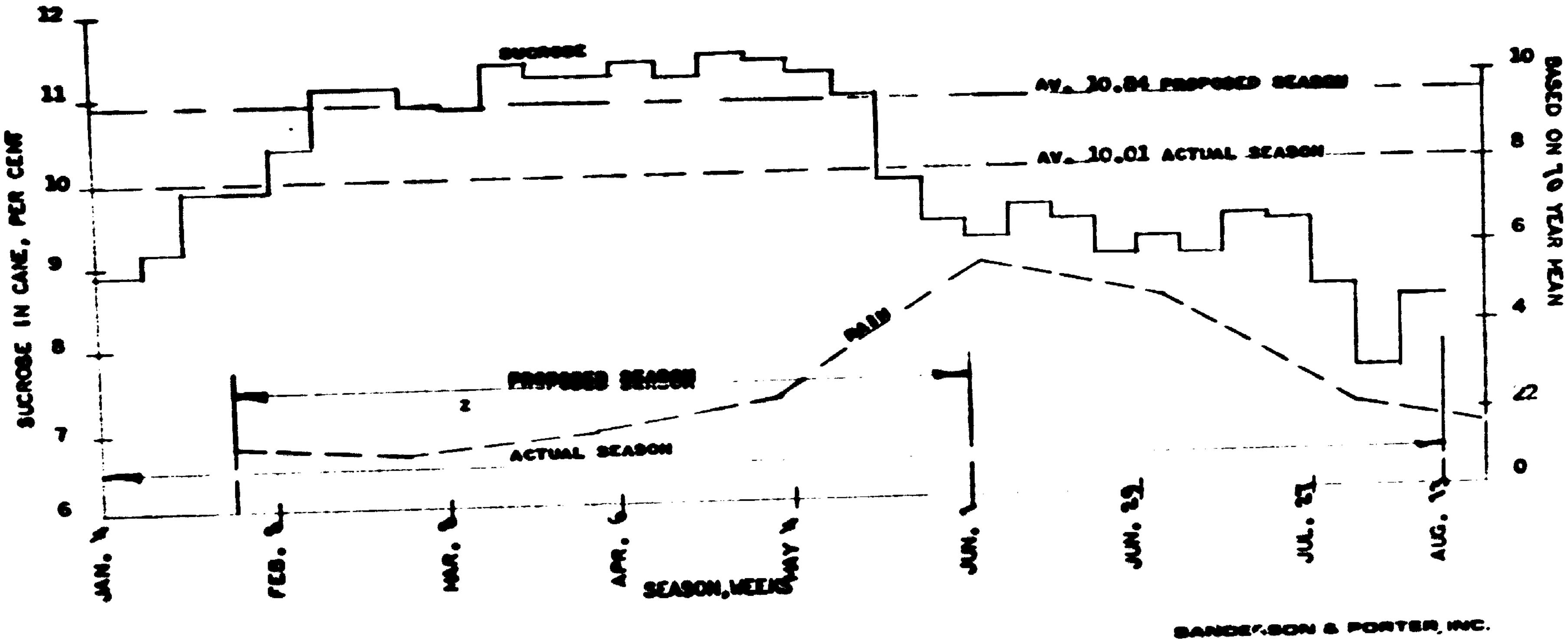
In addition, to increase syrup from 52 to 72 degrees Brix, a flash evaporator has to be placed after the quaduple effect.

The new grinding rate will produce 39.2 tons of bagasse. This is based on the quantity of bagasse as being equal to cane weight multiplied by per cent fiber in cane divided by per cent fiber in bagasse. With both turbo-alternator sets in use, the hourly steam requirements (based on 33 pounds of steam per indicated horsepower allowing for losses and that one pound of bagasse will produce 2.35 pounds of steam) are estimated at 123,250 pounds. Present boiler capacity rated for production of 135,000 pounds of steam per hour, is sufficient.

Capital Costs: It is estimated that the following capital expenditures for processing equipment will be needed to convert Innswood to a syrup unit processing 2,400 T.C.D.: $20,000 for the preevaporator, $12,000 for the polycell clarifier and $30,000 for the complete flash evaporator arrangement. Therefore, the total capital investment for processing equipment may be estimated at $62,000.

INNSWOOD:
DISTRIBUTION OF PER CENT SUCROSE IN CANE DURING 1970 CROP

ACTUAL DURATION OF GRINDING SEASON-JAN. 4-AUG. 13 OR 222 DAYS
PROPOSED " " " " -FEB. 1-MAY 29 OR 118 DAYS



INNSWOOD: MATERIAL BALANCE SHOWING QUANTITIES OF INTERMEDIATE AND FINAL PRODUCTS MANUFACTURED PER TIME UNIT DURING THE 1970 CROP SEASON

PURITY MIXED JUICE: 75.31

Material	Per Cent Cane	Pounds / Cubic Feet	Per Minute Pounds	Per Minute Cubic Feet	Per Minute Gallons	Per Hour Pounds	Per Hour Tons
Cane	100.00	25.00	2.434	97.30	-	146,026	65.19
Bagasse	39.80	5.00	969	194.30	-	58.118	25.95
Imbibition	20.42	62.00	497	8,01	60	29,819	13.31
Mixed Juice	80.62	65.92	1.962	29.80	223	117,726	52.56
Milk of Lime	0.79	67.00	19	.32	2.3	1,154	.52
Limed Juice	81.41	65.92	1.981	30.00	224	118,880	53.07
Mud to Filter	15.50	66.00	337	5.70	43	22,634	10.1[illegible]
Mud	2.54	85.00	62	.73	5	3,709	1.70
Wash Water	3.00	62.00	73	1.20	9	4,381	1.95
Filtrate	15.96	62.95	388	6.20	46	23,305	10.40
Clarified Juice	65.91	66.50	1.604	24.10	180	96,246	42.97
Juice to Evaporator	81.87	65.77	1,993	30.30	227	119,551	53.37
Syrup	21.98	77.39	534	6.90	52	32,094	14.30
Evaporation	59.89	62.00	1,459	23.50	176	87,457	39.05
MCA	9.65	94.05	235	3.599 cu. ft/day		14,104	6.30
Sugar A	4.82	53.00	118	2.20	16	7,052	3.14
Molasses A	5.12	89.51	125	1.40	10	7,483	3.34
Dil. Mol. A	6.13	84.04	149	1.80	13	8,950	3.99
MCB	6.07	94.46	148	2.253 cu. ft/day		8,868	3.96
Sugar B	2.67	53.00	65	1.20	9	3,902	1.74
Molasses B	3.82	89.92	93	1.03	8	5,580	2.4[illegible]
Dil. Mol. B	4.60	84.04	112	1.33	10	6,728	3.00
MCC	5.98	95.08	146	2.204 cu. ft/day		8,733	3.9
Sugar C	2.73	53.00	67	1.30	10	3,990	1.78
Magma	3.56	91.46	87	0.95	18	5,200	2.33
Final Molasses	3.51	90.98	85	0.93	7	5,12[illegible]	2.29

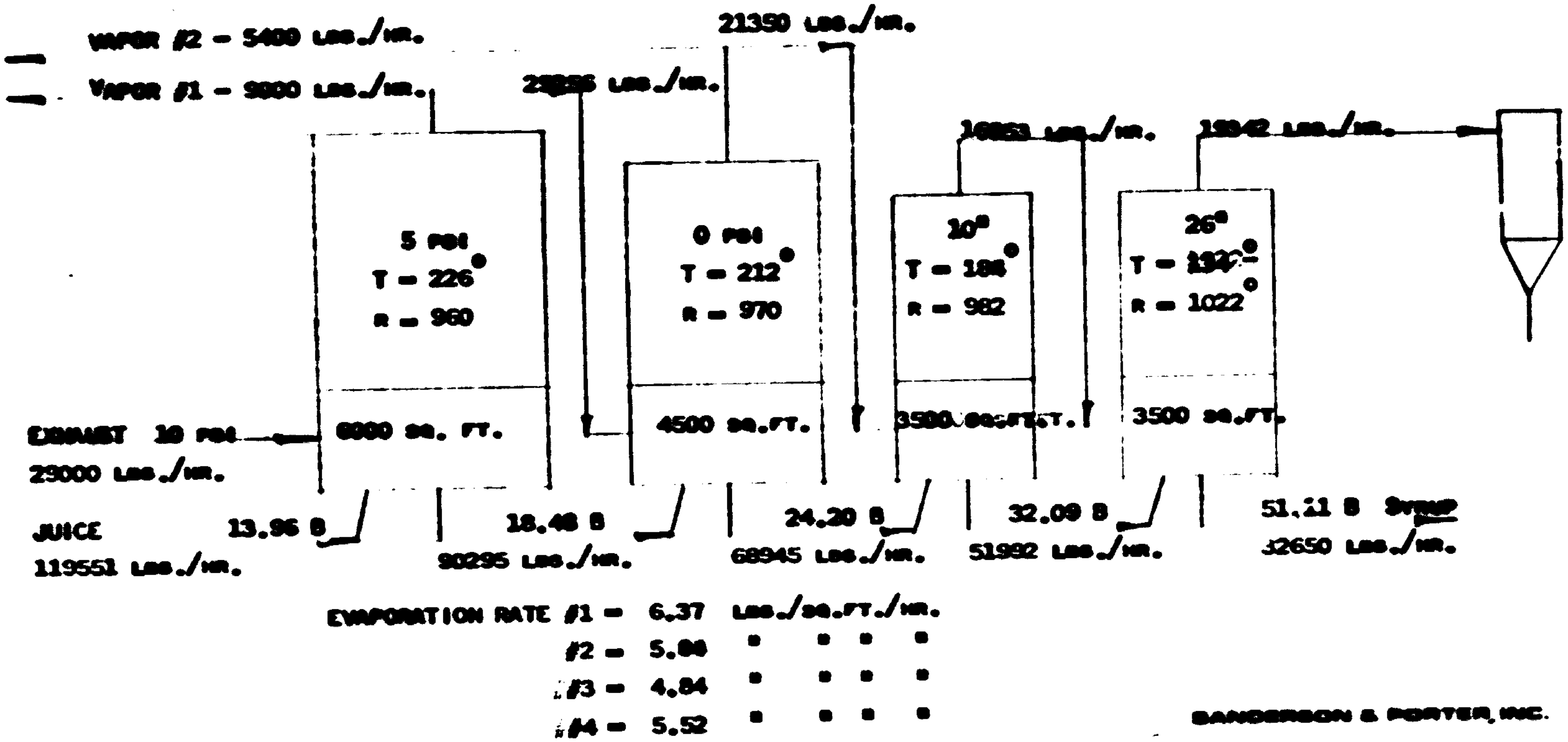
INNSWOOD: ACTUAL CAPACITY IN TONS CANE PER DAY FOR MAIN EQUIPMENT IN EACH PROCESSING STATION

Station	Average T. C. D.
Milling tandem	2,400
Juice heater	2,400
Clarifier	1,560 - 1,800
Filter	2,740
Evaporator	1,970
Vacuum pan	2,185
Supply tank, syrup	580
Supply tank, molasses	2,430
C crystallizer	1,560
High grade centrifugal	2,050
Low grade centrifugal	1,725

INNSWOOD: HEAT BALANCE FOR THE EVAPORATION STATION SHOWING THE STEAM CONSUMPTION IN B. T. U. NEEDED TO OBTAIN THE PRESENT DEGREE OF EVAPORATION IN EACH VESSEL

Calculation for Flow of Heat		Heat Content B. T. U.	Evaporation Pounds Per Hour	Juice Per Cent Brix
#1 Juice to #1	5 psi		119551	13.96
Exhaust to #1 (10 psi) 29000 x 952		27,608,000		
Add Flash from preheater (230-226) 119551		478,204		
Available for Evaporation		28,086,204		
Evaporation 28086204 -:- 960			29256	
Transfer to # 2	6000 sq. ft.		90295	18.48
#2 Vapor from # 1	0 psi	28,086,204		
To heater 9000 x 960		8,640,000		
Balance		19,446,204		
Add Flash 90295 (226-212)		1,264,130		
Available for Evaporation		20,710,334		
Evaporation 20710334 -:- 970			21350	
Transfer to # 3	4500 sq. ft.		68945	24.20
#3 Vapor from # 2	10"	20,710,334		
To heaters 5400 x 982		5,302,800		
Balance		15,407,534		
Add Flash 68945 (212-194)		1,241,010		
Available for Evaporation		16,648,544		
Evaporation 16648544 -:- 982			16953	
Transfer to # 4	3500 sq. ft.		51992	32.09
#4 Vapor from # 3	26"	16,648,544		
Add Flash 51992 (194-134) 8° BPR		3,119,520		
Available for Evaporation		19,768,064		
Evaporation 19768064 -:- 1022			19342	
Out of # 4 Syrup	3500 sq. ft.		32650	51,11

INNSWOOD: HEAT BALANCE DIAGRAM SHOWING EVAPORATOR INPUT AND OUTPUT OF STEAM, JUICE, VAPOR AND SYRUP, BASED ON HEAT BALANCE CALCULATIONS



Investigation Techniques

As stated previously, the information received for each plant was too voluminous to include in this report. Therefore, the methods used in the evaluation of each processing plant are included only for the Innswood plant. Calculations for the other plants were made in a similar manner and formed the basis upon which the recommendations for each plant were made.

The dimensions of the mills are 30"x60". Each is powered by a 300 h.p. engine. Linear speed for the rollers is 45.65 f.p.m. With 16 per cent fiber in cane, this tandem is capable of grinding 100 T.C.H. The engine capacity of 300 h.p. per mill is adequate to attain this grinding capacity.

Therefore, the maximum daily grinding capacity is 24x100 or 2,400 T.C.D. Present amount of cane processed: 220,709 tons. Effective number of hours available for grinding: 2,207 or 84 per cent of total time. Lost time during grinding season: 420 or 16 per cent of total time. Total time during season: 2,627 or 100 per cent of total time or 109 days. In the event that cane supplies increase by 20 per cent in the future, total grinding time will have to be extended to 131 days.

Juice Heaters: Quantity of juice to the heaters amounts to 117,727 pounds per hour with 14.58 per cent Brix in juice.

One cubic foot of juice weighs 65.92 pounds.

Juice velocity through heaters 1 or 2 is calculated at 4.55 f.p.s.; somewhat low. This velocity will increase to 6.92 f.p.s. and will be correct when grinding 100 T.C.H.

Heat transmission coefficients:

Present, $K = \dfrac{230 - 32}{0.9 + \dfrac{2.2}{4.55}}$ or 143 Future $\dfrac{230 - 32}{0.9 + \dfrac{2.2}{6.96}}$ or 162

Future heating surface required:

$$HS = \frac{117,727 \times 0.9}{162} \times 2.3 \ \log \frac{230 - 85}{230 - 215}$$ or 1,500 square feet

Capacity of the juice heating station is capable of grinding 100 T.C.H.

When using two heaters in series the steam consumption by these heaters will be:

$$\frac{117,727 \times 0.9}{958} \times (215-85)$$ or 14,400 pounds per hour.

Clarifier: Presently installed is "Bach" 20 foot diameter having a volume of 4,700 cubic feet.

Quantity of juice flowing to the clarifier equals 118,880 pounds per hour or 1,803 cubic feet per hour. Thus, the retention time for juice in the clarifier is $\frac{4,700}{1,803}$ or 2.6 hours.

A three hour retention time for juice is considered optimum. Therefore, the capacity for the clarifier is rated at 65 T.C.H.; or 1,560 T.C.D. If the juices are of very good quality; the minimum retention time for juice may be reduced to 2.25 hours. In this case the clarifier may be rated $\frac{2.6}{2.25} \times 65$ - 75 T.C.H.; or 1,800 T.C.D.

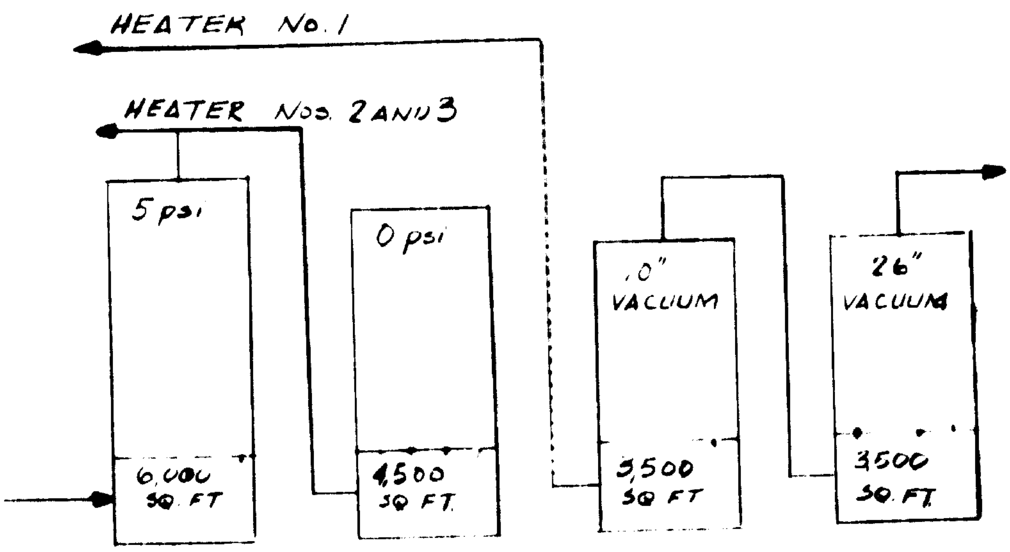
Filter: A "Dorr Oliver" filter, 8'x12' having a filtration area of 300 square feet is presently installed. Assuming a cake thickness of $\frac{1}{4}$" and 20 r.p.h. for the drum, the amount of filter cake produced equals 3,709 pounds per hour having a volume of 106 cubic feet per hour dried cake.

Required area for optimum filtration: $\frac{106 \times 12}{20 \times 0.25}$ or 255 square feet.

Present station capacity: $\frac{300}{255} \times 65 = 76.5$ T.C.H.; or 1,840 T.C.D.

Filtration capacity may be increased if more than $\frac{1}{4}$" thickness for cake is allowed. In this case the per cent sucrose lost in filtercake will slightly increase. Under this circumstance the capacity of the filter can be increased to: 114 T.C.H; or 2,740 T.C.D.

Evaporators: Total heating surface (H.S.) at present equals 17,500 square feet in the form of a quadruple effect with bleeding of vapor from the first and second vessel.



Total evaporation obtained equals 83,289 pounds per hour with an evaporation rate of $\frac{83,289}{17,500}$ or 4.75 pounds per hour per square foot.

The result is low for this equipment and the evaporation rate may be six pounds per square foot per hour if incrustations are cleaned well and/or more frequently.

The ultimate capacity may be augmented to produce $\frac{6}{4.75} \times 65 = 82$ T. C. H. or 1,970 T. C. D.

Pan Supply Tanks: Installed are -

4 tanks with a total content of 580 cubic feet for syrup.

4 tanks with a total content of 2,025 cubic feet for A molasses.

4 tanks with a total content of 2,025 cubic feet for B molasses.

Capacity for syrup tanks $\frac{580}{24} \times 24$, or 580 T. C. D.

Capacity for A+B Molasses tanks $\frac{4050}{40} \times 24$, or 2,430 T. C. D.

The quantity of syrup produced is 385 cubic feet per hour. Retention time for syrup storage is only $\frac{580}{385} = 1.5$ hours.

This time span is insufficient and storage capacity must be at least adequate for one complete pan load. The A pan having 500 cubic feet of volume, will utilize 900 cubic feet of syrup at the actual Brix (before evaporation in the pan).

Vacuum Pans: There are four pans.

Pan Number	1	2	3	4
Type	Calandria	Calandria	Calandria	Calandria
Massacuite Type	A	B	C	Grain
Heating Surface, Square Feet	750	740	800	800
Strike Volume, Cubic Feet	500	700	500	500

Pan Number	1	2	3	4
Pan Schedule - Strike Volume, Cubic Feet	500	500	500	500
Type of Strike	A	B	C	Grain
Duration of Strike, Hours	2½	3	5	2
Volume of Strike, Cubic Feet per Day:				
mc. A, 3,600- Strikes	7.2			
Hours	18			
Mc. B, 2,250- Strikes		4.5		
Hours		13.5		
mc. C, 2,200- Strikes			4.4	
Hours			22.0	
Grain+Magma- Strikes				1.5+6.0
Hours				15
Total Cubic Feet per Day - 8,050				
Per Cent of Time available for pan occupation -	75	56	92	63
Per Cent of Time still available for pan occupation -	25	44	8	37

Average time for pan occupation: 71.4 per cent.

Average time available for pan occupation: 28.6 per cent.

Pan station capacity: $\frac{100}{71.4} \times 65 = 91$ T.C.H., equivalent to a grinding capacity of 2,185 T.C.D.

Crystallizers: There are five water cooled units for serving massacuite C, each having an adequate volume to receive a complete pan load. Daily, 4.4 C type strikes are produced. While one crystallizer is being purged, another must be empty to receive the next pan load. Therefore, 3¼ crystallizers are filled at all times.

Retention time for the massacuite is $\frac{3.5}{4.4} \times 24$ or 19 hours. This is the minimum allowable time permitted for effective cooling of massacuite by water cooled units.

Therefore, the capacity for the crystallizer station can be rated as 65 T.C.H. or 1,560 T.C.D.

High Grade Centrifugals: Presently installed equipment includes:

Six W. L. 42"x24" 1,200 r.p.m. with manual sugar discharge.

One W. L. 42"x24" 1,200 r.p.m. with semi-automatic sugar discharge.

Total amount of massacuite to be cured equals 5,850 cubic feet per day.

Capacity for each basket: 8.38 cubic feet. Assuming an actual operation of 20 hours daily, and 6 and 10 cycles per hour for the manual and semi-automatic equipment respectively, the capacity for the station can be rated as:

(6x8.38x16x20) + (1.x8.38x10x20) or 7,710 cubic feet per day.

Actual amount of massacuite to be processed: 5,850 cubic feet per day.

Station capacity: $\frac{7,710}{5,850}$ x 65 = 85.15 T.C.H. or 2,050 T.C.D.

Low Grade Centrifugals: There are at present two continuous W.S., fully automatic low grade centrifugals. The capacity of continuous centrifugals depends on the type used, the quality of the massacuite, and whether steam is applied continuously during curing.

A safe capacity of 60 cubic feet per hour per machine can be assumed. Therefore, Station capacity would equal 2x50x20 or 2,400 cubic feet per day based one one day as being equivalent to 20 hours of active curing.

Station capacity is adequate to produce:
$\frac{2,400}{2,200}$ x 65 = 72 T.C.H. or 1,725 T.C.D.

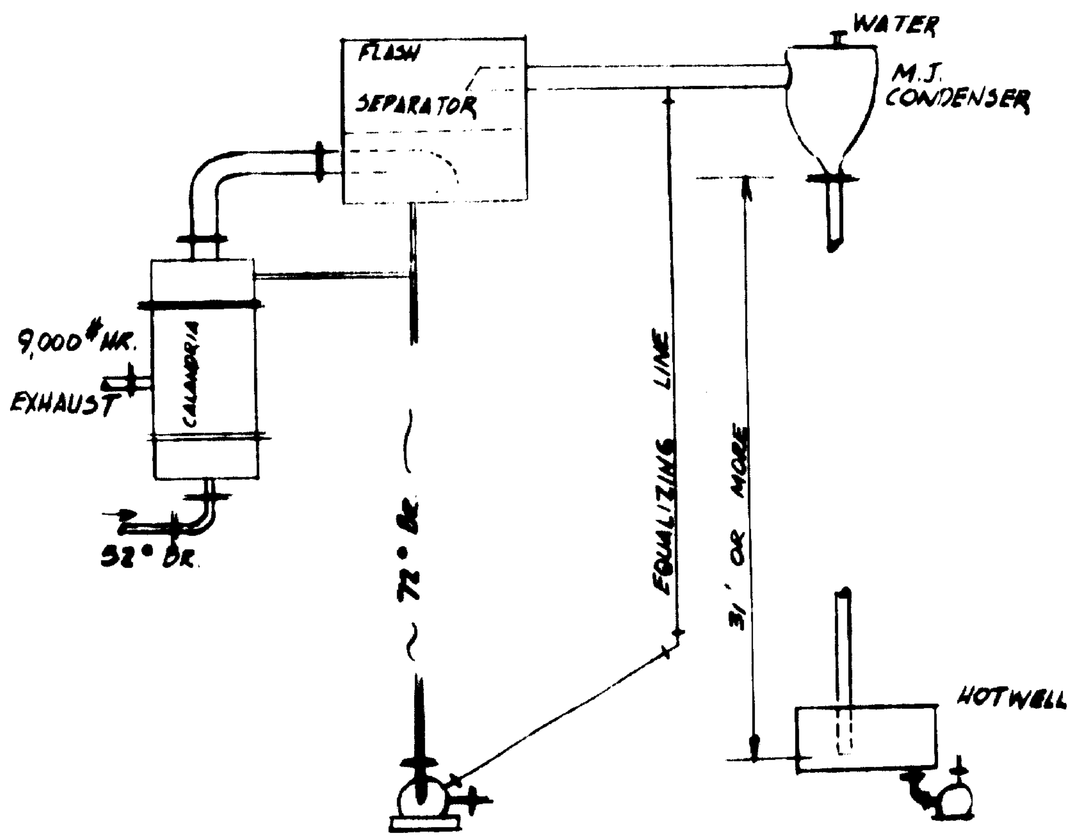
INNSWOOD: STEAM REQUIREMENTS IN POUNDS PER HOUR NEEDED FOR THE CONVERSION OF THE FACTORY INTO A SYRUP PRODUCING UNIT, TAKING INTO ACCOUNT THE INCREASE IN THE HOURLY GRINDING CAPACITY IN ORDER TO SHORTEN THE CROP DURATION

	Pounds per hour
Present required steam consumption:	29,000
Estimated allowance for radiation and condensation, 10%	2,900
Present total steam requirement:	31,900
Total future steam requirement, inclusive steam needed by juice heaters, in order to reach 100 T. C. H. grinding capacity (rounded off):	50,000
Quantity of syrup concentrated to 52 degrees Brix:	32,094
And concentrated to 72 degrees Brix:	23,179
Quantity of water evaporated between 52 and 72 degrees Brix at present grinding rate:	8,915
Quantity of water evaporated between 52 and 72 degrees Brix with future grinding rate:	14,000
Future quantity of steam required by a single effect flash evaporator, allowing for heat losses:	15,000
Total requirement needed in the form of steam to produce syrup of 72 degrees brix at the increased grinding rate:	65,000

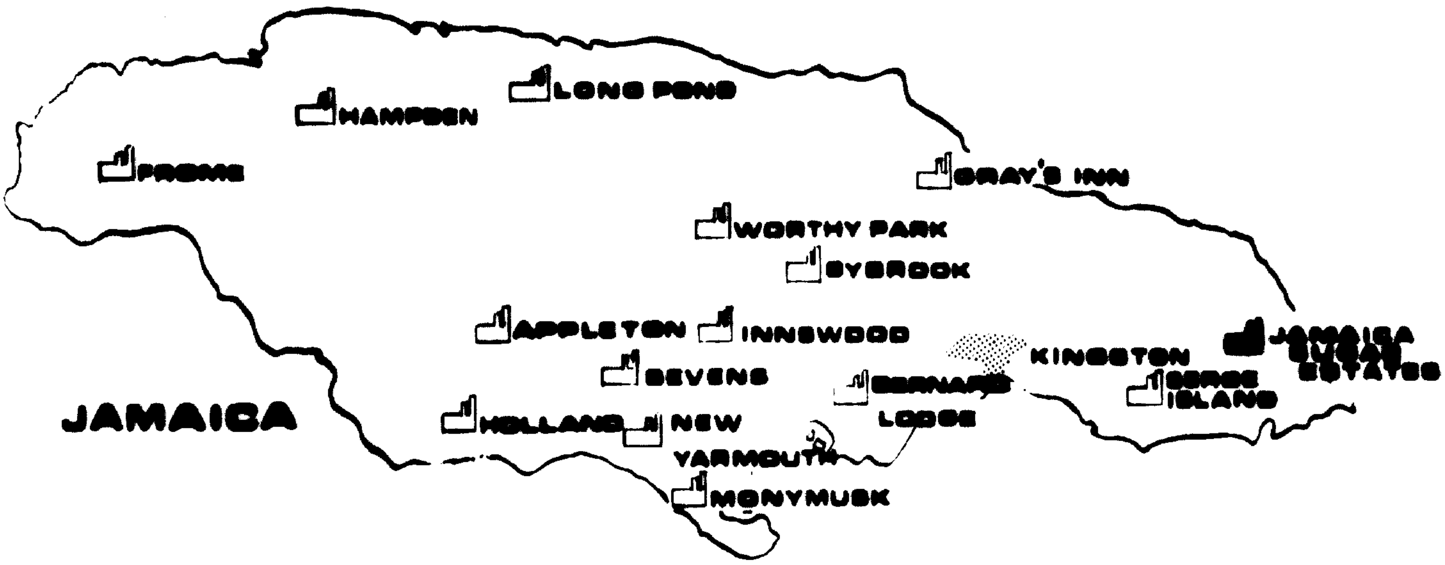
INNSWOOD: SUGGESTED OPERATIONAL AND DESIGN PRINCIPLE FOR A FLASH EVAPORATOR TO CONCENTRATE SYRUP FROM 52 TO 72 DEGREES BRIX

Specifications: 365 tubes, each being 7 feet long between plates and having 1-1/2 inch O. D.

Vapor pipe diameter 22 inches in order to maintain a vapor velocity of 165 fps. and based on a vapor volume of 431 cft/sec (sp. volume of vapor at 26 inches vacuum - 174 cf/lb). Approximate quantity of injection water needed for condensation: 750 gpm.



JAMAICA SUGAR ESTATES
Saint Thomas Parish



Jamaica Estates

It is recommended that the Jamaica Estates factory be converted to a syrup producing unit. Based on the sucrose distribution in cane the grinding capacity should be increased from 77.5 T.C.H. to 97.0 T.C.H. or 2,330 T.C.D. The proposed grinding rate may be limited by the following causes:

Milling: The linear speed for the rollers is inadequate due to the present power supply for the milling operation. There are two alternatives which can remedy this condition:

The existing first engine can remain to provide power to the combination crusher and the first mill. A new 300 h.p. turbine should be installed to power the second mill. The second existing engine should remain to power the third and fourth mills. With this system the linear speed can be increased from 29 to 40 f.p.m. and provide adequate power for the proposed grinding rate. At some future date the two existing engines should be replaced by a 600 h.p. turbine. The total investment needed for these improvements may amount to $180,000.

The second alternative would be to install a cane diffusion plant for 2,000 T.C.D. Such an installation would allow two of the existing mills to dewater the bagasse and make it suitable for firing the boilers. A shredder should also be installed in front of the diffusion plant together with one mill in order to extract a part of the juice. The first expressed juice can be mixed with the juice obtained from the diffusion plant. The price for the diffusion plant, including installation and remodelling, is estimated at $450,000.

Comparing the alternatives and although a difference of $270,000 is apparent, the diffusion plant will increase the actual reduced extraction by 4 per cent recovering an additional 750 tons of sugar annually valued in excess of $70,000. This is based on the actual reduced extraction of 92.6; probable extractionof 96.6; sucrose in cane 10.2; cane ground 210,000 tons; factor for available sucrose .89; and a price for sugar $94 per ton. Therefore the installation of a diffusion plant will prove more beneficial than the replacement of the units now powering the present milling tandem.

Juice Heaters: The present station has an adequate capacity. Vapor supplied to the heaters is received from the third evaporator vessel, a rather unusual arrangement. This vessel supplies vapor having a vacuum of about 11 inches mercury, a situation which makes it very difficult for steam traps to operate without fault. Also, the vapor consumption for the heaters, calculated at 640,000 cubic feet per hour, requiring large diameter piping, about 18" I. D., in order to maintain an acceptable vapor velocity.

Clarification: The clarifier capacity is too small for the proposed grinding rate. A small polycell type clarifier should be added.

In addition, the filter is too small. Variations in cake thickness may prove adequate to bring this station to capacity, accepting the slightly increased sucrose loss in cake.

Evaporators: The station's performance is excellent. The overall evaporation rate of 7.25 pounds per square foot per hour is high. No further improvement can be expected from the present 16,500 square feet of heating surface. The present density of syrup is only 55 degrees Brix. This verifies that the capacity of this station has been reached. A vaporcell should be installed in front of the existing quadruple effect. This cell would provide all the vapor needed by the heaters while a juice with a higher density than at present would be sent to the quadruple effect. A cell, with 2,500 square feet heating surface would produce the needed vapor for the heaters and also concentrate the juice from the present 13.22 to 15.50 degrees Brix. At the same time the evaporation load for the quadruple effect decreases from 119,622 to 102,100 pounds per hour.

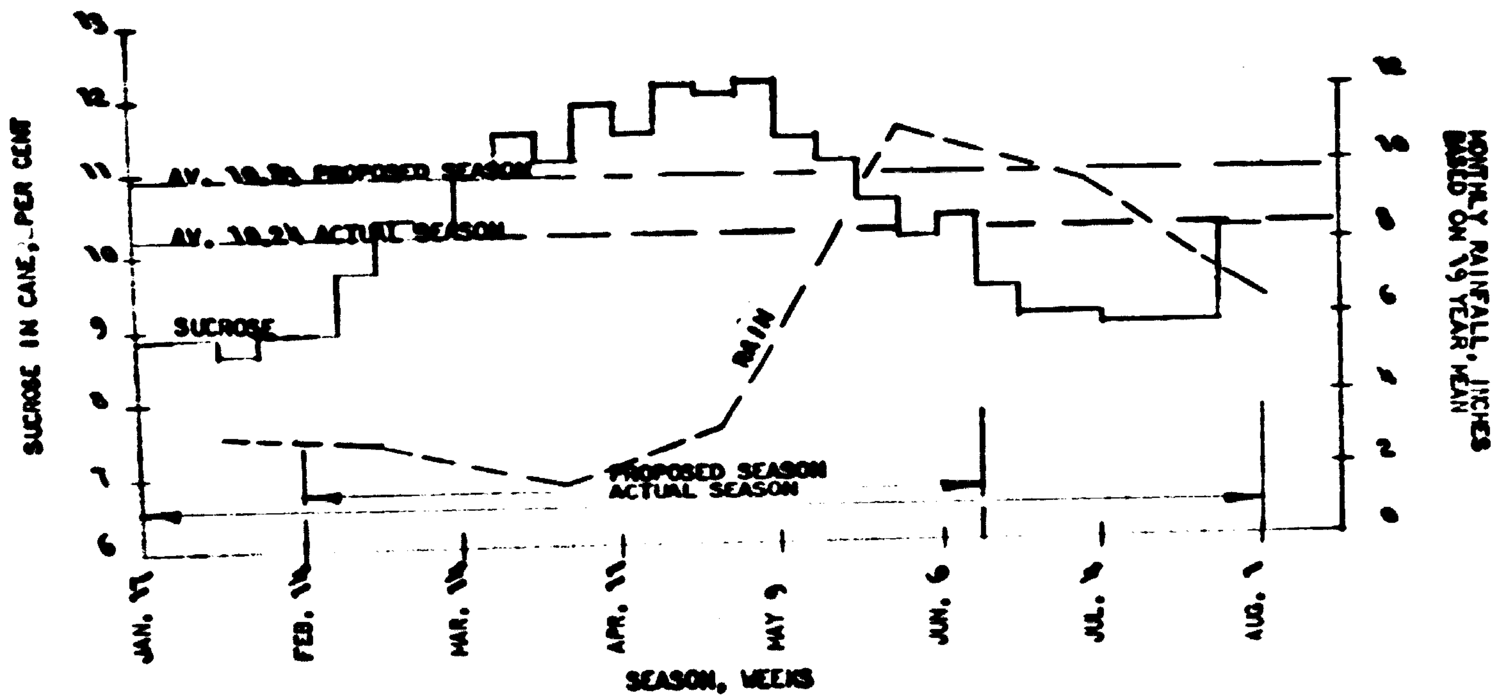
The last vessel should be replaced by a new one having a 5,000 square foot heating surface as the vapor cell instead of the third vessel will now supply vapor to the heaters. The present last vessel is the exact size to serve properly as the vapor cell. Only one new vessel with a 5,000 square foot heating surface will be needed increasing the total capacity for the evaporation station to 21,000 square feet of heating surface. This is considered adequate to service the proposed grinding rate of 2,330 T.C.D.

Capital Costs: The costs involved to increase the grinding rate to 2,330 T.C.D. and change the factory to a syrup producing unit are estimated as follows:

Turbine for third mill including secondary gearing and installation	$40,000
Clarifier	10,000
Vapor Cell	25,000
Total	$75,000

JAMAICA SUGAR ESTATES:
DISTRIBUTION OF PER CENT SUCROSE IN CANE DURING 1970 CROP

ACTUAL DURATION OF GRINDING SEASON-JAN. 17-AUG. 1 OR 197 DAYS
PROPOSED " " " FEB. 14-JUN. 13 OR 120 DAYS



SANDERSON & PORTER, INC.

JAMAICA ESTATES: MATERIAL BALANCE SHOWING QUANTITIES OF INTERMEDIATE AND FINAL PRODUCTS MANUFACTURED PER TIME UNIT DURING THE 1970 CROP SEASON

PURITY MIXED JUICE: 78.32

Material	Per Cent Cane	Pounds Cubic Feet	Per Minute Pounds	Per Minute Cubic Feet	Per Minute Gallon	Per Hour Pounds	Per Hour Tons
Cane	100.00	25.00	2,899	115.96	-	173,578	77.49
Bagasse	28.19	5.00	817	163.40	-	48,932	21.84
Imbibition	19.00	62.00	550	8.87	66	32,980	14.72
Mixed Juice	90.81	65.67	2,628	40.01	300	157,626	70.36
Milk of Lime	0.50	67.00	14	0.20	1.5	868	0.39
Limed Juice	91.31	65.67	2,642	40.23	301	158,494	70.75
Mud to Filter	15.50	66.00	449	6.80	51	26,905	12.01
Mud	3.77	69.11	109	1.57	-	6.544	2.92
Wash Water	3.00	62.00	87	1.40	10	5,207	2.32
Filtrate	14.73	64.47	427	6.62	50	25,568	11.41
Clarified Juice	75.81	65.61	2,198	33.50	250	131,589	58.74
Juice to Evaporator	90.54	65.58	2,625	40.02	300	157,157	70.15
Syrup	21.62	78.55	627	7.98	60	37,535	16.76
Evaporation	68.92	62.00	1,998	32.22	241	119,622	53.40
MCA	9.79	93.65	284	4.359 cu. ft/day		17,010	7.59
Sugar A	4.70	53.00	136	2.56	-	8,170	3.65
Molasses A	5.13	90.83	149	1.64	12	8,920	3.98
Dil Mol. A	6.35	84.04	184	2.18	16	11,028	4.92
MCB	7.86	94.32	228	3,472 cu. ft/day		13,645	6.09
Sugar B	3.37	53.00	98	1.84	-	5,853	2.61
Molasses B	4.51	91.45	131	1.43	11	7,842	3.50
Dil. Mol. B	5.67	84.04	164	1.95	15	9,850	4.40
MCC	6.42	94.70	186	2.826 cu. ft/day		11,151	4.98
Sugar C	2.73	54.00	79	1.46	-	4,752	2.12
Magma	3.40	92.33	99	1.07	8	5,917	2.64
Final Molasses	3.794	92.54	110	1.18	9	6,586	2.94

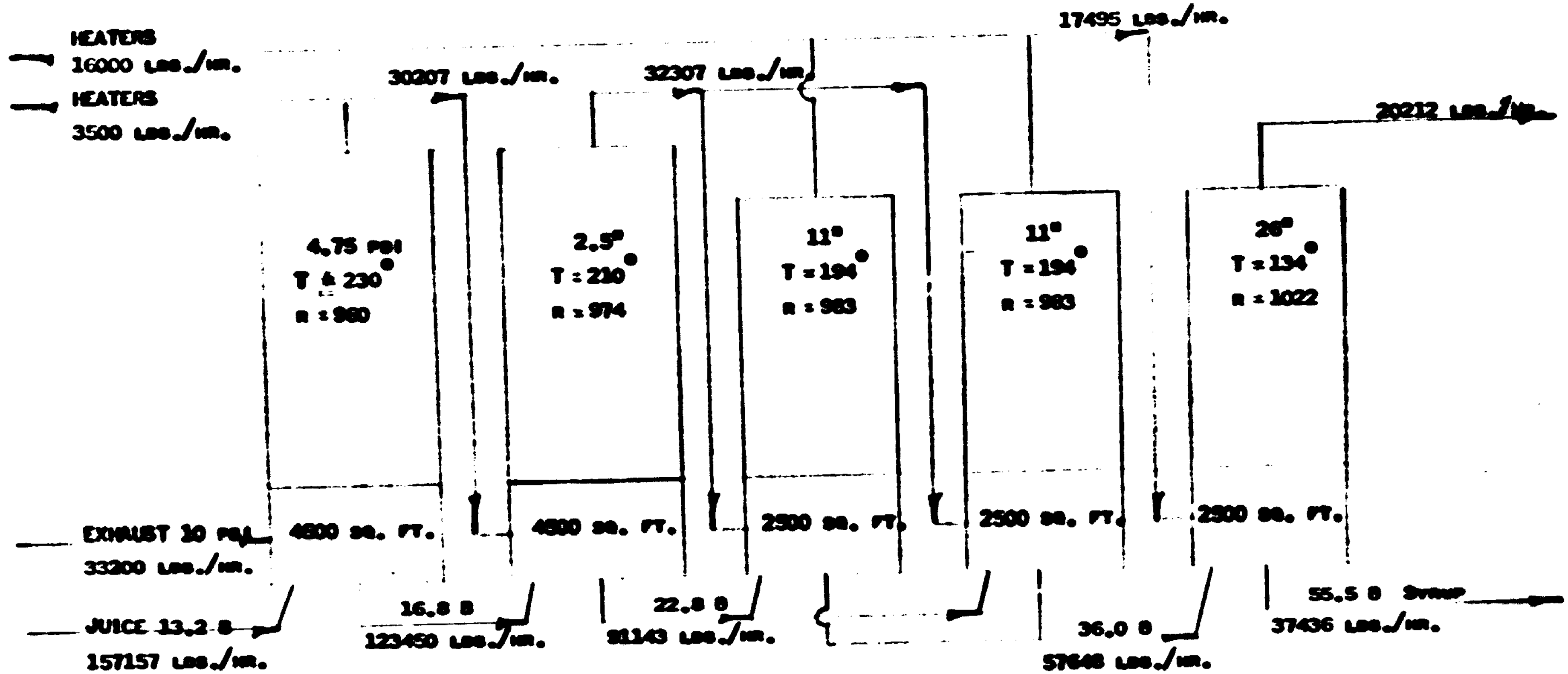
JAMAICA ESTATES: ACTUAL CAPACITY IN TONS CANE PER DAY FOR MAIN EQUIPMENT IN EACH PROCESSING STATION.

Station	Capacity T. C. D.
Mills	1,872
Juice heaters	6,330
Clarifiers	1,800
Filters	1,451
Evaporators	1,680
Vacuum pans	2,280
Syrup supply tanks	1,440
A and B molasses tanks	3,456
C crystallizers	3,720
High grade centrifugals	2,590
Low grade centrifugals	2,110

JAMAICA ESTATES: HEAT BALANCE FOR THE EVAPORATION STATION SHOWING THE STEAM CONSUMPTION IN B.T.U. NEEDED TO OBTAIN THE PRESENT DEGREE OF EVAPORATION IN EACH VESSEL

Calculation for Flow of Heat	Heat Content B.T.U.	Evaporation Pounds per hour	Juice Per Cent Brix
#1 Juice to #1 4.75 psi		157,157	13.22
Exhaust to #1 (10 psi) 33,200 x 951	31,573,200		
Add flash from pre-heater 157,157 x (235-230)	785,785		
Available for Evaporation	32,358,985		
Evaporation 32,358,985 -:- 960		33,707	
Transfer to #2		123,450	16.82
#2) Vapor from #1 2-1/2"	32,358,985		
Deduct for heaters 3,500 x 960	3,360,000		
Balance	28,998,985		
Add flash 123,450 (230-210)	2,469,000		
Available for Evaporation	31,467,985		
Evaporation 31,467,985 -:- 974		32,307	
Transfer to #3		91,143	22.79
#3) Vapor from #2 11"	31,467,985		
Add flash 91,143 (210-194)	1,458,288		
Available for Evaporation	32,926,273		
Evaporation 32,926,273 -:- 983		33,495	
Transfer to #4		57,648	36.03
#4) Vapor from #3 26"	32,926,273		
Deduct for heaters 16,000 x 983	15,728,000		
Balance	17,198,273		
Add flash 57,648 (194-134)	3,458,880		
Available for Evaporation	20,657,153		
Evaporation 20,657,153 -:- 1,022		20,212	
Leaving #4 as syrup		37,436	55.49

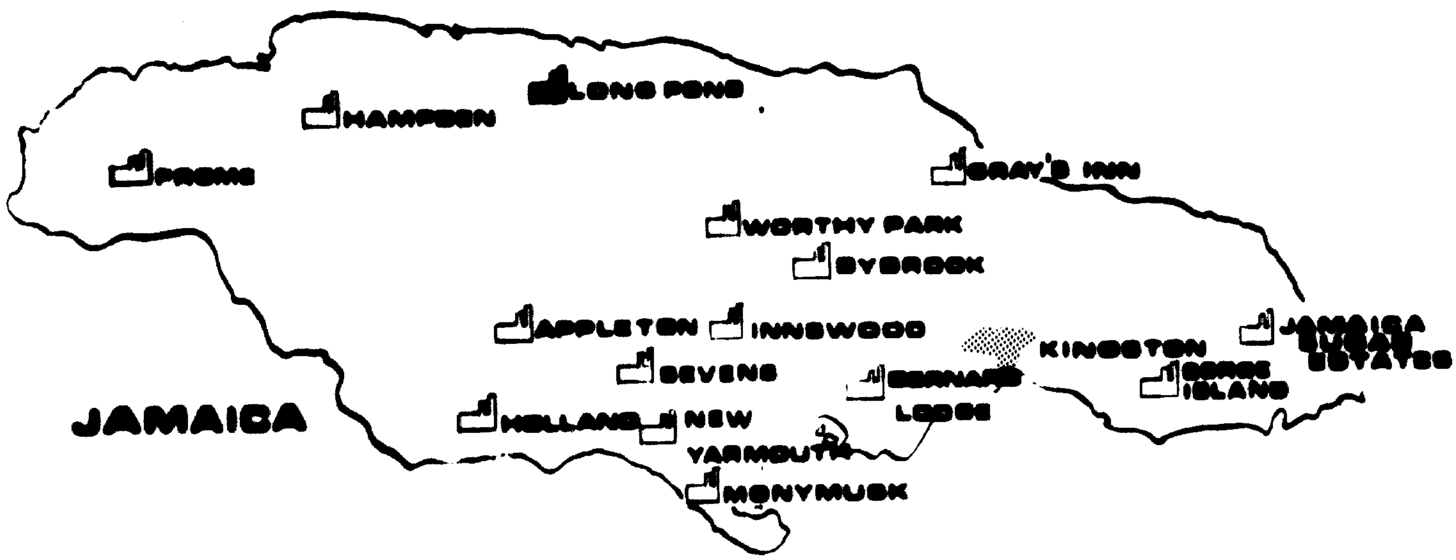
JAMAICA ESTATES: HEAT BALANCE DIAGRAM SHOWING INPUT AND OUTPUT OF STEAM, JUICE, VAPOR AND SYRUP BASED ON HEAT BALANCE CALCULATIONS



EVAPORATION RATE #1 = 7.40 LBS./SQ. FT./HR.
#2 = 7.17 " " " "
#3 = 6.60 " " " "
#4 = 8.08 " " " "
OVERALL # = 7.25 " " " "

SANDERSON & PORTER, INC.

LONG POND
Trelawny Parish



Long Pond

Judging from the per cent sucrose distribution in cane it is recommended that the crop duration to be shortened to 151 days and the grinding rate increased to 95 T.C.H. or 2,280 T.C.D. Also, Long Pond should be promoted to a syrup producing unit as this move would be in the interest of the large distilling facility now employed by Long Pond. The increased grinding capacity, the elimination of power requirements by pans and centrifugals and the resulting bagasse surplus will allow the bagasse to be baled and stored in the back of the end-factory. Here it can be utilized for one boiler after the completion of the cane crop and for continuation of the distilling plant. Similarly, with decreased steam consumption for syrup production during crop, the present boiler facility will be able to deliver an increased steam supply to the distilling units during this period.

To obtain the proposed grinding rate, the following factors are to be considered:

Milling: The present capacity of this station is adequate.

Juice Heaters: This station has also an adequate capacity.

Clarification: The present clarifier capacity is inadequate. Instead of adding a third clarifier unit it would be preferable to install a new polycell type clarifier which will replace both outdated units. One 16' diameter polycell type clarifier will easily handle the projected cane grinding rate.

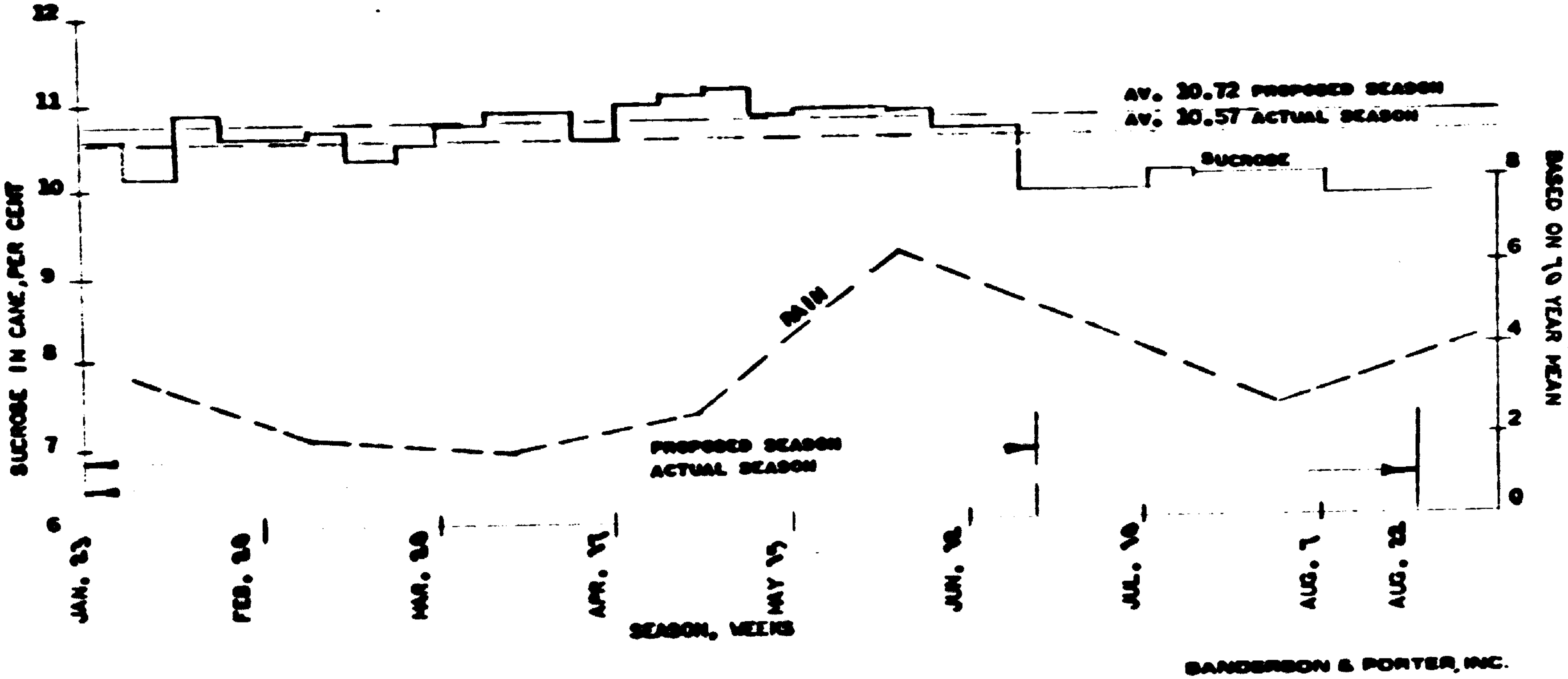
The present capacity of the filtering station is adequate for the proposed cane grinding rate.

Evaporators: The total capacity for present operations is adequate but will be barely sufficient for future requirements. To secure some margin of safety, a new vessel should be added to the existing evaporation station. The easiest and most inexpensive way in which to achieve efficiency is to add one vessel having a 2,400 square foot heating surface as the last vessel, and use the existing first vessel as a preevaporator. This will enable the evaporation station to handle 2,500 T.C.D., and will secure a Brix for syrup of high density.

Capital Cost: The estimated capital cost to increase the capacity and to operate as a syrup producing unit is $41,000 ($16,000 and $25,000 for clarifier and evaporator improvement, respectively). It should be noted that the present vacuum pans may be utilized by the central end-factory as Long Pond recently has been renovated. These pans, however, maintain their vacuum by means of double stage steam ejectors; a system which is of a doubtful value for maintaining vacuum effectively since the degree of vacuum completely depends on the working pressure for the boilers. Efficiency drops rapidly with even the slightest reduction in steam pressures. Also, there is little flexibility to ensure the needed evaporation rate at the beginning of each pan strike with the result that the syrup may become overheated and darkly colored. In the event the pans will be included for the erection of the central end-factory, the steam ejectors should be replaced by Nash type individual rotary vacuum pumps ($6,000 for four pumps).

LONG POND:
DISTRIBUTION OF PER CENT SUCROSE IN CANE DURING 1970 CROP

ACTUAL DURATION OF GRINDING SEASON-JAN. 23-AUG. 22 OR 212 DAYS
PROPOSED " " " " -JAN. 23-JUN. 22 OR 151 DAYS



LONG POND: MATERIAL BALANCE SHOWING QUANTITIES OF INTERMEDIATE AND FINAL PRODUCTS MANUFACTURED PER TIME UNIT DURING THE 1970 CROP SEASON

PURITY MIXED JUICE: 80.44

Material	Per Cent Cane	Pounds/ Cubic Feet	Per Minute Pounds	Per Minute Cubic Feet	Per Minute Gallons	Per Hour Pounds	Per Hour Tons
Cane	100.00	25.00	3,122	125.00	-	187,286	83.61
Bagasse	32.62	5.00	1,018	201.00	-	61,093	27.27
Imbibition	18.93	62.00	591	9.53	71	35,453	15.83
Mixed Juice	86.31	65.72	2,695	41.00	307	161,646	72.16
Milk of Lime	0.50	67.00	16	0.23	2	936	0.42
Limed Juice	86.81	65.72	2,711	41.25	309	162,532	72.58
Mud to Filter	15.50	66.00	484	7.33	55	29,029	12.96
Mud	2.49	69.70	78	1.11	8	4,663	2.08
Wash Water	3.00	62.00	94	1.51	11	5,619	2.51
Filtrate	16.01	64.74	500	7.72	58	29,985	13.39
Clarified Juice	71.31	65.66	2,226	33.90	254	133,553	59.62
Juice to Evaporator	87.32	65.63	2,726	41.53	311	163,538	73.01
Syrup	19.20	80.62	600	7.44	56	35,972	16.05
Evaporation	68.12	62.00	2,126	34.29	256	127,566	56.96
MCA	8.20	92.75	256	3,974 cu. ft/ day		15,358	6.86
Sugar A	4.47	53.00	140	2.64	-	8,372	3.73
Molasses A	3.73	88.45	116	1.31	10	6,986	3.12
Dil. Mol. A	4.31	84.04	135	1.60	12	8,078	3.61
MCB	8.02	94.15	250	3,829 cu. ft/ day		15,024	6.71
Sugar B	3.50	53.00	109	2.06	-	6,555	2.93
Molasses B	4.77	90.33	149	1.64	12	8,944	3.99
Dil. Mol. B	5.82	84.04	182	2.16	16	10,910	4.87
MCC	6.28	94.54	196	2,985 cu. ft/ day		11,762	5.25
Sugar C	2.69	54.00	84	1.55	-	5,055	2.26
Magma	3.48	92.33	109	1.18	12	6,536	2.91
Final Molasses	3.78	91.16	118	1.29	10	7,079	3.16

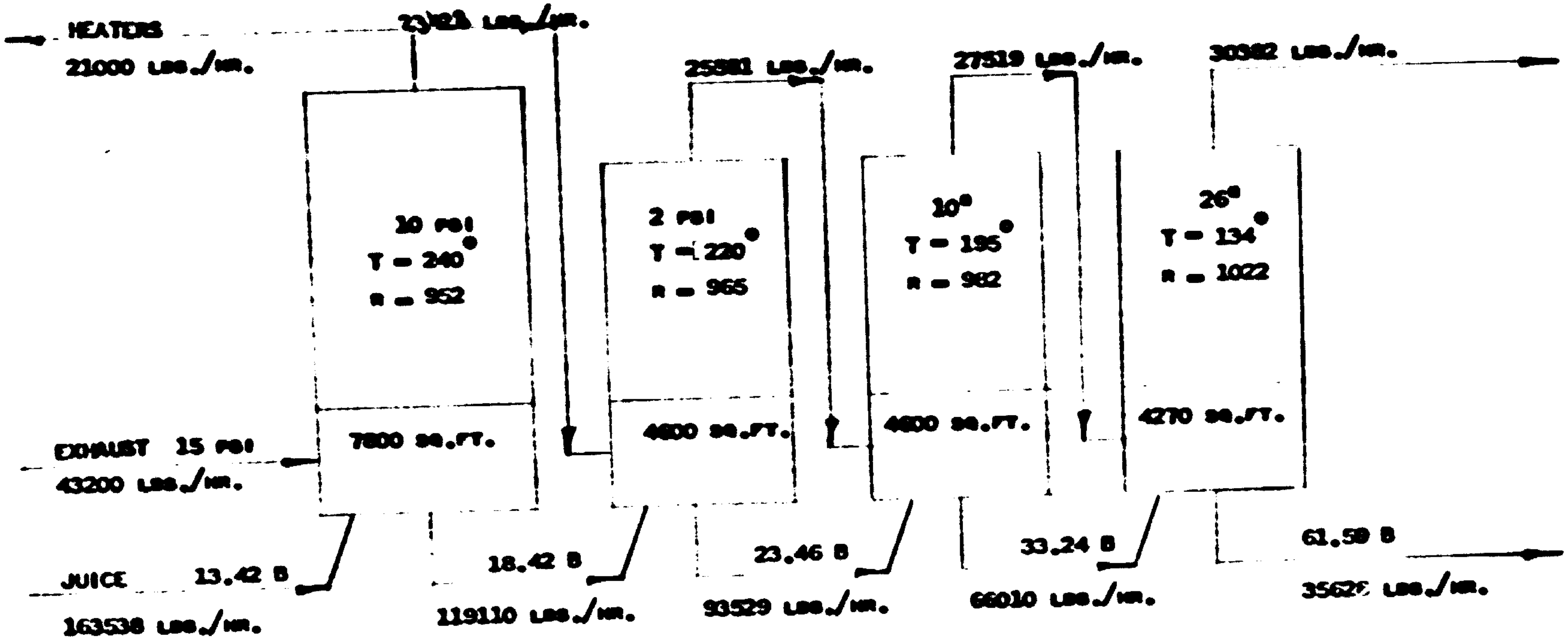
LONG POND: ACTUAL CAPACITY IN TONS CANE PER DAY FOR MAIN EQUIPMENT IN EACH PROCESSING STATION

Station	Average T. C. D.
Mills	2,256
Juice heaters	2,348
Clarifiers	1,850
Filters	2,508
Evaporation	2,050
Vacuum pans	2,420
Syrup supply tanks	2,250
A and B molasses tanks	2,200
C Crystallizers	4,000
High grade centrifugals	3,900
Low grade centrifugals	3,050

LONG POND: HEAT BALANCE FOR THE EVAPORATION STATION SHOWING THE STEAM CONSUMPTION NEEDED TO OBTAIN THE PRESENT DEGREE OF EVAPORATION IN EACH VESSEL

Calculations for Flow of Heat	Heat Content B.T.U.	Evaporation Pounds per Hour	Juice Per Cent Brix
1 Juice to #1		163,538	13.42
Exhaust to #1 (15 psi) 43,200 x 945	40,824,000		
Add Flash from pre-heater 163,538 (249-240)	1,471,842		
Available for Evaporation	42,295,842		
Evaporation 42,295,842 -:- 952		44,428	
Transfer to #2		119,110	18.42
#2 Vapor from #1	42,295,842		
To Heaters 21,000 x 952	19,992,000		
Balance	22,303,842		
Add Flash. 119,110 (240-220)	2,382,200		
Available for Evaporation	24,686,042		
Evaporation 24,686,042 -:- 965		25,581	
Transfer to #3		93,529	23.46
#3 Vapor from #2	24,686,042		
Add Flash. 93,529 (220-195)	2,338,225		
Available for Evaporation	27,024,267		
Evaporation 27,024,267 -:- 982		27,519	
Transfer to #4		66,010	33.24
#4 Vapor form #3	27,024,267		
Add Flas. 66,010 (195-134)	4,026,610		
Available for Evaporation	31,050,877		
Evaporation 31,050,877 -:- 1,022		30,382	
Leaving #4 as Syrup.		35,628	61.59

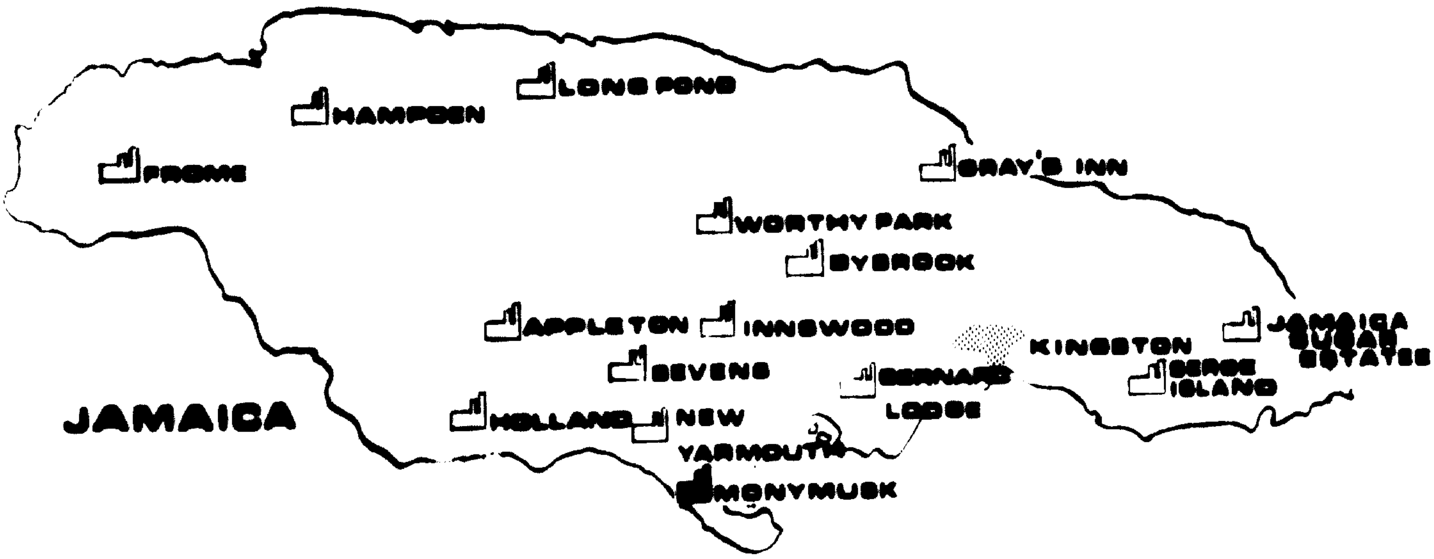
LONGPOND: HEAT BALANCE DIAGRAM SHOWING INPUT AND OUTPUT OF STEAM, JUICE, VAPOR AND SYRUP BASED ON HEAT BALANCE CALCULATIONS



EVAPORATION RATE #1 = 5.70 LBS./SQ.FT./HR.
#2 = 5.56 " " " "
#3 = 5.98 " " " "
#4 = 7.11 " " " "
OVERALL = 6.01 " " " "

SANDERSON & PORTER INC.

MONYMUSK
Clarendon Parish



Monymusk

The crop duration should be reduced to 130 days per season. Accordingly, an average grinding rate of 312 T.C.H. or about 7,500 T.C.D. based on the 1970 cane supply, must be obtained. Monymusk should remain a crystallizing unit. The following factors are to be considered to increase the grinding rate from 204 to 312 T.C.H.:

Milling: The speed of the mills should be increased from the present 49.9 f.p.m. to 55.0 f.p.m. The faster speed will require the utilization of 675 h.p. per mill instead of the present 600 h.p. The increased power delivery is within the capability of the existing steam turbines. The maximum speed for the first mill is estimated to be at 6.05 r.p.m. delivering 56.4 f.p.m. As the proposed grinding rate will require 55.0 f.p.m. at 5.9 r.p.m. no additional capital investment for milling appears to be necessary.

Juice Heaters: The present capacity of this station is somewhat insufficient to service the increased grinding rate. The juice velocity in the heaters, however, is rather low for the present cane grinding capacity (4.4 f.p.s.) and the increased grinding rate more than will correct this with a resulting increase in heat transmission rate. Therefore, the present station is adequate for servicing the proposed grinding rate.

Clarification: The present capacity of the clarifer is insufficient. A small polycell unit should be added. A 12 foot diameter unit could service 1,500 - 2,000 T.C.D. and would be adequate for reaching the increased T.C.D.

Similarly, the capacity of the filters will be too low. The installation of a new 10'x20' (625 square foot filtering area) is recommended. This will bring the station's capacity to 340 T.C.H.

Evaporation: Heat balance data reveals that the present quadruple effect is functioning very efficiently. This is mainly due to the bleeding of vapor from the #1, 2, and 3 vessels. However, the present installation will be too small to service the proposed grinding rate.

The most practical solution would be to convert the present installation into two quadruple effects; the first effect comprising the present 1a, 1b, 2a and 2b vessels, while two new vessels would be added to operate in conjunction with the present #3 and 4 vessels to form the second quadruple effect. The two new vessels each should have 7,500 square feet of heating surface.

The new arrangement will be comprised of:

Quadruple #1: 7,500+7,500+6,875+6,875 or 28,750 square feet total.

Quadruple #2: 10,000+7,500+7,500+7,500 or 32,500 square feet total.

About 20,000 pounds of vapor per hour can be obtained from the first vessel of quadruple #1 and about 5,000 pounds of vapor per hour can be bled from the second vessel of quadruple #2, for use by the juice heaters. The rest of the heaters will be supplied by exhaust steam.

Pan Floor: Tanks would have to be added as was suggested for the Frome installation. Five additional tanks, each having 750 cubic foot capacity would be needed for syrup while four additional tanks of the same size are needed for the A and B molasses. Also, one pan having 2,000 cubic foot massacuite capacity will have to be added.

Crystallizers: This station could handle the increased grinding rate fairly well.

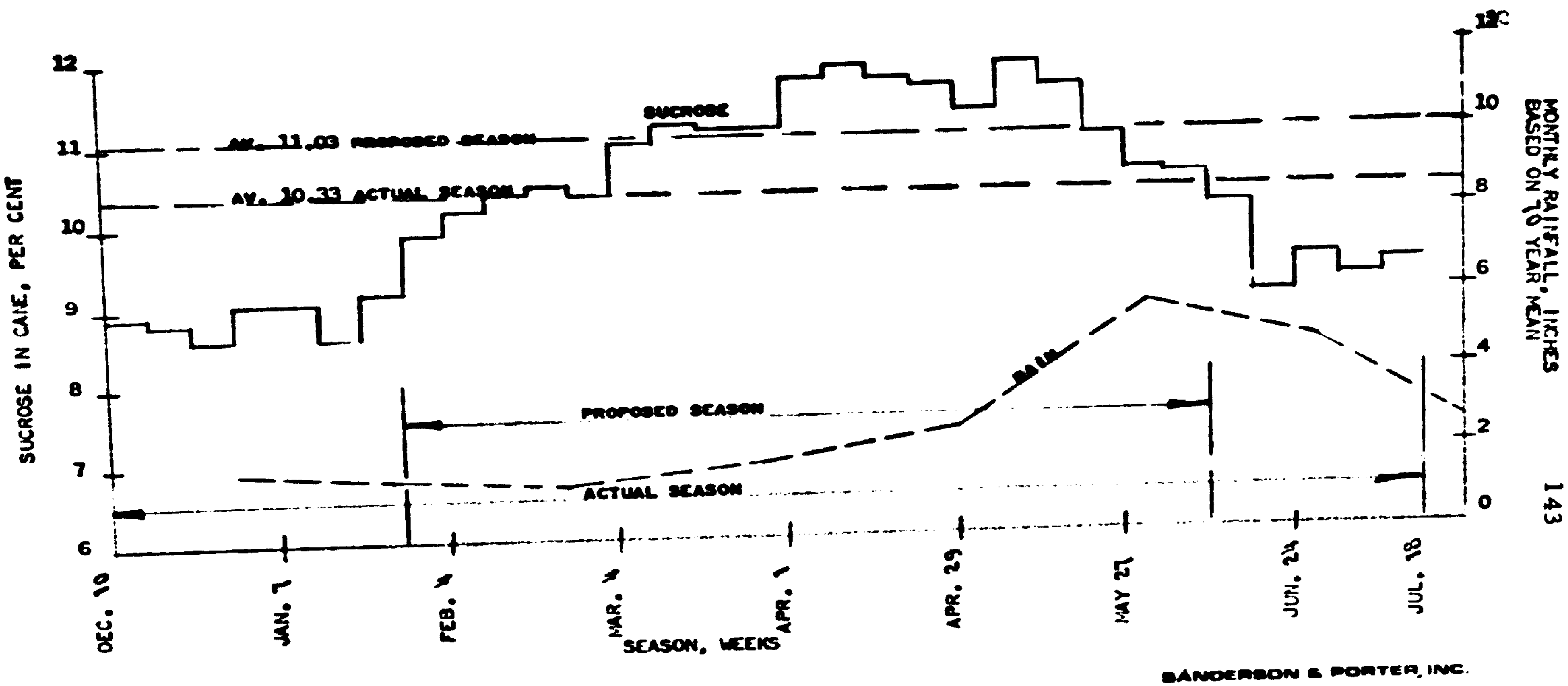
Centrifugals: The present capacity to service the expected increase in flow for A and B Massacuite is sufficient. The installation of one additional machine is preferred to handle the needed capacity for the C Massacuite.

Capital Cost: The cost to increase the different stations to the proposed grinding rate is estimated as follows:

Clarifier	$ 10,000
Filter	35,000
Evaporation, inclusive of pumping arrangement and condensor equipment	100,000
Pan floor supply tanks	5,000
Vacuum pan	45,000
Low grade centrifugal	20,000
Total	$215,000

MONYMUSK:
DISTRIBUTION OF PER CENT SUCROSE IN CANE DURING 1970 CROP SEASON

ACTUAL DURATION OF GRINDING SEASON - DEC. 10-JULY 18=220 DAYS
PROPOSED " " " " FEB. 1-JUNE 10=130 DAYS



/SANDERSON & PORTER, INC.

MONYMUSK: MATERIAL BALANCE SHOWING QUANTITIES OF INTERMEDIATE AND FINAL PRODUCTS PER TIME UNIT DURING THE 1970 CROP SEASON

PURITY MIXED JUICE: 77.27

Material	Per Cent Cane	Pounds/ Cubic Feet	Per Minute Pounds	Per Minute Cubic Feet	Per Minute Gallons	Per Hour Pounds	Per Hour Tons
Cane	100.00	25.00	7,605	[illegible]04.2	-	456,310	203.71
Bagasse	30.85	5.00	2,346	469.2	-	140,771	62.80
Imbibition	16.14	62.00	1,228	19.8	148	73,648	32.90
Mixed Juice	85.29	65.84	6,486	90.5	737	389,187	173.74
Milk of Lime	.50	67.00	38	0.6	4.5	2,281	1.02
Limed Juice	85.79	65.84	6,524	99.0	741	391,468	174.76
Mud to Filter	15.50	66.00	1,180	17.9	134	70,728	31.60
Mud	2.77	85.00	211	2.5	19	12,640	5.64
Wash Water	3.00	62.00	288	3.7	28	13,689	6.11
Filtrate	15.73	65.30	1,197	18.3	137	71,777	32.04
Clarified Juice	70.29	65.87	5,347	81.2	607	320,740	143.19
Juice to Evaporator	86.02	65.77	6,432	97.8	732	392,515	175.23
Syrup	22.05	78.24	1,677	21.4	160	100,598	44.90
Evaporation	63.97	62.00	4,866	78.5	587	291,917	130.33
MCA	9.93	93.86	756	11,590 cu. ft/day		45,327	20.23
Sugar A	4.67	53.00	355	6.7	-	21,314	9.51
Molasses A	5.26	91.56	400	4.4	33	24,013	10.72
Dil. Mol. A	6.71	83.70	511	6.1	46	30,641	13.68
MCB	8.16	94.80	621	9.433 cu. ft/day		37,261	16.63
Sugar B	3.39	53.00	258	4.9	-	15,462	6.90
Molasses B	4.77	93.35	363	3.9	29	21,799	9.73
Dil Mol. B	6.27	84.17	477	5.7	43	28,627	12.78
MCC	6.09	95.27	463	7,003 cu. ft/day		27,801	12.4'
Sugar C	2.80	54.00	213	3.9	-	12,788	5.71
Magma	3.47	92.33	264	2.9	22	15,844	7.07
Final Molasses	3.29	89.19	250	2.8	21	15,013	6.70

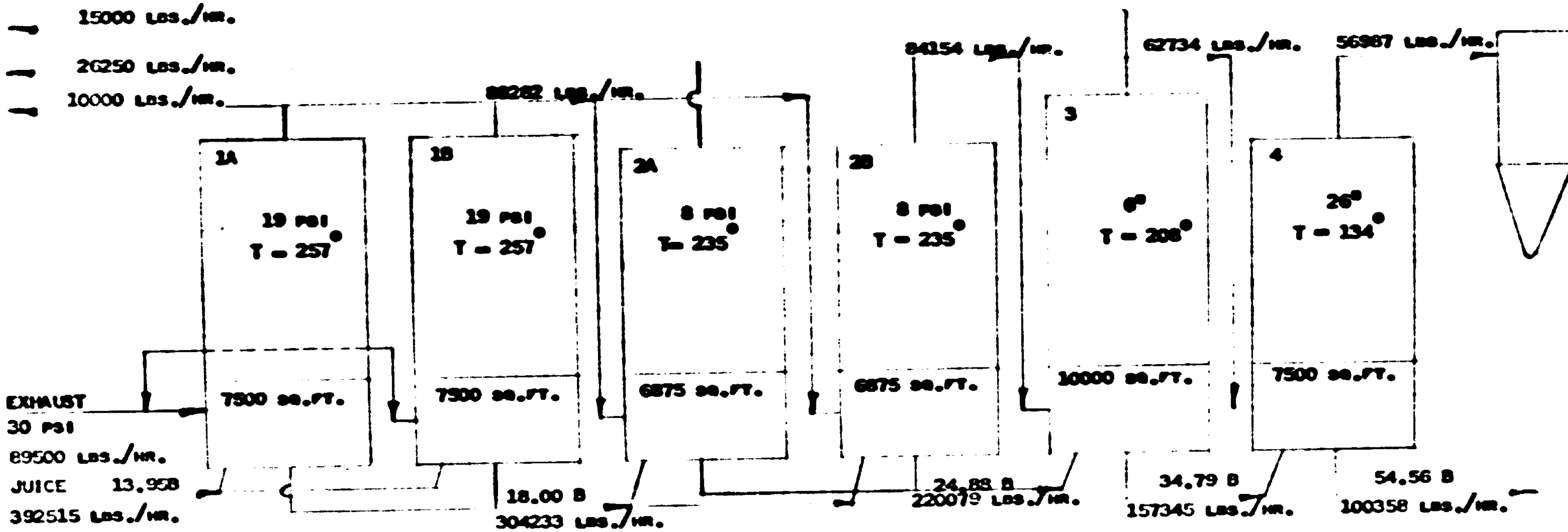
MONYMUSK: ACTUAL CAPACITY IN TONS CANE PER DAY FOR MAIN EQUIPMENT IN EACH PROCESSING STATION

Station	Average T. C. D.
Milling tandems	6,800
Juice heaters	7,200
Clarifiers	5,000
Filters	4,512
Evaporators	5,000
Vacuum pans	6,550
Supply tanks for syrup	3,744
Supply tanks for A and B molasses	4,598
C crystallizers	6,920
High grade centrifugals	7,585
Low grade centrifugals	6,720

MONYMUSK: HEAT BALANCE FOR EVAPORATION STATION SHOWING THE STEAM CONSUMPTION IN B. T. U. NEEDED TO OBTAIN THE PRESENT DEGREE OF EVAPORATION IN EACH VESSEL

Calculation for Flow of Heat	Heat Content B. T. U.	Evaporation Pounds Per Hour	Juice Per Cent Brix
#1 Juice to #1		392,515	13.95
Exhaust to # 1 (30 psi) 89500 x 928.2	83,073,900		
Available for Evaporation	83,073,900		
Evaporation 83073900 -:- 941		88,282	
Transfer to # 2		304,233	18.00
# 2 To Heaters 10,000 x 941	9,410,000		
Balance	73,663,900		
Add Flash 304233 (257-235)	6,703,972		
Available for Evaporation	80,367,872		
Evaporation 80,367,872 -:- 955		84,154	
Transfer to # 3		220,079	24.88
# 3 Vapor from # 2	80,367,872		
To Heaters 26250 x 955	25,068,875		
Balance	55,298,997		
Add Flash 220079 (235-208)	5,942,133		
Available for Evaporation	61,241,130		
Evaporation 61,241,230 -:- 976.2		62,734	
Transfer to # 4		157,345	34.70
# 4 Vapor from #3	61,241,130		
To Heaters 15,000 x 976,2	14,643,000		
Balance	46,598,130		
Add Flash 157,345 (208-134)	11,643,530		
Available for Evaporation	58,241,660		
Evaporation 58,241,660 -:- 1022		56,987	
Out of # 4		100.00	54.56

MONYMUSK: HEAT BALANCE DIAGRAM SHOWING EVAPORATOR INPUT AND OUTPUT OF STEAM, JUICE, VAPOR AND SYRUP, BASED ON HEAT BALANCE CALCULATIONS



EVAPORATION RATE #1 = 6.55 LBS./SQ.FT./HR.
#2 = 8.02 " " " "
#3 = 7.77 " " " "
#4 = 7.59 " " " "
OVERALL = 7.48 " " " "

SANDERSON & PORTER, INC.

OVERALL 5.79 " " "

/SANDERSON & PORTER, INC.

NEW YARMOUTH
Clarendon Parish

New Yarmouth

It is recommended to shorten the crop duration of New Yarmouth to 134 days per season. To process the cane tonnage, the grinding rate would have to be increased from the present to 120 T. C. H. or 2,880 T. C. D. Also, New Yarmouth should remain a sugar crystallizing unit. The proposed cane grinding rate will prove beneficial to the steam requirement of the factory as well as the adjoining distilling operations due to the increased availability of bagasse.

The following points should be noted:

Milling: The present milling tandem has just enough power and capacity to reach the proposed cane grinding rate.

Juice Heaters: The juice heaters have sufficient capacity for the future cane grinding rate.

Clarification: The present clarifier is too small. A possible solution would be to modify the present clarifier into a polycell type unit, or to add another small polycell type unit.

The capacity of the filtration station will be somewhat small. The resulting moderate increase in loss of sucrose of the filter mud will not warrant investment for an additional unit.

Evaporators: The present capacity of this station would be too small to handle the proposed cane grinding. A new dead-ended vessel (vapor cell) should be installed. The vapor cell, with a 2,500 square foot heating surface, is supplied by 25 p.s.i. exhaust steam and will exhaust vapor at about 10 p.s.i. for feeding the vacuum pans. A vapor connection to the rest of the evaporation station will not be possible since the vapor cell is dead-ended.

A free vapor exhausting arrangement should be provided in the event the vacuum pans become inoperative. Otherwise the evaporation rate of the vapor cell will be significantly reduced.

Vacuum Pans: Either a new pan should be added or an existing small pan should be replaced by a larger unit. The latter is preferred because there are fewer complications in securing the structural support and available spacing. A pan having a capacity of 1,400 cubic feet and a heating surface of 2,500 square feet is recommended for this purpose. In order to provide adequate capacity for syrup and molasses storage a second floor of tanks should be erected.

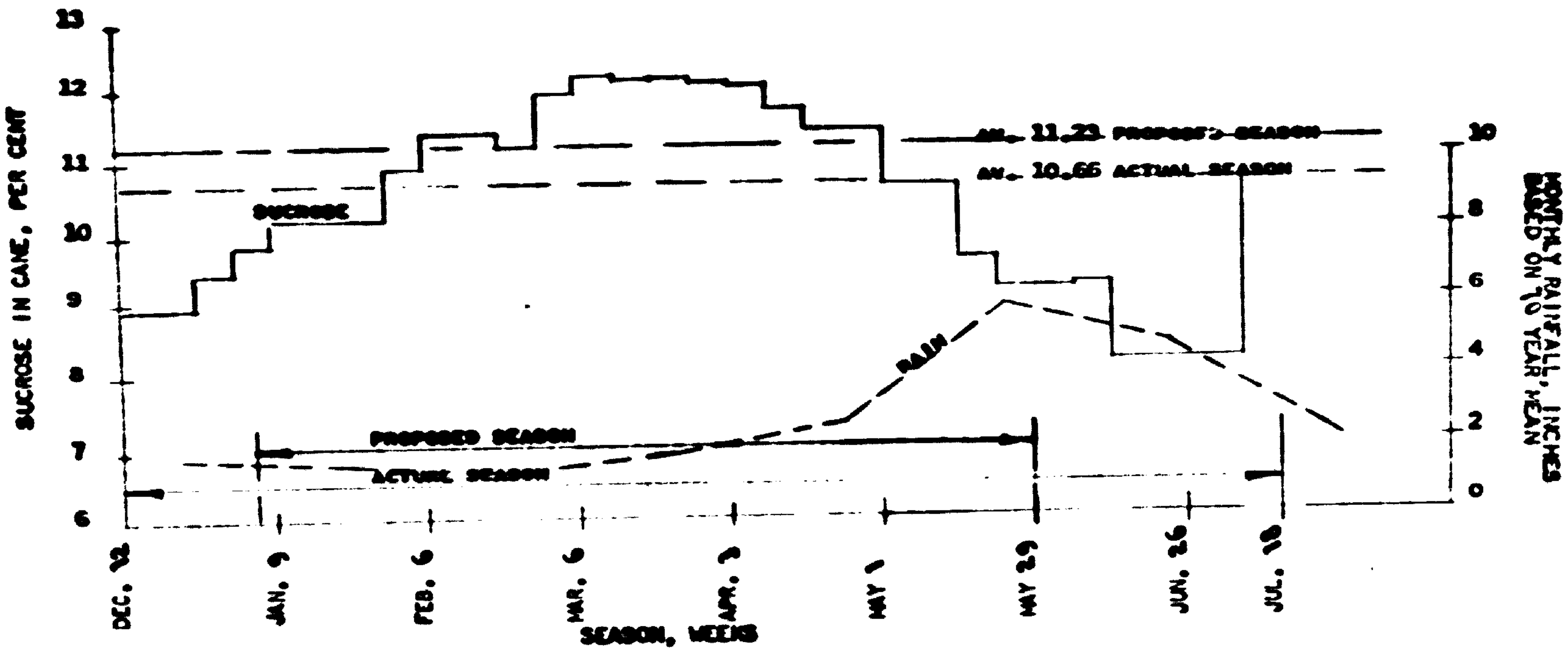
C Crystallizers: Enough capacity is available.

Centrifugals: The present capacity of the high grade as well as the low grade centrifugal stations is adequate to meet the proposed cane grinding rate.

Capital Costs: A total estimated cost of $56,000 ($8,000, $15,000, $25,000 and $8,000 for clarifier, evaporator, vacuum pans and syrup supply tanks, respectively) is needed to effect the proposed changes.

NEW YARMOUTH:
DISTRIBUTION OF PER CENT SUCROSE IN CANE DURING 1970 CROP

ACTUAL DURATION OF GRINDING SEASON-DEC. 18-JUL. 18 OR 219 DAYS
PROPOSED " " " JAN. 16-MAY 29 OR 134 DAYS



SANDERSON & PORTER, INC.

OVERALL 5.79 " " "

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NEWYARMOUTH: MATERIAL BALANCE SHOWING QUANTITIES OF INTERMEDIATE AND FINAL PRODUCTS MANUFACTURED PER TIME UNIT DURING THE 1970 CROP SEASON

PURITY MIXED JUICE: 79.50

Material	Per Cent Cane	Pounds Cubic Feet	Per Minute Pounds	Per Minute Cubic Feet	Per Minute Gallons	Per Hour Pounds	Per Hour Tons
Cane	100.00	25.00	3,323	132.92	-	199,338	88.99
Bagasse	30.56	5.00	1,017	203.40	-	60,929	27.20
Imbibition	16.11	62.00	536	8.64	65	32,113	14.35
Mixed Juice	85.55	65.86	2,848	43.24	323	170,522	76.12
Milk of Lime	0.50	67.00	17	0.25	2	997	0.44
Limed Juice	86.05	65.87	2,864	43.47	325	171,519	76.66
Mud to Filter	15.50	66.15	516	7.80	58	30,897	13.79
Mud	2.84	68.54	94	1.37	10	5,661	2.53
Wash Water	3.00	62.00	100	1.61	12	5,980	2.67
Filtrate	15.66	64.96	521	8.02	60	31,216	13.95
Clarified Juice	70.55	65.81	2,348	35.67	267	140,633	62.78
Juice to Evaporator	86.21	65.82	2,870	43.60	326	171,849	76.71
Syrup	19.90	80.65	662	8.20	61	39,687	17.72
Evaporation	66.37	62.00	2,207	35.59	266	132,162	59.00
MCA	10.69	92.34	356	5,542 cu. ft/day		21,323	9.52
Sugar A	4.62	53.00	154	2.90	-	9,212	4.11
Molasses A	6.07	89.32	202	2.26	17	12,111	5.41
Dil. Mol. A	7.21	84.04	240	2.85	21	14,368	6.41
MCB	11.22	92.02	367	5,731 cu. ft/day		21,973	9.81
Sugar B	3.97	53.00	132	2.49	-	7,912	3.53
Molasses B	7.05	89.63	235	2.62	20	14,061	6.28
Dil. Mol. B	8.44	84.04	281	3.34	25	16,817	7.51
MCC	6.59	93.72	219	3.365 cu. ft/day		13,141	5.87
Sugar C	2.76	54.00	92	1.70	-	5,506	2.46
Magma	3.57	92.33	119	1.28	10	7,127	3.18
Final Molasses	3.90	91.32	130	1.42	11	7,774	3.47

OVERALL 5.79

/SANDERSON & PORTER, INC.

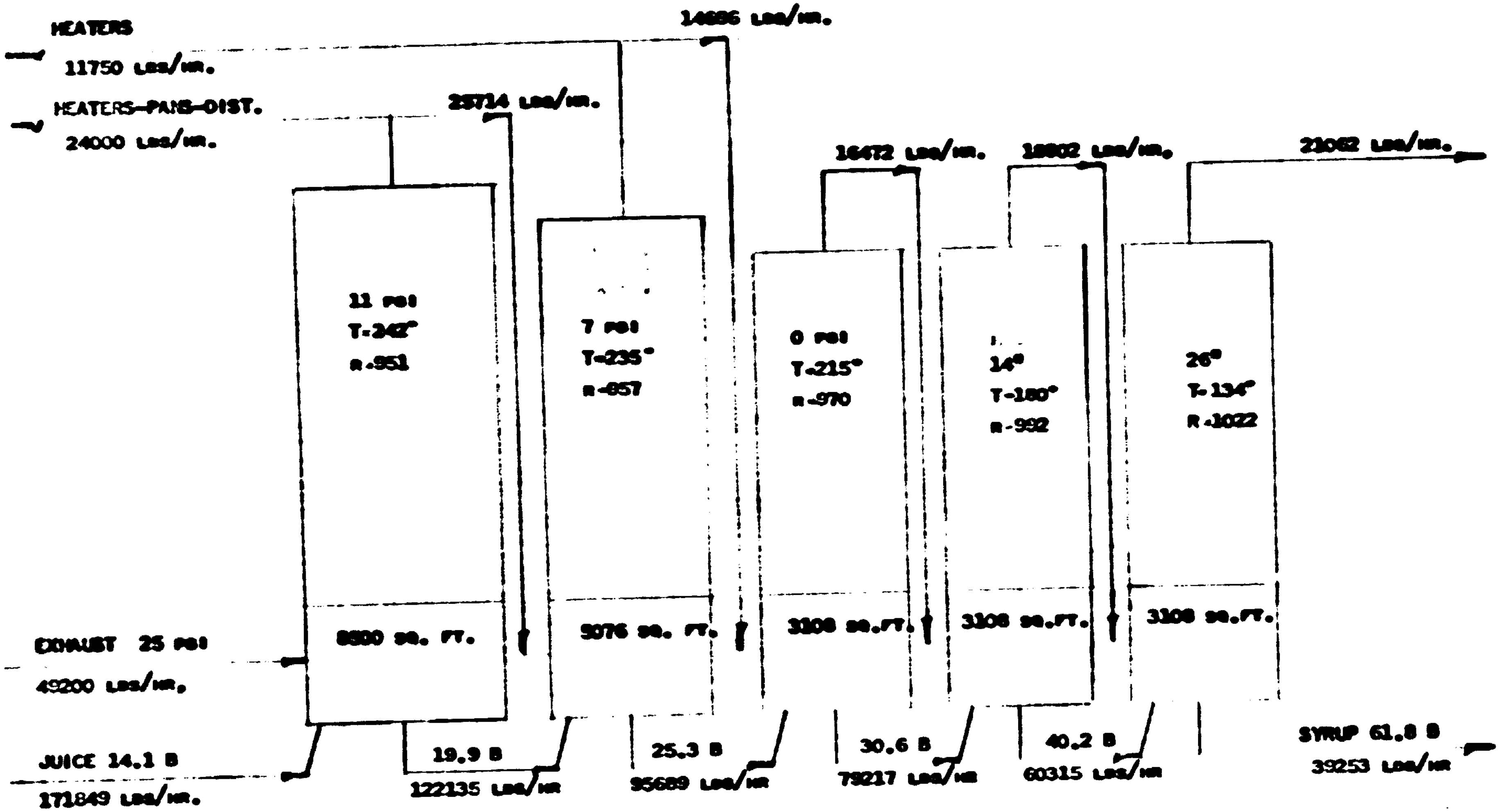
NEW YARMOUTH: ACTUAL CAPACITY IN TONS CANE PER DAY FOR MAIN EQUIPMENT IN EACH PROCESSING STATION.

Station	Capacity T. C. D.
Mills	2,600
Juice heaters	3,850
Clarifiers	1,735
Filters	1,650
Evaporators	2,280
Vacuum pans	2,160
Syrup supply tanks	1,440
A and B molasses tanks	1,200
C crystallizers	4,000
High grade centrifugals	3,100
Low grade centrifugals	3,025

NEW YARMOUTH: HEAT BALANCE FOR THE EVAPORATION STATION SHOWING THE STEAM CONSUMPTION IN B.T.U. NEEDED TO OBTAIN THE PRESENT DEGREE OF EVAPORATION IN EACH VESSEL

	Calculations for Flow of Heat	Heat Content B.T.U.	Evaporation Pounds per Hour	Juice Per Cent Brix
#1	Juice to #1		171,849	14.12
	Exhaust to #1 (25 psi) 49,200 x 933	45,903,600		
	Add flash from heater 171,849 (250-242)	1,374,792		
	Available for Evaporation	47,278,392		
	Evaporation 47,278,392 -:- 951		49,714	
	Transfer to #2		122,135	19.86
#2	Vapor from #1	47,278,392		
	Deduct for heaters etc. 24,000x951	22 824,000		
	Balance	24,454 392		
	Add flash. 122.135 (242-235)	854,945		
	Available for Evaporation	25,309,337		
	Evaporation 25,309.337 -:- 957		26,446	
	Transfer to # 3		95,689	25.35
#3	Vapor from #2	25,309,337		
	Deduct for heater 11,750 x 957	11,244,750		
	Balance	14,064,587		
	Add flash 95,689 (235-215)	1,913,780		
	Available for Evaporation	15,978,367		
	Evaporation 15,978,367 -:- 970		16,472	
	Transfer to # 4		79,217	30.63
#4	Vapor from #3	15,978,367		
	Add flash. 79,217 (215-180)	2,772,595		
	Available for Evaporation	18,750,962		
	Evaporation 18,750,962 -:- 992		18,902	
	Transfer to # 5		60,315	40.23
#5	Vapor from # 4	18,750,962		
	Add flash 60,315 (180-134)	2,774,490		
	Available for Evaporation	21,525,452		
	Evaporation 21,535,452 -:- 1.022		21,062	
	Leaving # 5 as Syrup		39,253	61.81

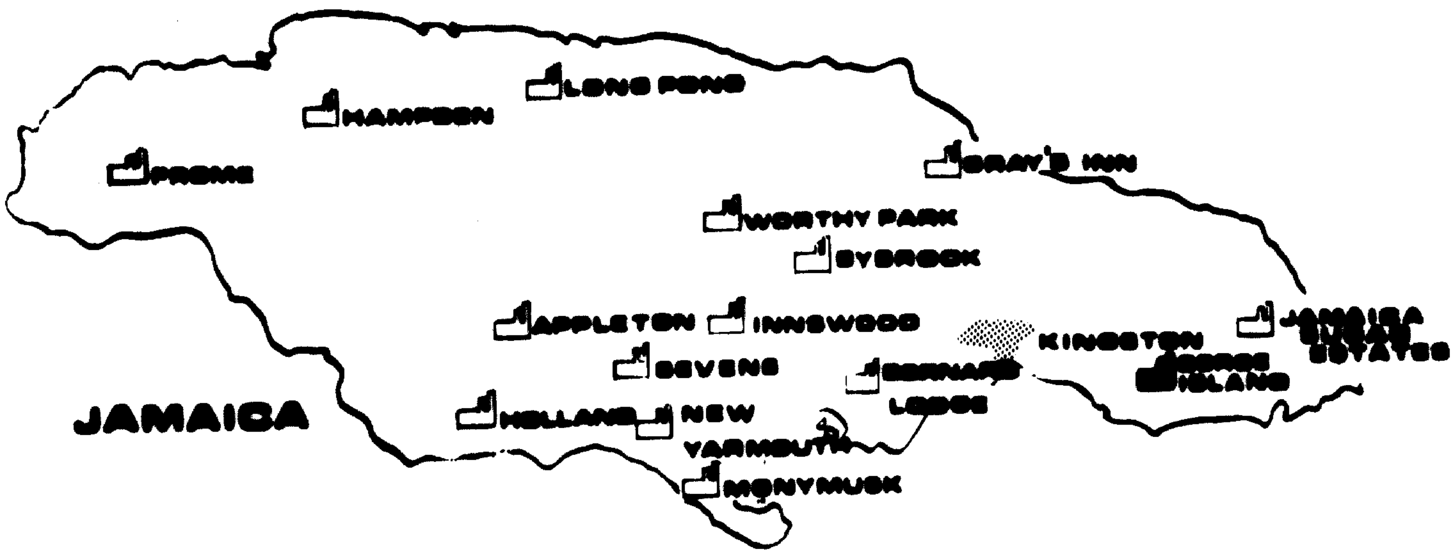
NEW YARMOUTH: HEAT BALANCE DIAGRAM SHOWING INPUT AND OUTPUT OF STEAM, JUICE, VAPOR AND SYRUP, BASED ON HEAT BALANCE CALCULATIONS



EVAPORATION RATE	#1	5.84	LBS/SQ.FT./HR.
	#2	5.21	" " "
	#3	5.29	" " "
	#4	6.08	" " "
	#5	6.77	" " "
	OVERALL	5.79	" " "

/SANDERSON & PORTER, INC.

SERGE ISLAND
Saint Thomas Parish



Serge Island

This factory should be converted to a syrup producing unit, the crop duration reduced to 155 days, and the grinding rate reduced to 32 T. C. H. or 1, 100 T. C. D. The following considerations should be given to reach the grinding rate of 1, 100 T. C. D. for this syrup producing unit:

Mills: Tandem capacity is limited due to the inadequate power of the engine driving the last mill. The other mills are sufficiently powered. The "Fletcher" engine now driving the last mill should be replaced by a steam turbine of 250 h. p., complete with gear reduction to bring the milling tandem to the required capacity.

Juice Heaters: Sufficient capacity is available to attain the new cane grinding rate.

Clarification: Both the clarifier and the filter have adequate capacity for the proposed cane grinding rate.

Evaporators: The present capacity is sufficient providing the system for operation of this station will be changed. From the heat balance diagram, it can be seen that the quantity of vapor bleeding from vessel #1 to the heaters is much larger than the heating surface the vessel can provide. Thus, only a limited amount of vapor can be supplied to vessel #2 and the rest of the evaporation station.

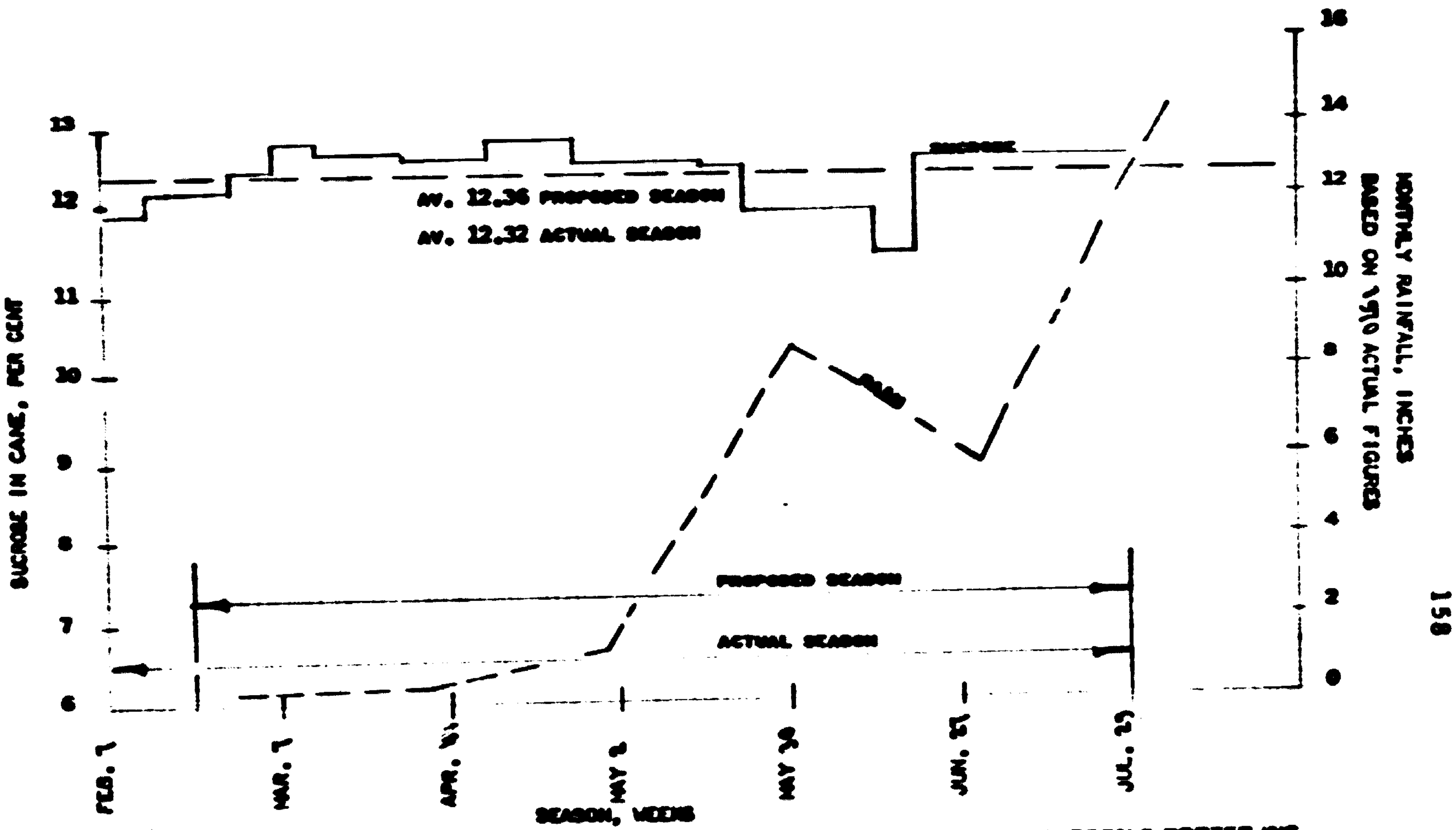
To correct this situation all vapor produced by vessel #1 should be used by the rest of the vessels of this station. In this case the juice heaters, as well as the flash evaporator for concentrating syrup to 72 degrees Brix, should be supplied with exhaust steam. This arrangement should work satisfactorily since no steam supply would be needed for the pans.

Capital Costs: An estimated $50,000 is needed for the last mill's turbine including the required gear reduction.

<u>SERGE ISLAND:</u>

DISTRIBUTION OF PER CENT SUCROSE IN CANE DURING 1970 CROP

ACTUAL DURATION OF GRINDING SEASON FEB. 7-JUL. 25 OR 165 DAYS
PROPOSED " " " FEB. 21-JUL. 25 OR 155 DAYS



SANDERSON & PORTER, INC.

SERGE ISLAND: MATERIAL BALANCE SHOWING QUANTITIES OF INTERMEDIATE AND FINAL PRODUCTS MANUFACTURED PER TIME UNIT DURING THE 1970 CROP SEASON

PURITY MIXED JUICE: 80.27

Material	Per Cent Cane	Pounds Cubic Feet	Per Minute Pounds	Per Minute Cubic Feet	Per Minute Gallons	Per Hour Pounds	Per Hour Tons
Cane	100.00	25.00	1,719	68.76	-	103,107	46.03
Baggasse	38.11	5.00	656	131.40	-	39,294	17.54
Imbibition	22.88	62.00	394	6.35	47	23,591	10.53
Mixed Juice	84.77	66.35	1,457	21.95	164	87,404	39.02
Milk of Lime	0.50	67.00	9	0.13	1	515	0.23
Limed Juice	85.27	66.35	1,466	22.09	165	87,919	39.25
Mud to Filter	15.50	66.54	267	4.01	30	15,982	7.13
Mud	2.04	68.58	35	0.51	-	2,103	0.94
Wash Water	3.00	62.00	52	0.83	6	3,093	1.38
Filtrate	16.46	65.48	283	4.32	32	16,972	7.58
Clarified Juice	69.77	66.33	1,201	18.10	135	71,937	32.12
Juice to Evaporator	86.23	66.41	1,483	22.33	167	88,909	39.69
Syrup	21.58	82.20	371	4.51	34	22,251	9.93
Evaporation	64.65	62.00	1,112	17.93	134	66,658	29.76
MCA	10.55	92.77	182	2,815 cu. ft/day		10,882	4.86
Sugar A	5.03	53.00	87	1.64	-	5,190	2.32
Molasses A	5.53	89.41	95	1.06	8	5,712	2.55
Dil. Mol. A	6.58	84.04	113	1.34	10	6,790	3.03
MCB	11.84	93.21	204	3,144 cu. ft/day		12,209	5.45
Sugar B	4.65	53.00	80	1.50	-	4,800	2.14
Molasses B	7.20	91.10	124	1.36	10	7,429	3.32
Dil. Mol. B	8.96	84.04	154	1.83	14	9,242	4.13
MCC	8.27	93.65	142	2,186 cu. ft/day		8,532	3.81
Sugar C	3.54	54.00	61	1.12	-	3,657	1.63
Magma	4.76	92.33	82	0.88	7	4,910	2.19
Final Molasses	4.84	90.93	83	0.91	7	4,992	2.23

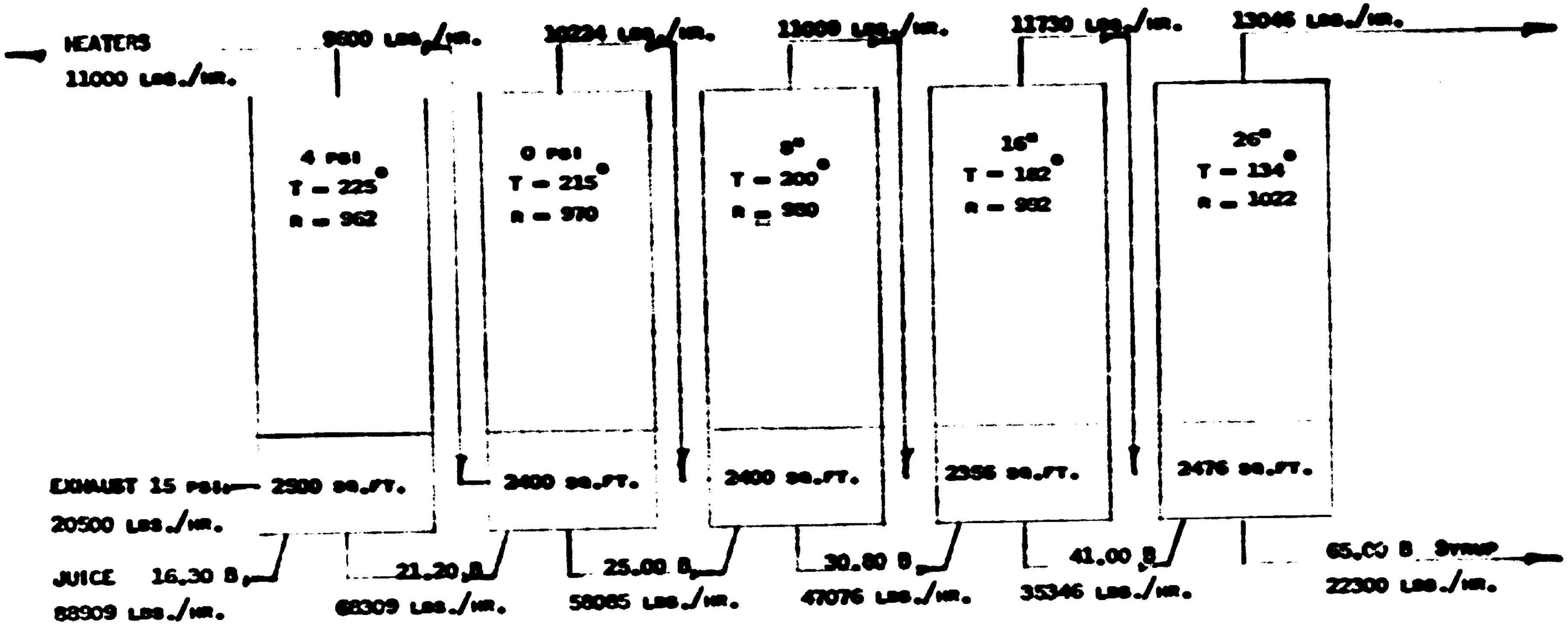
SERGE ISLAND. ACTUAL CAPACITY IN TONS CANE PER DAY FOR MAIN EQUIPMENT IN EACH PROCESSING STATION.

Station	Capacity in T. C. D.
Mills	985
Juice heaters	1,770
Clarifiers	1,215
Filters	1,535
Evaporators	1,200
Vacuum pans	1,510
Syrup supply tanks	648
A and B molasses tanks	385
C crystallizers	1,320
High grade centrifugals	1,970
Low grade centrifugals	1,600

SERGE ISLAND: HEAT BALANCE FOR THE EVAPORATION STATION SHOWING THE STEAM CONSUMPTION IN B. T. U. NEEDED TO OBTAIN THE PRESENT DEGREE OF EVAPORATION IN EACH VESSEL

Cauculation for Flow of Heat	Heat Content B. T. U.	Evaporation Pounds per Hour	Juice Per Cent Brix
#1) Juice to # 1		88, 909	16. 32
Exhaust to #1 20, 500x945	19, 372, 500		
Add flash from heater 88, 909 (230-225)	444, 545		
Available for Evaporation	19, 817, 045		
Evaporation 19, 817, 045 -:- 962		20, 600	
Transfer to #2		68, 309	21.24
#2) Vapor from #1	19, 817, 045		
Deduct for heater 11, 000 x 962	10, 582, 000		
Balance	9, 235, 045		
Add flash 68, 309 (225-215)	683, 090		
Available for Evaporation	9, 918, 135		
Evaporation 9, 918, 135 -:- 970		10, 224	
Transfer to # 3		58, 085	24. 98
#3) Vapor from #2	9, 918, 135		
Add flash 58, 085 (215-200)	871, 275		
Available for Ecaporation	10, 789, 410		
Evaporation 10, 789, 410-:- 980		11, 009	
Transfer to #4		47, 076	30. 82
#4) Vapor from #3	10, 789, 410		
Add flash 47, 076 (200-132)	847, 368		
Available for Evaporation	11, 636, 778		
Evaporation 11, 636, 778-:- 992		11, 730	
Transfer to # 5		35, 346	41. 05
#5) Vapor from #4	11, 636, 778		
Add flash 35, 346 (182-134)	1, 696, 608		
Available for Evaporation	13, 333, 386		
Evaporation 13, 333, 336 -:- 1. 022		13, 046	
Leaving #5 as syrup		22, 300	65. 06

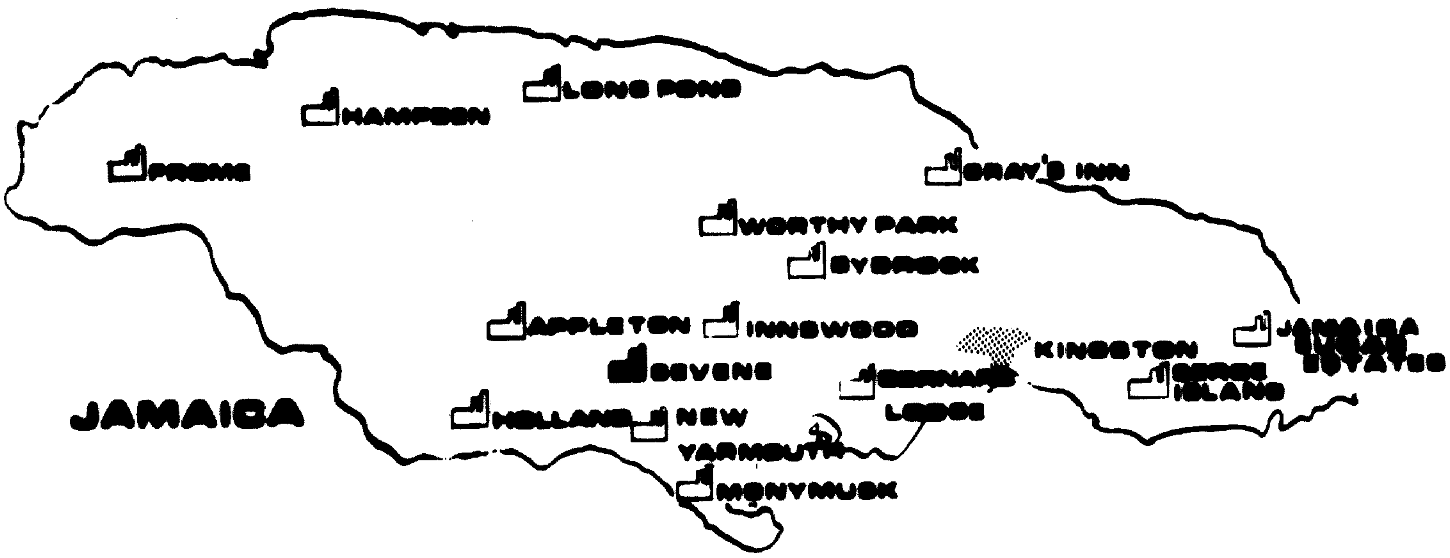
SERGE ISLAND: HEAT BALANCE DIAGRAM SHOWING INPUT AND OUTPUT OF STEAM, JUICE, VAPOR AND SYRUP BASED ON HEAT BALANCE CALCULATIONS



EVAPORATION RATE	#1 =	8.24	LBS./SQ.FT./HR.
	#2 =	4.26	" " " "
	#3 =	4.58	" " " "
	#4 =	4.97	" " " "
	#5 =	5.26	" " " "
OVERALL	=	5.48	" " " "

SANDERSON & PORTER, INC.

SEVENS
Clarendon Parish



Sevens

According to the distribution of sucrose in cane, and to optimize sugar production, the crop season should be reduced from the present 258 days to 139 days. The reduced crop season would signal an increase in the grinding rate from the present 90 T.C.H. to 130 T.C.H. or 3,120 T.C.D. and Sevens should remain a sugar producing plant.

The following factors for reaching the proposed cane grinding capacity are to be considered:

Milling: The present linear speed of the mill rollers is too low. Linear speed must be increased from 39 to 49 f.p.m. (assuming 14 per cent fiber in cane) which will require 375 h.p. per mill.

The third and fourth mills are driven by a 1,000 h.p. steam turbine and as a result are adequately powered. The first mill (actually a three roller crusher) and the second mill are powered by a 650 h.p. steam engine, which is in poor condition. This unit is underpowered and should be replaced by a turbine identical to the one now driving the third and fourth mills.

With the proper mill settings and with the suggested speed, it is recommended to install feeder rolls in front of each mill. Presently, only the last mill has a feeder roll while the crusher has an underfeeder (Mayo type).

As the sugar extraction may become somewhat low with the suggested cane grinding rate and roller speed, the installation of a new mill complete with gears and an independent 400 h.p. steam turbine placed at the end of the milling tandem should be considered.

Because of cost, installation of an additional mill is preferred over a diffusion plant since the present milling tandem is fairly new and in relatively good condition. Future improvements may involve changing the three roller crusher into a mill, and installing a shredder in front of the tandem.

Juice Heaters: The juice heater station has adequate capacity to service the proposed grinding rate.

Clarification: Presently six trays and 44 polycell elements are installed in the "Bach" clarifier. The addition of another 16 cone trees, thus increasing the number to 60 trees, is recommended. This change, together with the newly installed "Graver" clarifier should attain the proposed cane grinding rate. The presently installed combination of a polycell "Bach" and "Graver" clarifier is not an ideal situation as the retention time required for juice differs for each type of installation.

Normally, the 8'x16' vacuum filter is capable of handling 2,500-3,000 T.C.D. In the past, the per cent of cake on cane weight has been relatively high for Sevens. This probably has been due to the small capacity of the clarifier station. With the installation of the "Graver" this situation would be remedied and no radical changes in the filter station are anticipated.

Evaporators: The present evaporation station, consisting of a vapor cell with a quadruple effect (five vessels) performs effectively. An increase in the heating surface for the fourth and fifth vessel of the quadruple effect is recommended. The present tubes are rather short (5'-6') and by adding a 1'-6" belt to the calandria, 7' tubes can be accommodated. An increase of 845 square feet for each vessel or a total increase of 1,700 square feet in heating surface would be the result.

The change in tube length may have a two-fold effect: First, it would increase the overall heating surface of the evaporation station and effect a 7 per cent gain in performance. Secondly, the longer tubes would increase juice velocity in the pipes. The present juice velocity in the short pipes is rather low, possibly accounting for the heavy incrustations experienced by Sevens. The installation of seven foot tube lengths and the improvement in juice velocity may result in a reduction of these incrustations.

Vacuum Pans: The present capacity will be adequate to service the proposed cane grinding rate.

The capacity of the storage tanks for syrup and molasses is insufficient. Present capacity should be doubled by installing a second level of tanks above the existing ones.

Crystallizers: The crystallizers have adequate capacity to obtain the proposed grinding rate.

Centrifugals: The high grade centrifugals are of adequate capacity but the capacity for the low grade centrifugals is insufficient. Using screens with a larger open area may bring the capacity of the low grade centrifugals to adequacy.

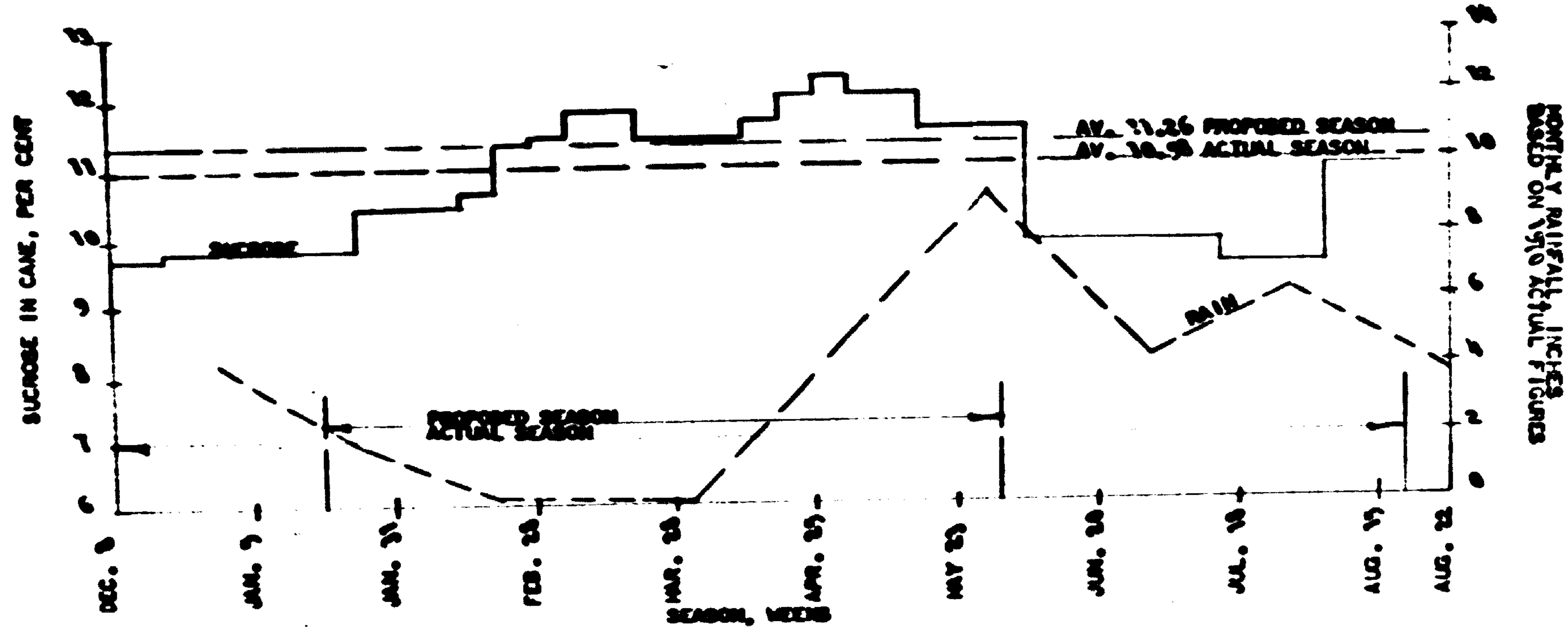
Capital Costs: The following costs are estimated to upgrade Sevens and allow it to produce the proposed grinding rate:

One 1,000 h.p. turbine, complete with gears and installation	$ 60,000
Feeder Rolls	8,000
One mill, complete with 400 h.p. turbine, gears and installation	90,000
Seven foot Stainless Steel Tubes for fourth and fifth vessel of quadruple effect	20,000
Supply Tanks for syrup and molasses	8,000
Total	$186,000

SEVENS:

DISTRIBUTION OF PER CENT SUCROSE IN CANE DURING 1970 CROP

ACTUAL DURATION OF GRINDING SEASON-DEC. 8- AUG. 22 OF 258 DAYS
PROPOSED " " " JAN. 6- JUN. 6 OR 139 DAYS



SANDERSON & PORTER, INC.

SEVENS: MATERIAL BALANCE SHOWING QUANTITIES OF INTERMEDIATE AND FINAL PRODUCTS MANUFACTURED PER TIME UNIT DURING THE 1970 CROP SEASON

PURITY MIXED JUICE: 77.06

Material	Per Cent Cane	Pounds Cubic Feet	Per Minute Pounds	Per Minute Cubic Feet	Per Minute Gallons	Per Hour Pounds	Per Hour Tons
Cane	100.00	25.00	3,349	153.96	-	200,906	89.69
Bagasse	31.98	5.00	1,073	214.60	-	64,250	28.68
Imbibition	14.70	62.00	493	7.95	59	29,533	13.18
Mixed Juice	82.72	66.18	2,770	41.85	313	166,189	74.19
Milk of Lime	0.50	67.00	17	0.25	2	1,005	0.45
Limed Juice	83.22	66.18	2,787	42.11	315	167,194	74.64
Mud to Filter	15.50	66.45	520	7.82	58	31,140	13.90
Mud	4.27	69.80	143	2.04	-	8,579	3.83
Wash Water	3.00	62.00	101	1.62	12	6,027	2.69
Filtrate	14.23	64.60	477	7.38	55	28,588	12.76
Clarified Juice	67.72	66.14	2,268	34.29	256	136,054	
Juice to Evaporator	81.95	66.19	2,750	41.54	311	164,642	60.73
Syrup	21.00	80.47	705	8.76	66	42,193	18.83
Evaporation	60.95	62.00	2,045	32.98	247	122,449	54.66
MCA	9.87	93.65	331	5,083 cu. ft/day		19,835	8.85
Sugar A	4.07	53.00	137	2.58	-	8,178	3.65
Molasses A	5.95	90.77	200	2.20	16	11,956	5.34
Dil. Mol. A	7.34	84.04	246	2.92	22	14,757	6.59
MCB	10.38	94.10	348	5,322 cu. ft/day		20,868	9.32
Sugar B	4.13	53.00	138	2.60	-	8,300	3.71
Molasses B	6.39	91.70	214	2.33	17	12,855	5.74
Dil. Mol. B	8.08	84.04	271	3.22	24	16,252	7.25
MCC	7.19	94.55	241	3,669 cu. ft/day		14,456	6.45
Sugar C	3.04	54.00	102	1,88	-	6,120	2.73
Magma	3.92	92.33	132	1.42	11	7,889	3.52
Final Molasses	4.32	91.76	145	1.58	12	8,689	3.88

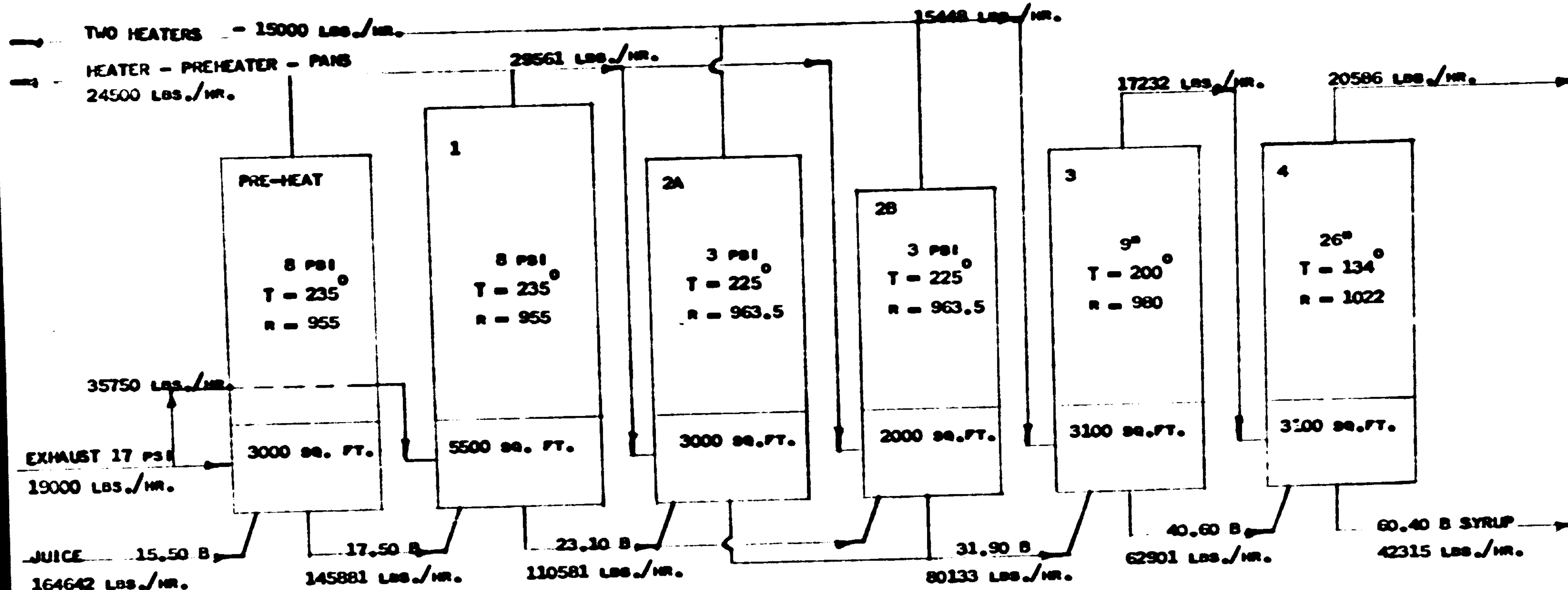
SEVENS: ACTUAL CAPACTIY IN TONS CANE PER DAY FOR MAIN EQUIPMENT IN EACH PROCESSING STATION.

Station	Capacity T. C. D.
Mills	2,472
Juice heaters	4,278
Clarifiers	2,715
Filters	1,464
Evaporators	2,425
Vacuum pans	2,620
Syrup supply tanks	1,000
A and B molasses tanks	1,392
C crystallizers	3,675
High grade centrifugals	3,385
Low grade cent rifugals	2,800

SEVEN: HEAT BALANCE FOR THE EVAPORATION STATION SHOWING THE STEAM CONSUMPTION IN B. T. U., NEEDED TO OBTAIN THE PRESENT DEGREE OF EVAPORATION IN EACH VESSEL.

	Calculation for Flow of Heat	Heat Content B. T. U.	Evaporation Pounds per Hour	Juice Per Cent Brix
pre)	Juice to pre		164,642	15.53
	Exhaust to pre 19,000 x 943	17,917,000		
	Available for Evaporation	17,917,000		
	Evaporation 17,917,000 -:- 955		18,761	
	Transfer to #1		145,881	17.52
#1)	Exhaust to #1 35,750, x 943	33,712,250		
	Available for Evaporation	33,712,250		
	Evaporation 33,712,250 -:- 955		35,300	
	Transfer to #2		110,581	23.12
#2)	Vapor from #1	33,712,250		
	Deduct for heaters 5,739 x 955	5,480,745		
	Balance	28,231,505		
	Add flash . 110,581 (235-225)	1,105,810		
	Available for Evaporation	29,337,315		
	Evaporation 29,337,315 -:- 963.5		30,448	
	Transfer to #3		80,133	31.90
#3)	Vapor from #2	29,337,315		
	Deduct for heaters 15,000x963.5	14,452,500		
	Balance	14,884,815		
	Add flash. 80,133 (225-200)	2,003,325		
	Available for Evaporation	16,888,140		
	Evaporation 16,888,140 -:- 980		17,232	
	Transfer to #4		62,901	40.64
#4)	Vapor from #3	16,888,140		
	Add flash. 62,901 (200-134)	4,151,466		
	Available for Evaporation	21,039,606		
	Evaporation 21,039,606 -:- 1.022		20,586	
	Leaving as syrup		42,315	60.42

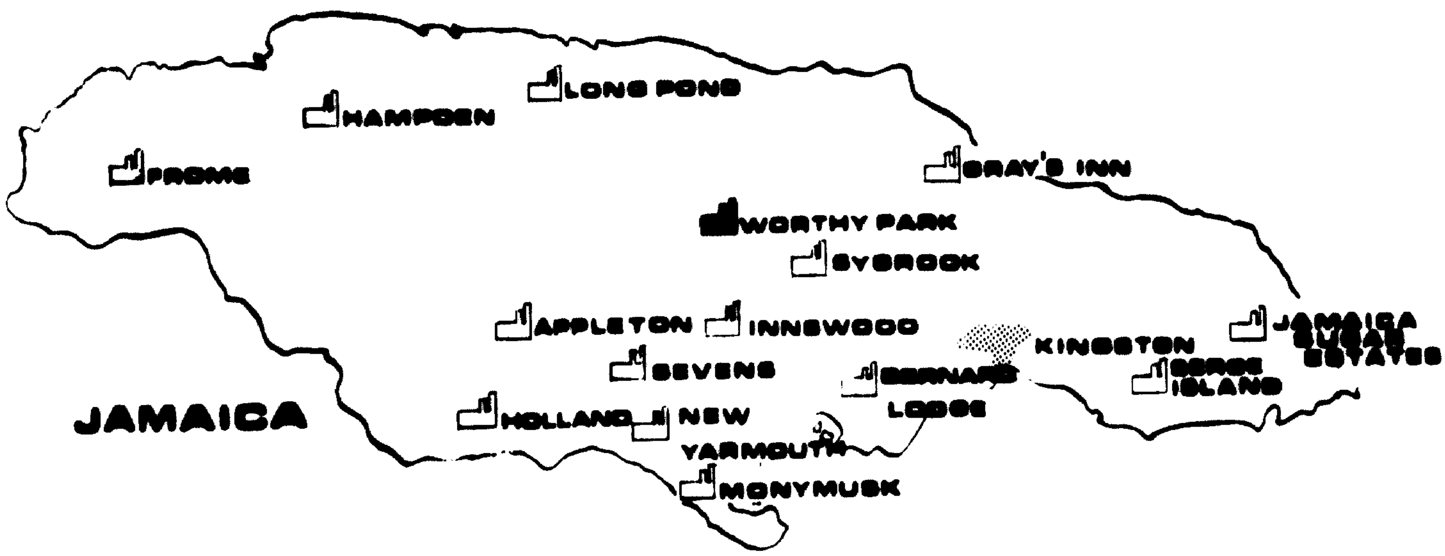
SEVENS: HEAT BALANCE DIAGRAM SHOWING INPUT AND OUTPUT OF STEAM, JUCIE, VAPOR AND SYRUP BASED ON HEAT BALANCE CALCULATIONS



EVAPORATION RATE	PRE-HEAT =	6.25	LBS./SQ.FT./HR.
	#1 =	6.41	" " " "
	#2 =	6.08	" " " "
	#3 =	5.55	" " " "
	#4 =	6.64	" " " "
OVERALL	=	6.20	" " " "

SANDERSON & PORTER, INC.

WORTHY PARK
Saint Catherine Parish



Worthy Park

This factory differs from all other processing units in Jamaica. Not only is the factory and its cane growing area very isolated but the quality of cane that is processed is superior compared to the cane quality produced in other areas. Worthy Park is situated in a valley and at high elevation where the prevailing cool nights promote an optimum cane maturity.

The cane grinding capacity of the plant should be increased from 50.8 T.C.H. to 60 T.C.H. or 1,440 T.C.D. to optimize sugar production. In addition, Worthy Park should be converted to a syrup producing unit.

Milling: The present tandem is underpowered for the proposed grinding rate. The peripheral speed of the mill rollers should be increased from 30 f.p.m. to 45 f.p.m. which would allow the production of 1,600 T.C.D. (with 15 per cent fiber in cane) in a 25"x42" mill.

To augment the peripheral roller speed, the present steam engine should be replaced by three 375 h.p. steam turbines, and driving two mills by a change in gearing so as to allow a maximum roller speed of 45 f.p.m. An alternative, but less practical solution, would be employing two 550 h.p. turbines and driving three mills.

Juice Heaters: The present capacity is sufficient to obtain the proposed cane grinding rate.

Clarification: The clarifier capacity is too small for the even present grinding capacity. The excellent quality of the juice obtained is the only reason why the present grinding capacity can be maintained. For future use, a second clarifier should be added to insure adequate juice clarification. The installation of a 12" diameter polycell unit is therefore recommended.

The present 8'x8' "Emco" filter has limited capacity, but should be able to handle the mud load expected from 1,440 T.C.D., providing a cake thickness of more than 1/4" is acceptable.

Evaporators: The quintuple effect presently is working at optimum capacity due to the removal and efficient use of the first and second type of vapors. An additional preevaporator should be installed to service the increased grinding rate. Vessel #1 could be operated as the pre-evaporator, with a new vessel, having about 2,000 square feet heating surface replacing the operation of the present first vessel.

Capital Costs: The capital costs necessary for achieving the proposed cane grinding capacity can be estimated as follows:

Turbines for mills with high speed gears	$ 50,000
Reduction change for main gears	25,000
Foundations for turbines and gears	25,000
Clarifier	10,000
Evaporator	15,000
Total	$125,000

Should it be decided not to convert the present plant to a syrup producing unit and to optimize sugar production at 1,440 T.C.D., one of the present coil pans should be replaced by a large 1,000 cubic foot calandria pan at an estimated cost of $25,000. Furthermore, the capacity of syrup and molasses tanks should be increased by 550 cubic feet at an estimated cost of $3,000. The existing crystallizers should be equipped with water cooled "Blanchard" units and the station should be arranged for continuous flow of massacuites adding a strike receiver at an estimated cost of $8,000.

Although the centrifugals for high and low grade sugar have adequate capacity for servicing 1,440 T.C.D., both stations are outdated and the machinery should be repladed. The cost of one 54" "Roberts", fully automatic centrifugal for high grade sugar and two continuous centrifugals for low grade sugar is estimated at

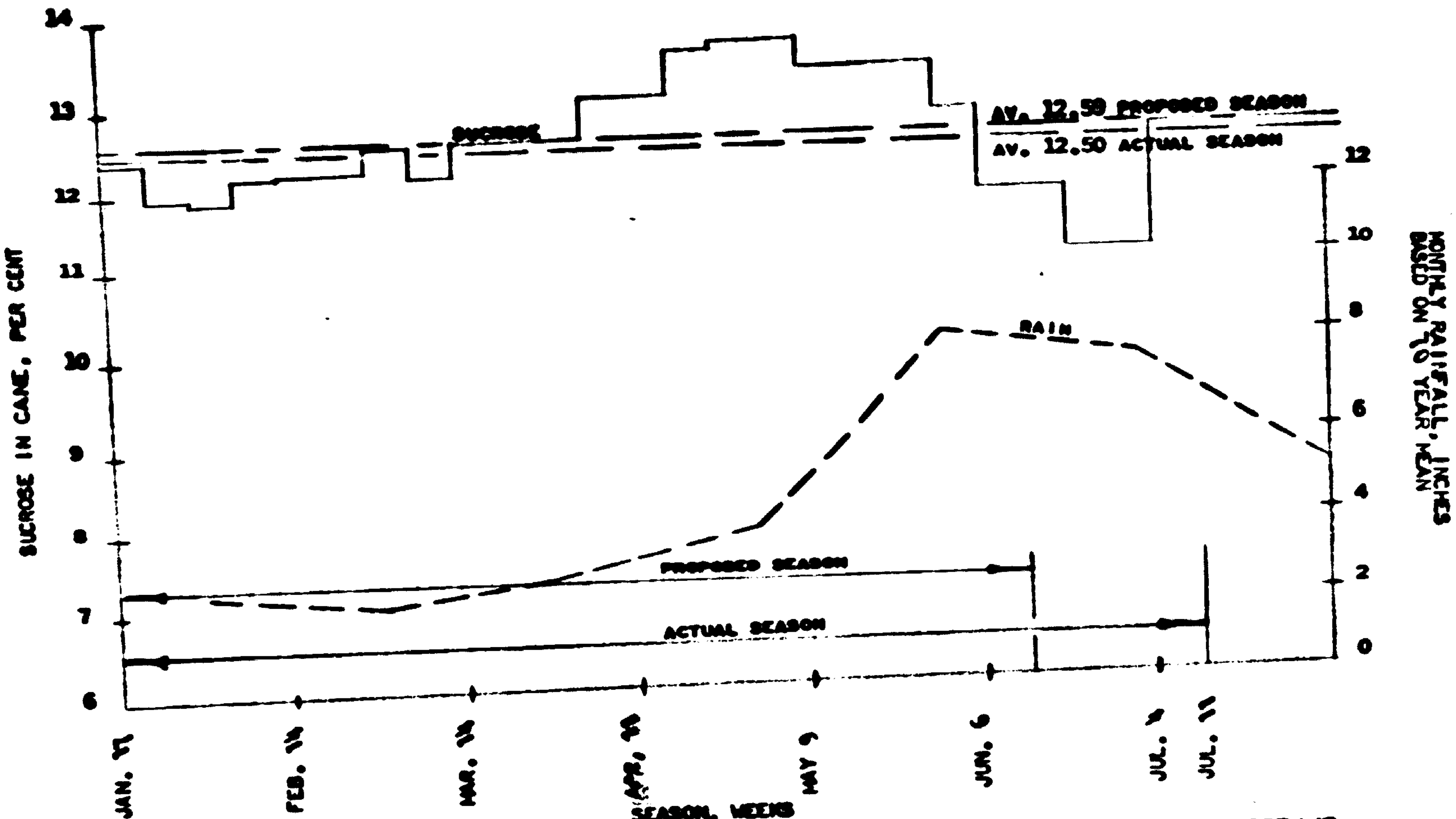
$35,000 and $30,000, respectively. Thus, the modernization of a factory processing only 1,440 T.C.D. would amount to about $1000,000 in additional capital expenditure.

The manufacturing process at Worthy Park is somewhat peculiar - neither steam turbines nor generators are used for electricity generation. Electric power is produced by diesel units, as the area is not served by the Jamaica Public Service and the sugar company supplies electricity both during the crop and the out-of-crop season to the community in the valley.

Worthy Park does not have sufficient boiler capacity to produce steam for processing 1,440 T.C.D. It may have adequate capacity to institute the improvements for reaching 1,440 T.C.D. as a syrup unit, but would have to install a new boiler at an estimated cost of $300,000, if it should continue as a sugar producing unit. As such, Worthy Park should seriously consider converting to a syrup producing unit.

WORTHY PARK:
DISTRIBUTION OF PER CENT SUCROSE IN CANE DURING 1970 CROP

ACTUAL DURATION OF GRINDING SEASON JAN. 17-JUL. 11 OR 176 DAYS
PROPOSED " " " " JAN. 17-JUN. 13 OR 148 DAYS



SANDERSON & PORTER, INC.

WORTHY PARK: MATERIAL BALANCE SHOWING QUANTITIES OF INTERMEDIATE AND FINAL PRODUCTS PER TIME UNIT DURING THE 1970 CROP SEASON.
PURITY MIXED JUICE: 82.71

Material	Per Cent Cane	Pounds/ Cubic Feet	Per Minute Pounds	Per Minute Cubic Feet	Per Minute Gallons	Per Hour Pounds	Per Hour Tons
Cane	100.00	25.00	1,897	75.88	-	113,770	50.79
Bagasse	29.20	5.00	554	110.80	-	33,221	14.83
Imbibition	16.92	62.00	321	5.17	39	19,250	8.59
Mixed Juice	87.72	66.41	1,664	25.05	187	99,800	44.55
Milk of Lime	0.50	67.00	9.5	0.14	1	569	0.25
Limed Juice	88.22	66.41	1,673	25.19	188	100,368	44.80
Mud to Filter	15.50	67.03	294	4.38	33	17,634	7.87
Mud	2.89	85.00	55	0.64	5	3,288	1.47
Wash Water	3.00	62.00	57	0.91	7	3,413	1.52
Filtrate	15.61	65.52	296	4.51	34	17,759	7.92
Clarified Juice	72.72	66.55	1,379	20.72	155	82,734	36.[illegible]3
Juice to Evaporator	88.33	66.35	1,675	25.24	189	100,493	44.86
Syrup	22.56	81.46	428	5.25	39	25,671	11.46
Evaporation	65.77	62.00	1,247	20.11	150	74,822	33.40
MCA	12.72	92.70	-	3,748 cu. ft/ day		14,478	6.46
Sugar A	6.88	53.00	130	2.45	-	7,828	3.49
Molasses A	5.84	88.52	111	1.25	9	6,650	2.97
Dil. Mol. A	6.77	84.04	128	1.52	11	7,702	3.44
MCB	9.58	93.32	-	2,802 cu. ft/ day		10,898	4.86
Sugar B	4.22	53.00	80	1.50	-	4,798	2.14
Molasses B	5.36	90.96	102	1.12	8	6,100	2.72
Dil. Mol. B	6.65	84.04	126	1.49	11	7,568	3.38
MCC	5.38	94.63	-	1,551 cu. ft/ day		6,119	2.73
Sugar C	2.94	54.00	56	1.04	-	3,348	1.49
Magma	3.92	92.33	74	0.80	6	4,464	1.99
Final Molasses	3.14	90.83	60	0.66	5	3,577	1.60

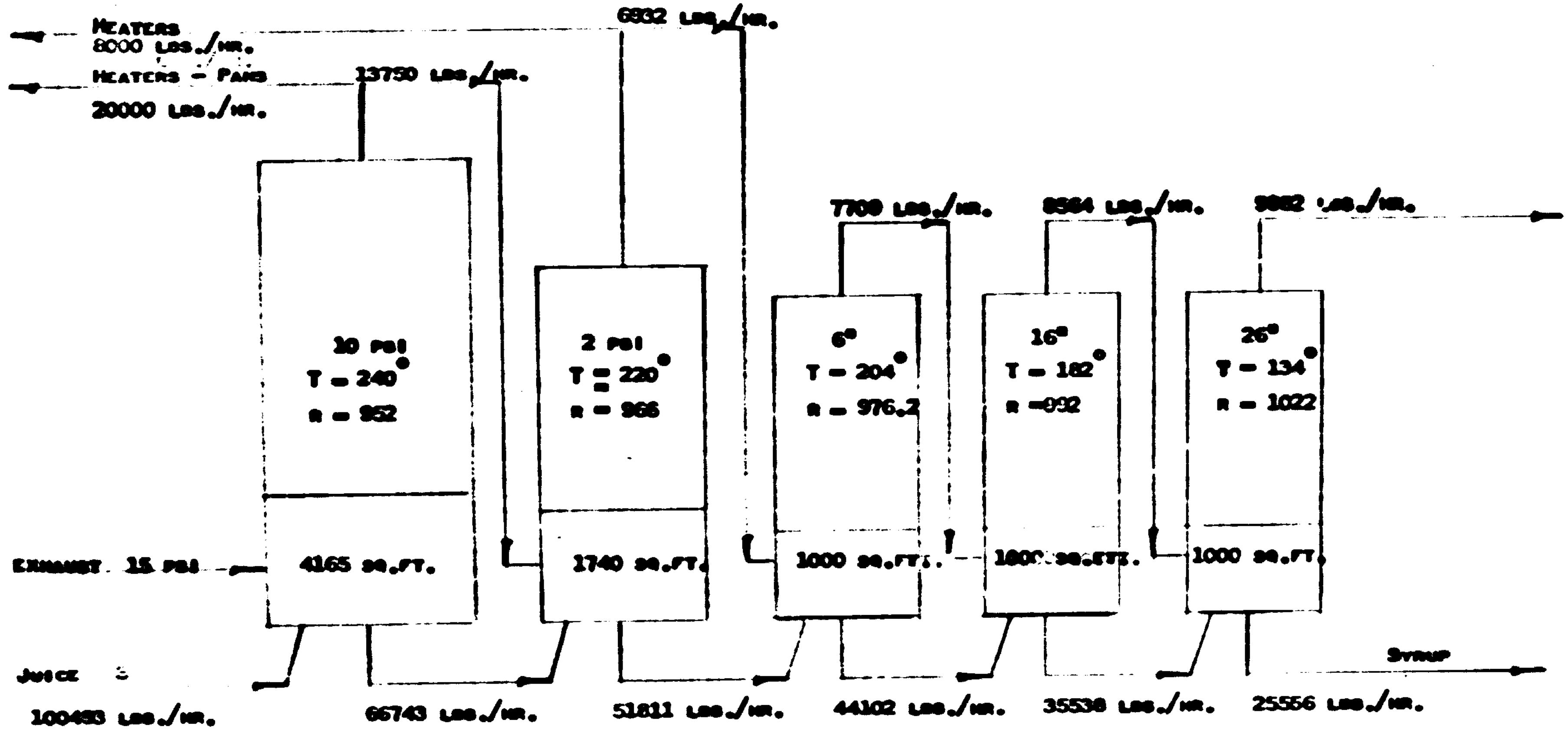
WORTHY PARK: ACTUAL CAPACITY IN TONS CANE PER DAY FOR MAIN EQUIPMENT IN EACH PROCESSING STATION

Station	Average T. C. D.
Mills	984
Juice heaters	1,676
Clarifiers	633
Filters	1,073
Evaporation	1,220
Vacuum pans	1,220
Syrup supply tanks	528
A and B molasses tanks	1,152
C crystallizers	762
High grade centrifugals	1,440
Low grade centrifugals	1,885

WORTHY PARK. HEAT BALANCE FOR THE EVAPORATION STATION SHOWING THE STEAM CONSUMPTION IN B. T. U. NEEDED TO OBTAIN THE PRESENT DEGREE OF EVAPORATION IN EACH VESSEL

Calculation for flow of heat	Heat Content B. T. U.	Evaporation Pounds per Hour	Juice, Per Cent Brix
#1 Juice to evaporators		100,493	16.16
exhaust steam to #1 34,000x945	32,130,000		
available for evaporation	32,130,000		
evaporation 32,130,00-:-932		33,750	
transfer to #2		66,743	24.33
#2 Vapor from #1	32,130,000		
to heaters and pans 20,000 x 952	19,040,000		
balance	13,090,000		
add flash, 66,743 (240-220)	1,334,860		
available for evaporation	14,424,860		
evaporation 14,424,860-:-966		14,932	
transfer to #3		51,811	31.34
#3 Vapor from #2	14,424,860		
to heaters 8,000 x 966	7,728,000		
balance	6,696,860		
add flash, 51,811 (220-204)	828,976		
available for evaporation	7,525,836		
evaporation 7,525,836-:- 976.2		7,709	
transfer to #4		44,102	36.82
#4 Vapor from #3	7,525,836		
add flash, 44,102 (204-182)	970,244		
available for evaporation	8,496,080		
evaporation 8,496,080-:- 992		8,564	
transfer to #5		35,538	45.69
#5 Vapor from #4	8,496,080		
add flash. 35,538 (182-134)	1,705,824		
available for evaporation	10,201,904		
evaporation 10,201,904-:- 1,022		9,982	
syrup leaving #5		25,556	63.54

WORTHY PARK: HEAT BALANCE DIAGRAM, SHOWING INPUT AND OUTPUT OF STEAM, JUICE, VAPOR AND SYRUP BASED ON HEAT BALANCE CALCULATIONS



EVAPORATION RATE #1 = 8.10 LBS./SQ.FT./HR.
#2 = 8.60 " " "
#3 = 7.70 " " "
#4 = 8.60 " " "
#5 = 10.00 " " "
OVERALL = 8.40 " " "

SANDERSON & PORTER, INC.

CENTRAL END-FACTORY

From this investigation it has been concluded that the Holland factory be closed and its cane ground at the Appleton factory. Topographic conditions in the area should not prove a deterrent to transportation from the Holland Estate to the Appleton Factory. This would enable Appleton to produce about 25, 000 tons of sugar annually, for which it has the machine capability.

The same arrangement was broahced for Serge Island and the Jamaica Sugar Estates. In this case, however, road and topographical conditions cause transportation difficulties, making amalgamation of Serge Island and Jamaica Estates not feasible In any event, both factories should be converted to syrup producing units. In addition, and as an integral part of the recommended plan of action, Monymusk, Frome, Bernard Lodge, New Yarmouth, Appleton and Sevens would remain sugar producing units. Worthy Park, Gray's Inn, Long Pond, Innswood, Hampden and Bybrook together with Jamaica Sugar Estates and Serge Island, would be converted to syrup producing units. These plants have not pursued vigorous modernization programs Thus, fortuitously, they lend themselves to our overall recommendations. In the long range plan, Appleton, New Yarmouth and Sevens would eventually convert to syrup production when sugar production costs will become prohibitive for their present size Concurrently, Monymusk, Bernard Lodge, Frome and the central end-factory will be the only sugar crystallizing plants in Jamaica; the latter being supplied with raw material from the smaller syrup producing plants. It might be added that no sugar plants have plans for meaningful modernization due to insufficient return on investment.

The new end-factory would prouce ten months per year, it should be constructed at a centrally located deep water port where large bulk-load ships can be accommodated. This will enable Jamaica to remain competitive in its exports

The end-factory will function 305 days per year. Allowing for a five per cent downtime for official holidays, or 15 days per year, 290 effective working days can be realized During this time

242,128 tons of syrup may be processed into 125,000 tons of sugar. This is based on the assumption that four full shifts of workers will be utilized to assure non-stop production. Shifts would rotate so that no employee would work more than 40 hours per week.

The end-factory's required daily consumption of syrup is estimated to be 920 tons. Daily syrup producing capacity for all participating units has been estimated at 1,681 tons. The daily requirement for syrup storage is estimated at 761 tons; this being the difference between total daily output and consumption of syrup. Therefore, at the end of the average crop season (144 days), 109,584 tons of syrup must be stored so that the effective working days of the end-factory can be fully utilized.

The storage facilities that would be required, and their locations, are as follows:

Location	Storage Capacity U. S. Gallons
Bowden	4,662,300
Salt River	5,692,000
Falmouth	3,041,000
Ocho Rios	8,245,600

Tanks holding one million U. S. gallons would be erected. Also, several syrup storage units would be located at the end-factory as well to assure continuous production. The units would be allocated as follows:

Location	Number of Units
Bowden	4
Salt River	5
Falmouth	2
Ocho Rios	7
Site of end-factory	4
Total	22

The daily quantity of intermediate materials produced in the end-factory is illustrated on the next page.

END-FACTORY: AMOUNT OF MATERIALS TO BE PROCESSED, PRINCIPAL EQUIPMENT AND CAPACITIES, AND POWER REQUIREMENTS

(Based on a daily input of 920 tons of 72 degrees Brix syrup and a daily output of 467 tons of sugar, at 97 degrees polarization and 0.70 per cent moisture, and 214 tons of final molasses at 88 degrees Brix (42,700 U. S. gallons.)

Required boiler capacity, pounds per hour (Based on total water evaporation in pans of 35,000 pounds per hour with an allowance to meet an estimated peak load of 45,000 pounds per hour at the beginning of pan loads.)	45,000
A Massacuite, cubic feet per day	14,419
B Massacuite, cubic feet per day	9,376
C Massacuite, cubic feet per day	8,054
Total A and B Massacuite, cubic feet per day	23,795
Required strike volume per pan, cubic feet	2,000
Number of pans required for A and B Massacuite	2
Number of pans required for C Massacuite	1
Number of pans required for magma and grain development	1
Heating surface required for syrup, square feet (Bases on expected volume for syrup of 0.281 c.f.s. and a required syrup velocity of four feet per second in the heater requiring 0.07 square feet per pass.)	500
Steam consumption (10 p.s.i.) required by heater pounds per hour (Based on 2" O.D. heater tubes, four tubes per pass, 20 passes, requiring a total of 80 tubes, providing 500 square feet of total heating surface.)	700

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1.0 1.1 1.25 1.4 1.6 1.8 2.0 2.2 2.5 2.8 3.2 3.6 4.0

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

24x
C

Crystallizers for A and B strikes, units of 2,000 cubic feet each: (One crystallizer is equal to the volume of Pugmill to feed A and B centrifugals. Two small crystallizers are required for magma and grain storage.)	2
Crystalizers for C strike, water cooled, units of 2,000 cubic feet each (Based on Massacuite cooling period of 24 hours)	4
A and B centrifugals, 48"x30", units required (Or seven 42"x30" units.)	5
C centrifugals, continuous, units required (Based on output of 60 cubic feet of Massacuite per hour.)	7
Syrup pumps, 150 gpm, 100' head, 7.5 h.p. units required (All pumping units duplicated to assure continuous plant operation. Pump head corrected for losses in syrup heater.)	2
A molasses pumps, 50 gpm, 75' head, 4 h.p. units required	2
B molasses pumps, 50 gpm, 75' head, 4 h.p. units required	2
Magma pump, "Rota-type", 40 gpm, 100' head gear motor, 10 h.p. units required	1
Final molasses pumps, 35 gpm, 20' head, 5 h.p. units required (For transferring final molasses from centrifugals to weighing scale.)	2
Final molasses pumps, 35 gpm, 20' head, 5 h.p. units required (For transferring final molasses from weighing scale to storage tank.)	2

Based on the quantity of cane processed for 1970, together with the material balance calculated for each factory, and the assumption of 72 degrees Brix for stored syrup, syrup production as shown below can be anticipated.

Name of Unit	Shipping Port	Syrup Produced Long Tons	Syrup Produced U. S. Gallons
Jamaica Sugar Estates	Bowden	34,870	
Serge Island	Bowden	17,298	10,304,750
Bybrook	Salt River	28,655	
Innswood	Salt River	35,027	12,579,100
Hampden	Falmouth	34,027	6,721,350
Long Pond	Ocho Rios	41,605	
Worthy Park	Ocho Rios	30,702	
Gray's Inn	Ocho Rios	19,944	18,222,340
Total			47,827,540

This volume does not represent the required storage space for syrup. The actual space is less as the end-factory also will consume syrup during the crop season.

The end-factory must be totally electrified. Several systems for power generation providing electricity as well as process steam have been evaluated. These include diesel, gas turbine and steam turbine. A diesel unit, compared to a similar size steam turbine, is much lower in capital cost requirements. It is capable of producing the required process steam through recovery of heat normally lost in the exhaust and from the jacket water cooling system. A high thermal efficiency can be obtained. But the advantages are offset by the disadvantages.

As the factory would operate ten months a year, the steam must be available throughout this period. Diesel plants are unable to operate, continually, for such a length of time span without maintenance. As a result a second diesel unit would be needed increasing the capital cost significantly In addition, in case a breakdown occurs, the steam supply would be lost entirely shutting down production in the entire plant A standby steam generator plant would be needed to avoid such a possibility This again increases the capital costs. Finally, diesel maintenance costs are higher than those for steam turbines, completely ruling out a diesel plant. A gas turbine also was considered as the initial capital cost is low. But high operating costs and low thermal efficiencies ruled this out as well

A steam plant similar to the existing systems at the projected syrup producing factories, is recommended. Steam requirements at the end-factory have been calculated at 45,000 pounds per hour; electrical load is estimated at 1,200 kilowatts per hour. These values may vary slightly once the final design has been established

The power plant should consist of one package type, oil fired (Bunker "C") boiler with a rating of 50,000 pounds of steam per hour. The turbine (50 cycles) would be designed to operate at 150 to 250 p.s.i. with a back pressure of 10 p.s.i Special considerations should be given to the turbine design as the quantities of exhaust steam can vary considerably, and provisions must be made to compensate for these fluctuations to avoid costly blow-off of steam.

The entire plant concept would be based upon the steam requirements for sugar processing rather than electricity generation.

Piping would be designed to allow a direct and constant steam flow from the boiler to the boiling pan via a pressure regulator. Normally, the pans would be fed through the exhaust of the turbine, but in the event of a malfunction, the by-pass line can be used to supply the factory.

During a major breakdown, or during the off-season, power must be furnished by the Jamaica Public Service Company or by a standby 300 to 350 k.w diesel-generator set.

Capital expenses for the purchase and installation of the power plant for the end-factory are estimated to be $625,000.

Finally, as the end-factory will be located at a deep harbor port, consideration should be given to the feasibility of purchasing Bunker "C" oil in bulk form. With proper storage facilities, delivery could be effected by either a tanker or barge resulting in considerably lower fuel costs.

The total cost for the end-factory, excluding the power plant, is estimated at $3.8 million inclusive of construction. The centrifugals now located in those plants which will convert to syrup processing might be removed from those plants and installed at the end-factory. This would reduce the estimated cost to $3.5 million.

The approach will help to preserve the individual autonomy of the sugar producing companies. Under this new program these companies will sell their syrup production to an intermediate processor who in turn will sell the crystallized product to refiners. Presently, the crystallized product is sold by pooled arrangements to refiners. An intermediate step, to reduce production costs would not be objectionable to the individual sugarcane processor. The sugar producers have long recognized their strength by a common effort. The entire sugar production has been sold through one marketing organization and negotiations with sugar importing countries are carried out on a regional basis.

END-FACTORY: MATERIAL BALANCE SHOWING EXPECTED QUANTITIES OF INTERMEDIATE AND FINAL PRODUCTS BASED ON AN ASSUMED AVERAGE PURITY OF 76.77 FOR MIXED JUICE BY SYRUP PRODUCING MILLS.

Material	Per Cent Cane	Pounds Cubic Feet	Per Minute Pounds	Per Minute Cubic Feet	Per Minute Gallon	Per Hour Pounds	Per Hour Tons
Cane	-	-	-	-	-	513,632	229.30
Syrup	16.71	84.82	1,431	16.87	126	85,860	38.33
M.C.A	2.62 cu. ft/T	93.21	934	14,419 cu. ft/day		56,045	25.02
Sugar A	5.26	53.00	451	8.50	64	27,637	12.07
Molasses A	-	90.17	484	5.36	40	29,008	12.95
Dil. Mol. A	-	84.04	587	7.00	52	35,190	15.71
M. C. B	1.70 cu. ft/T	93.65	610	9,376 cu. ft/day		36,624	16.35
Sugar B	3.23	53.00	277	5.22	39	16,600	7.41
Molasses B	-	91.55	334	3.64	27	20.025	8.94
Dil. Mol. B	-	84.04	420	5.00	37	25,222	11.26
M. C. C	1.46 cu. ft/T	94.55	528	8,054 cu. ft/day		31,651	14.13
Sugar C	-	54.00	195	3.61	27	11,670	5.21
Magma	-	92.33	286	3.09	23	17,180	7.67
Final Molasses	3.89	91.46	333	3.64	27	19,980	8.92

END FACTORY: ESTIMATED QUANTITIES OF SYRUP WHICH COULD HAVE BEEN PRODUCED BY DIFFERENT UNITS FROM THEIR CANE DELIVERIES DURING THE 1970 CROP (SYRUP AT 72 DEGREES BRIX)

Name of Unit	Syrup produced, long tons
Worthy Park	30,702
Jamaica Sugar Estates	34,870
Gray's Inn	19,944
Long Pond	41,605
Innswood	35,027
Hampden	34,027
Serge Island	17,298
Bybrook	28,655

Total quantity of syrup which could have been produced, long tons: 242,128

Average time per unit after crop duration has been shortened, days: 144

Average production of syrup per day, long tons: 1,681

Average production of syrup per day, U.S. gallons: 332,050

Source: Production data from units and own calculations

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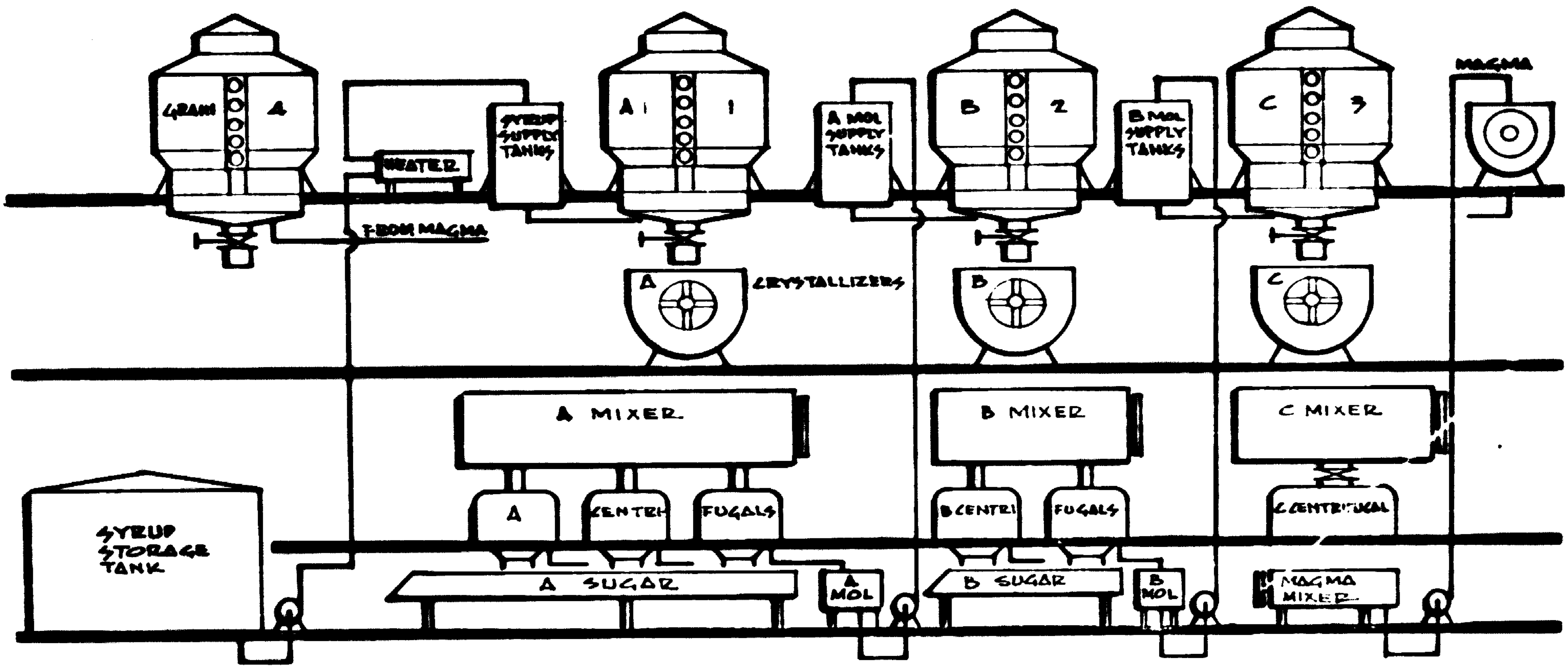
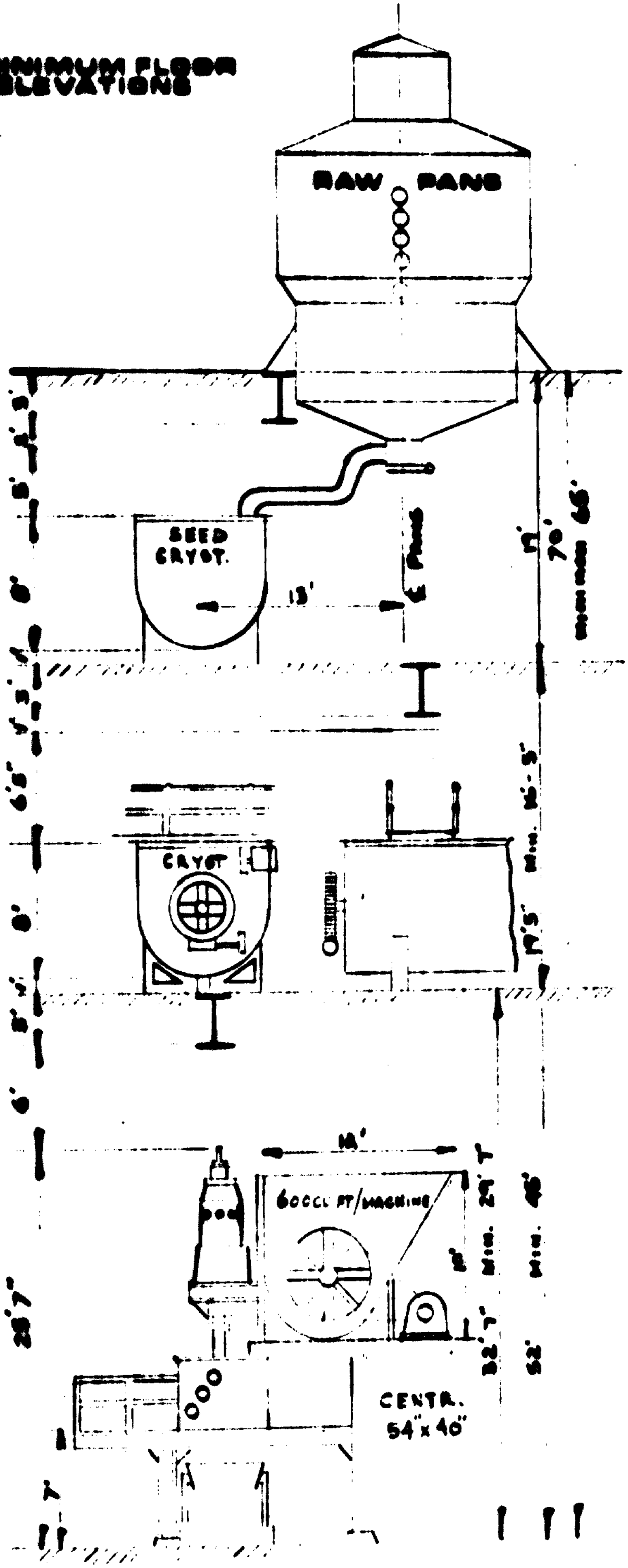
Source: Production data from units and own calculations

SCHEMATIC DIAGRAM OF PROJECTED END-FACTORY, PROCESSING SYRUP AND PRODUCING SUGAR

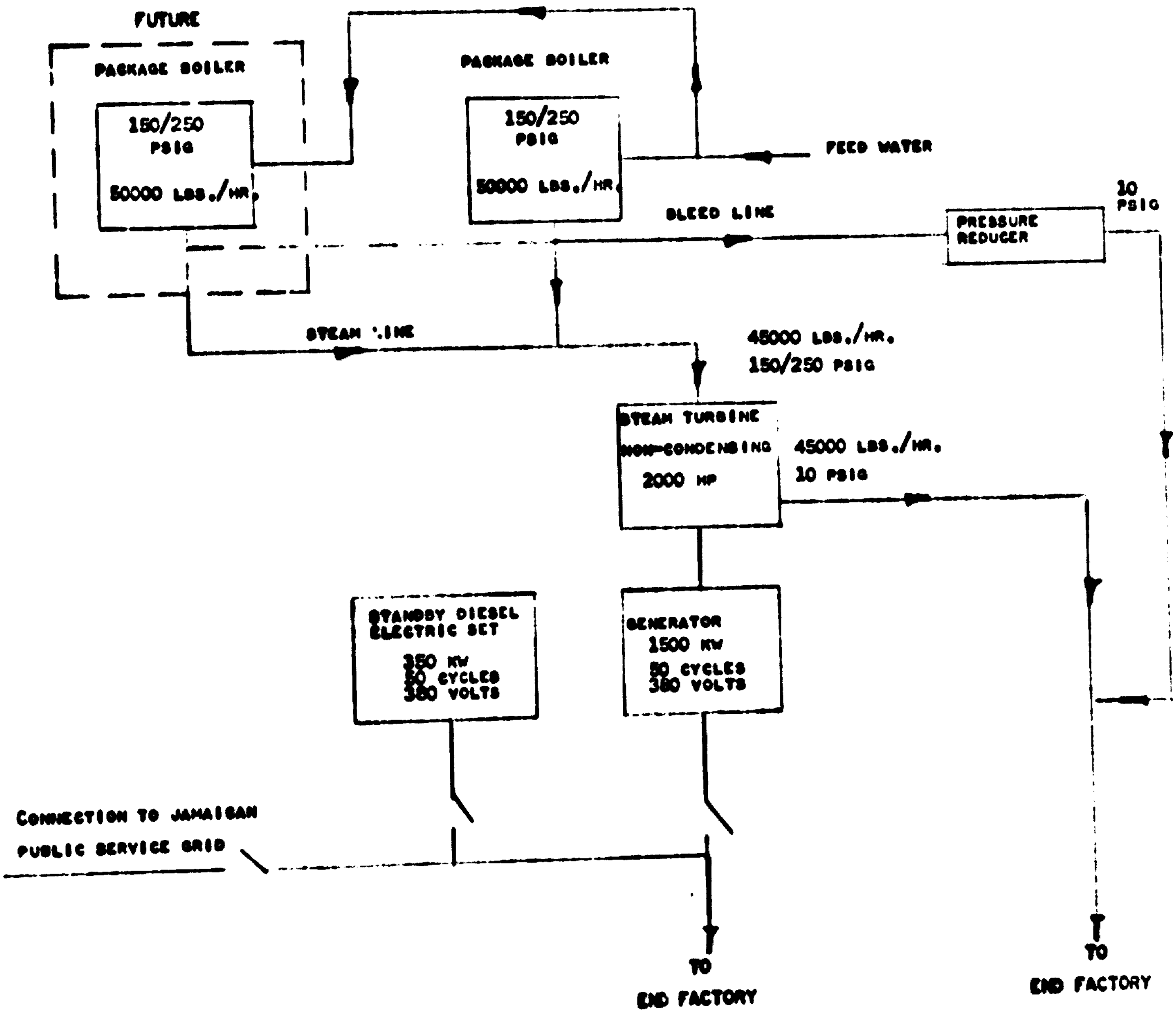


SANDERSON & PORTER, INC.

MINIMUM FLOOR ELEVATIONS



PROPOSED DIAGRAM FOR STEAM AND ELECTRICITY GENERATION TO BE USED FOR PROCESSING BY THE CENTRAL END-FACTORY



SANDERSON & PORTER, INC.

THE JAMAICA MACHINERY COOPERATIVE (JMC)

In order to eliminate some of the high costs associated with machine maintenance, which are a result of the small economies of size for each plant, the low efficiency of labor, the lack of machinery standardization and spare parts, as well as the lack of job specialization for the factory worker, a centralized machinery facility should be established. This would reduce both repair costs and foreign exchange expenditures, benefitting the Balance of Payments.

The name suggested is the Jamaica Machinery Cooperative (JMC).

Purpose

The primary purpose of the JMC would be to relieve the financial problems of the sugar manufacturers. Secondly, a central repair facility for maintenance and purchasing of parts and equipment would result in overall monetary savings.

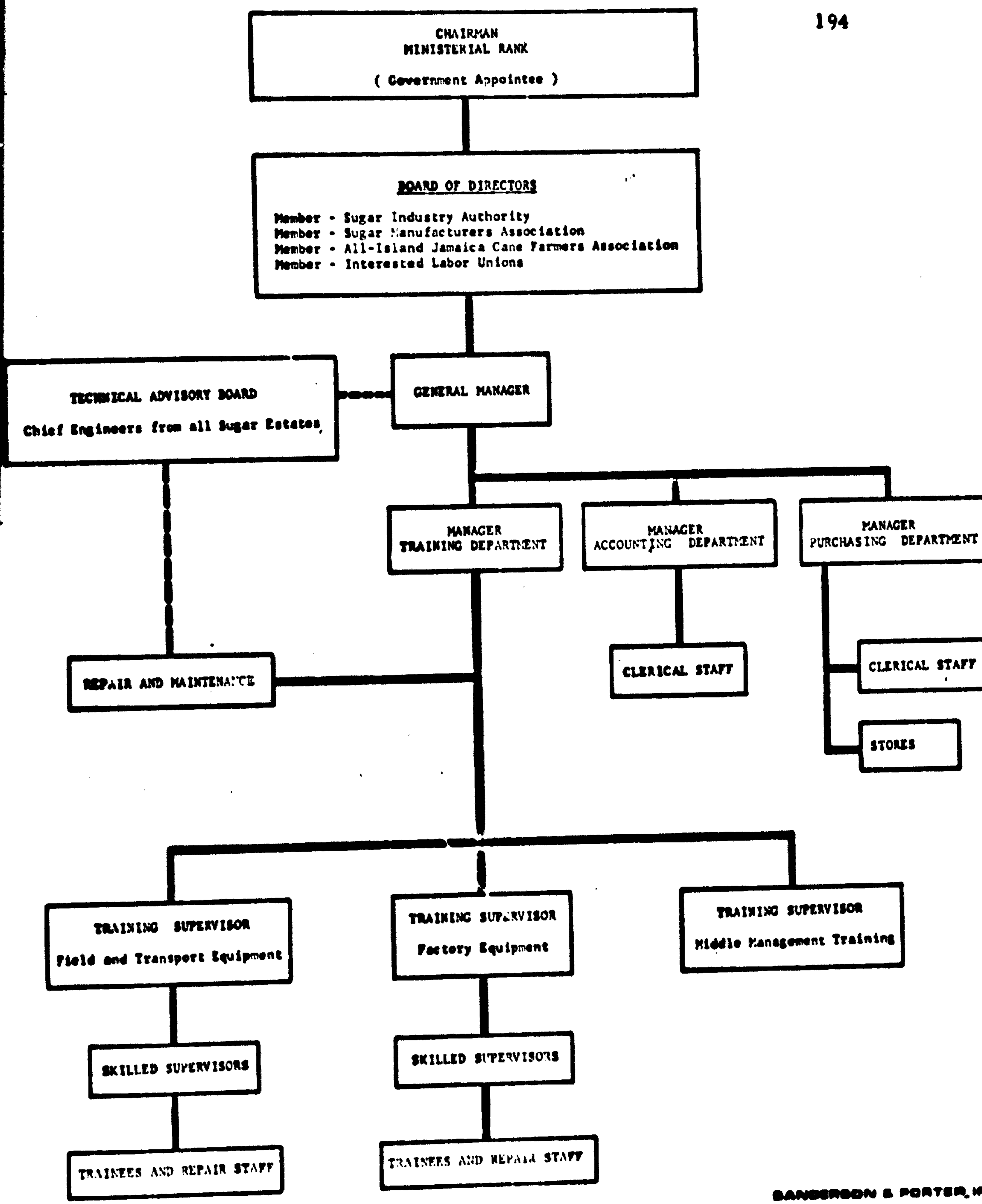
It is the intent that the JMC eventually would become self-supporting and become a profitable venture in itself.

The policies under which the JMC would operate would be well formulated and in accordance with Jamaican laws and regulations. A Board of Directors with a representation as shown on the attached organization chart, on the following page, is proposed.

The Sugar Industry Authority representing the national and international sugar interests of Jamaica.

The Sugar Manufacturers' Association representing each individual sugar processing facility.

PROPOSED ORGANIZATION CHART FOR THE JAMAICA MACHINERY COOPERATIVE



The All-Island Jamaica Cane Farmers' Association representing the interests of all cane farmers.

The Unions representing all field and factory workers.

The Chairman appointed by the Ministerial Office under which the JMC would be governed. The Chairman would have an arbitrary function in all matters. He would have no financial interest, directly or indirectly, with the sugar industry.

Specific responsibilities of the JMC would be as follows:

To own, operate, maintain, repair and lease to the manufacturers and cane growers the mechanical equipment needed by each operation. This would initiate a concerted effort in equipment standardization optimum utilization by growers of limited cane holdings.

To own, operate, maintain, repair and lease to the sugar manufacturers the required transportation equipment in order to optimize the utilization of capital invested and to promote standardization of equipment.

To own, operate, maintain, repair and lease to the sugar manufacturers and sugar cane estates the required equipment for cane cultivation in order to optimize the capital investment utilized in this sector.

To provide central repair facilities for effective and economical repair of equipment.

To provide a central warehousing system to reduce the stock needed for all processing plants and estates and to profit from volume buying.

To provide central training facilities so as to offer specialization for skills particularly needed by the sugar industry.

Once organized and functioning, the JMC would prove beneficial to the producer as well as to the grower for a number of reasons:

> The centralized system will relieve the individual factory and estate from the responsibility of maintaining and upgrading the skills required to repair the equipment.
>
> Only the central repair facilities can be equipped with modern tools and testing equipment. Better supervisors will ease the severe maintenance and repair problems now resulting in excessive repair costs.
>
> The central warehousing for standard parts will greatly reduce the time lost in procuring these supplies. Availability of parts upon request will reduce "frozen" capital now held in the form of spare parts at each factory and estate.
>
> Inventory control of parts would be computerized and the information made available to all interested parties. There are computers in Jamaica which have time available to process the information effectively.
>
> Collective purchase of parts will result in a substantial lowering of price per unit of spare parts. This saving, together with the lesser quantity needed, will have a beneficial effect on the Balance of Payments.
>
> The central training facility operating in conjunction with the central repair facility will ease the skilled manpower shortage. Central repair facilities of the magnitude proposed and coupled with an effective practical training program, could restore the prestige for employment in the sugar industry.

The formation of the JMC is a practical step toward curbing the rapidly increasing costs of maintenance and repairs.

Formation and Operation

To form the JMC, offshore financing plus a contribution from the Jamaican Government will be necessary. In its early stages, the JMC would have to be subsidized annually by the Jamaican Government. (See next page.)

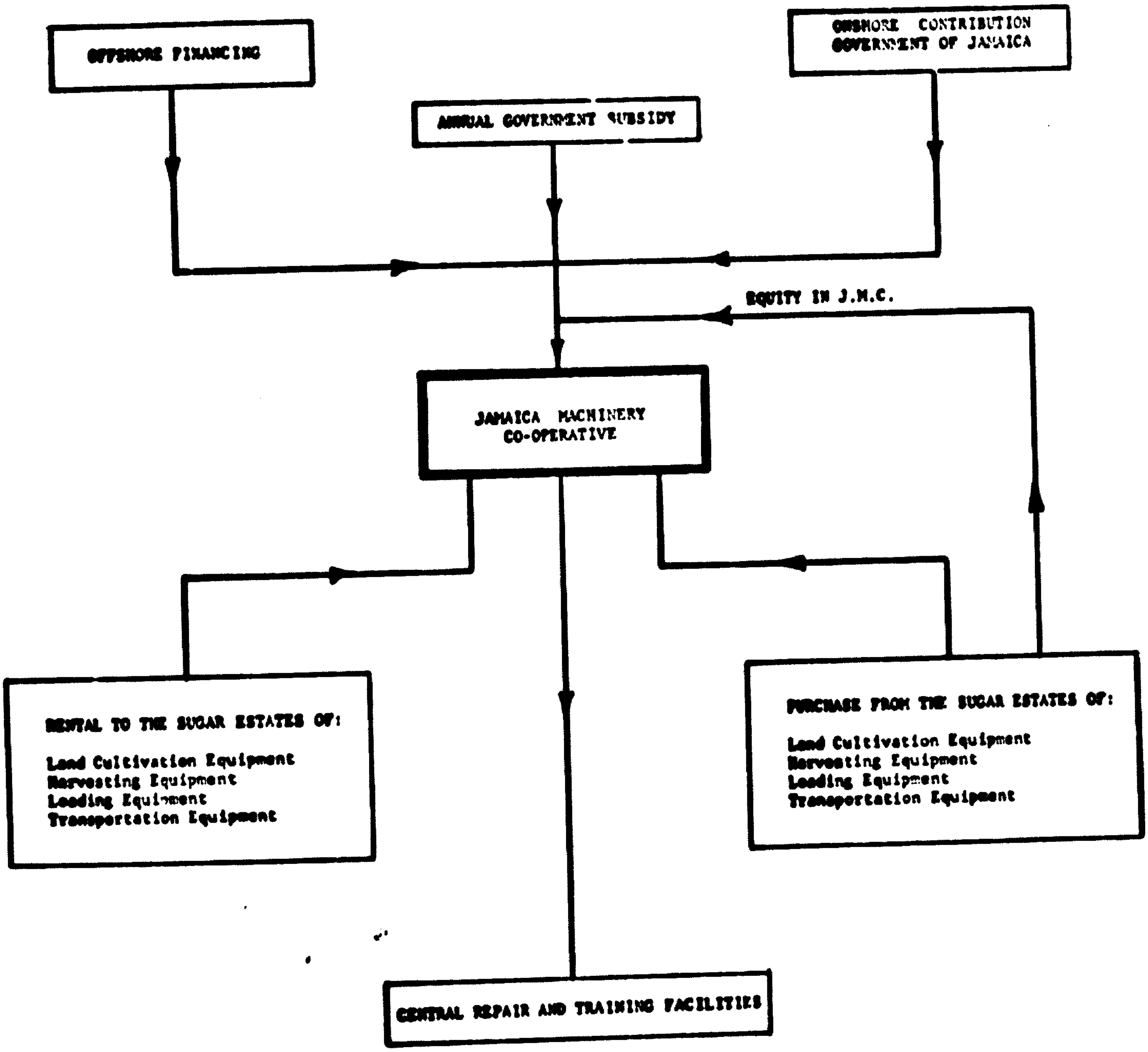
In addition to the capital necessary for the construction and equipping of the central repair facilities, other funds must be made available for purchase of the field and transportation equipment now owned by the individual sugar manufacturers. This equipment will be leased back to the manufacturers as it is required. However, and to give them a voice in control of the equipment, each sugar manufacturer should secure equity in the JMC by donating some equipment to the JMC without any charge. The size of the equity would depend on the amount of equipment contributed.

Initially, the monies derived by JMC would be solely from the rental of field and transportation equipment and from the repair work performed in the central repair facility. Eventually, it should realize substantial sums from the equipment and repair facilities and from the sale of spare parts. Outlays of cash are illustrated on the page following the next page.

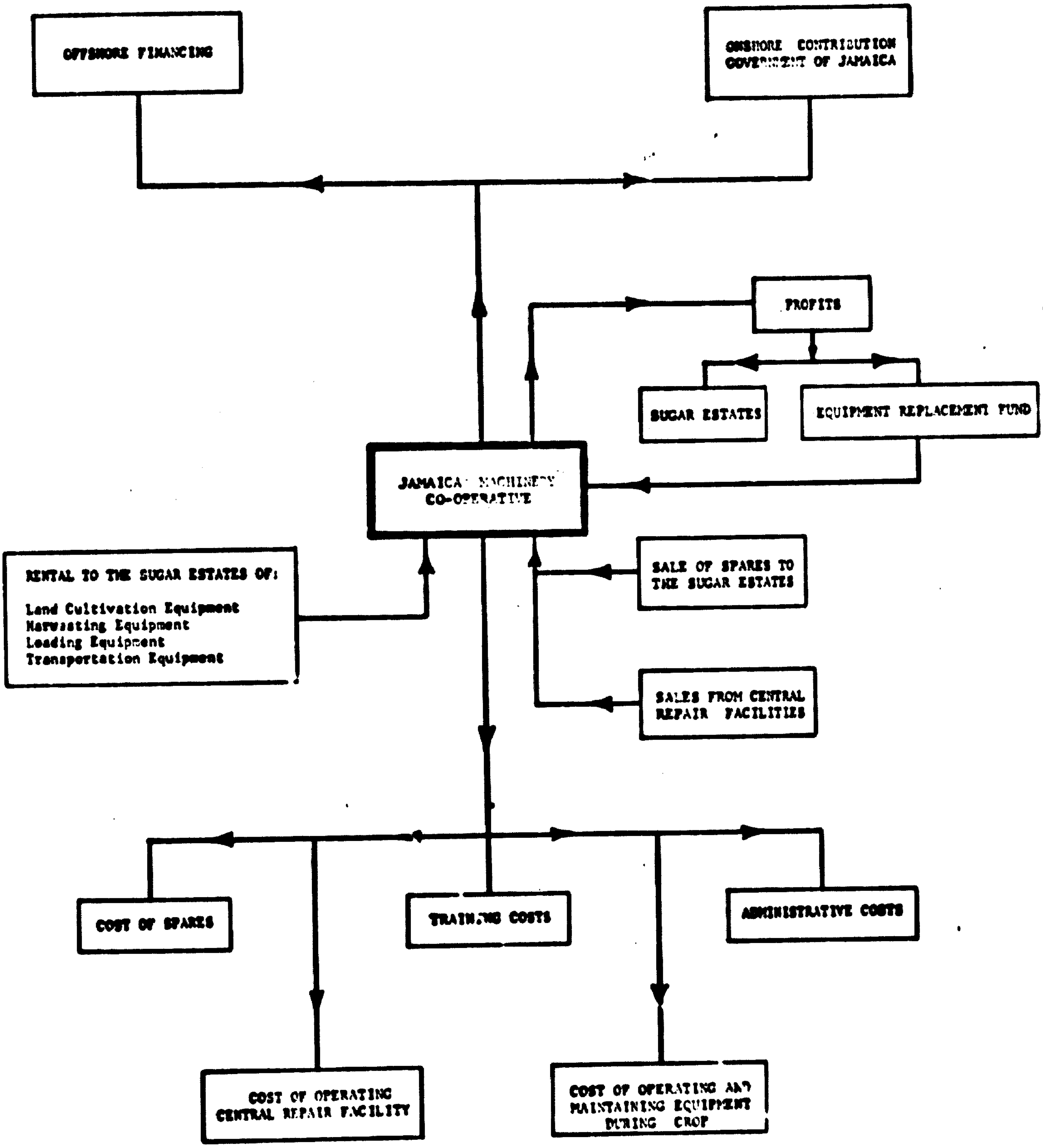
With proper direction, the JMC can become a very profitable organization. After meeting the repayment schedule for the initial financing, profits can be shared between the sugar manufacturers and the Jamaican Government. A certain part of the income must be put into an equipment replacement fund for worn and old equipment.

As already stated, the JMC will own, operate, maintain, repair and loan the necessary equipment to load, possibly harvest and transport the cane to the factory. At the beginning of the crop, the sugar manufacturers will inform the JMC of their equipment requirements. The JMC would schedule the equipment to be brought to an area, complete with operators, maintenance and repair crews in accordance with these equipment requests. Equipment and crews would remain on the estate until the crop season is complete. At that time the workers and machines would be returned to the central facilities.

JAMAICA MACHINERY COOPERATIVE
CASH FLOW DIAGRAM DURING PHASE ONE, THE FORMATIVE STAGE



JAMAICA MACHINERY COOPERATIVE CASH FLOW DIAGRAM DURING PHASE TWO, THE FINAL STAGE



Similarly, the sugar manufacturers and estates would inform the JMC of their plans for cultivation and planting so necessary manpower and machines can be supplied.

At the end of the crop, repair and maintenance will be performed by the same crew who operated and maintained the equipment during the crop.

The end of the crop would also signal the beginning of factory maintenance. Reshelling of mill rollers, regrooving of new shells, machining of turn plates, and major overhaul of equipment would be performed at the central facility.

Many mills have machinery that is common to all. The present practice of purchasing spare parts on an individual basis, represents substantial capitalization. Under a centrally governed system, the same spare parts and even some large items now purchased in finished form could be purchased unfinished in larger quantities at substantial savings. They could be finished in the central machine shop as required. Most commonly used items such as valves, nuts, bolts, washers, welding rods, evaporator-pan-boiler tubes, cane knives and many other items could be stocked in smaller quantities than is now the case.

Maintenance and Training

The Jamaican Government has expressed concern about the rising costs of repairs and maintenance. A similar concern was expressed in the Mordecai report which indicated that during a five-year period, manufacturing costs increased 20 per cent while maintenance costs increased 35 per cent. In another report - "Study of Machinery; Repair and Maintenance Problems of the Sugar Industry", in Jamaica for UNIDO, by M. S. Sahni, maintenance difficulties were also delineated.

Both reports are concerned essentially with statistics; while alarming they have not discussed the problems which face the Chief Engineer in a sugar factory who is responsible for the repair and maintenance of the plant during the off-crop season as well as for efficient operation of the mechanical and electrical equipment during the crop. His skill, ability and experience has a direct influence on the success, or the failure, of sugar production.

Preparing a factory for a crop is difficult. It is standard practice to disassemble, inspect, and repair if necessary each piece of equipment in the factory. To accomplish this task the Engineer must overcome the following: lack of a skilled staff; excessive delivery time for spare parts; high cost of spare parts; budget limitations.

Despite these difficulties the plant is usually ready in time. Many of the older factories, still in operation, are testimonials to the skill of their engineers.

There is no quick and easy answer to solving these maintenance problems. However, a training and modernization program is essential. This is most important in that it would take at least five years before any meaningful benefits could be realized. Therefore, a program must be developed as soon as possible. Existing factories must continue in the hope of survival until the fruits of the program can be realized.

Training is the simplest answer to the maintenance problem. In addition to training, monetary inducements must be offered to retain skilled labor in the sugar industry. In addition, as there is certainly a limit as to how many skilled tradesmen the other industries will be able to employ, the sugar industry must be prepared to attract and hold the excess labor when these workers become available.

A training center should be established at the site of the central repair facility of the JMC. An experienced training supervisor should be in charge of the overall program while individual assistants would be in charge of three special training sections. One section would concentrate on skills needed in the factory. A second on the skills necessary in repair and maintenance of transportation equipment. The third on training of middle management.

A Technical Advisory Board, consisting of the Chief Engineers of all the factories, would advise on the curriculum as to the skills to be taught and the methods of training to be employed. This will prove invaluable as the Engineers' intimate association with the problems of the factory will be an asset to the training program.

Essentially the Technical Advisory Board would be responsible for:

Determining the general methods for and the extent of repairs.

Designing of maintenance and repair forms to be used throughout the industry.

Determining the areas and industrywide methods for training workers.

Determining the type and inventory of parts needed for an effective maintenance program.

Discussing particular problems facing certain factories in order to determine solutions in accordance with the common approach.

Training would take place during the off-crop season. Each factory would send a specific quota of trainees to the center. As repair work in the factories must continue, a rotating schedule would be developed to allow most of the employees to participate.

To provide equipment for the training program, each factory would supply various pieces of machinery for repair. As time progresses, and as funds allow, the school would purchase machinery for training purposes. Also, the equipment manufacturers usually are most helpful in making training equipment available.

Training would be on a practical basis. No reading or writing tests would be required since training courses requiring technical reading are usually unsuccessful. Although many people can read and write they have extreme difficulty in comprehending even the most elementary technical literature. As there are limitations in the simplification of technical terms, technical reading skills should not be included in the curriculum for mechanics. However, technical reading would be a requisite for the middle management positions.

Certificates would be presented at the successful completion of each course. These would be graded to establish standards of competence. A passing grade in one course would be required before a person could apply for other courses or for a higher position.

Once a trainee has reached semi-skilled status, a number of approaches should be considered so as to retain his skills in the sugar industry:

> The school could be located near a large urban area and quarters provided for the trainee either free of charge or at a nominal cost. In this manner the increasing trend of young people to move from rural to urban areas can be satisfied. If crop duration is shortened to four months, the remaining eight months can be spent in or near the city.
>
> Before training begins, the student would agree that in return for his training he would work in the sugar industry for at least five years.
>
> The Government, in conjunction with the sugar industry, would initiate a public relations program in which the importance of the sugar industry, and the sugar worker, to Jamaican national development would be fully emphasized.
>
> Legislation might be introduced making it unlawful for a sugar trainee to be employed by another industry within the stipulated five-year employment period unless that industry is willing to make some compensation for this employment.

Inventory Control of Parts

Lengthy delivery schedules for equipment and spare parts is common to all machinery users in the world. In efforts to reduce inventories most manufacturing firms keep only a minimum amount of parts on the shelf. In many instances spare parts are not manufactured until an order is recieved.

Inflationary trends during the late sixties greatly increased the price of machinery parts. The Jamaican sugar industy, already experiencing high costs for spare parts, should attempt to reduce the amount of spares. Normal wear and tear must be expected and cannot be avoided. However, replacements due to the negligence of a semi-skilled tradesman can now be avoided by worker training.

The JMC can be a valuable asset in another area also. Purchasing large quantities of spares will dictate better discount rates and storage at the JMC warehouse will reduce the monetary values of the inventories now stocked at each factory.

Safety

A final item that needs mentioning is the current lack of conscientious safety precautions in the Jamaican sugar factories. A few factories have tried to develop some sort of safety program but other, and ostensibly more important work has taken priority over safety. It is doubtful whether any Jamaican sugar factory could pass a routine safety inspection as instituted in a more developed country. The importance of safety cannot be over-emphasized. Adopting proper safety measures will, in addition to benefiting management, almost certainly result in the reduction of lost grinding time. Thus, safety should form an integral part of the JMC's overall training curriculum.

STORAGE TECHNIQUES AND TRANSPORTATION OF SYRUP

Syrup must be stored away from the cane producing units so the central end-factory can function on a year round basis. As long as certain precautions are taken, syrup produced from cane can be stored for a certain period of time without deterioration.

Syrup with a density range of 55-62 degrees Brix normally undergoes deterioration rapidly. For storage, the density must be increased to 72 degrees Brix for two reasons. First, a higher-Brix means more removal of water. As a result, less volume is needed for the storage tanks. Secondly, the concentration of solids in the syrup must be increased to such a degree that it becomes unfavorable for bacterial growth. In order to prevent spontaneous crystallization of sugar, the density of syrup should not be increased beyond 72 degrees Brix. As the purity of syrup seldom exceeds 80 or 81, 72 degrees Brix should be adapted as the optimum for preservation of syrup.

To eliminate any possibility of condensation, the temperature of the syrup at the time it is introduced into a tank should be as low as possible The water droplets formed by condensation fall into the syrup. This dilutes the syrup and forms minute areas of a medium favorable for bacterial growth. Thus, sterilized syrup, after leaving the flash evaporator, would have to pass through a cooler prior to storage. The flash evaporator and cooler would have to form a hermetically closed system to prevent reinfection of syrup.

To reduce any chance of moisture further it would be advisable to insulate, if not the whole outside of the tank, at least the top of the tank, with a one-inch thick layer of styrofoam. A continuous stream of air must be circulated through the empty space above the liquid level. The air should be slightly hotter than the ambient temperature. This air layer, having a lower relative humidity, would then absorb and eliminate the water saturated air from the tank. The inlet and outlet for the air circulation system should be mounted in domes on opposite sides of the top of the tank to prevent liquid from entering the system when the tank is totally filled. Also, a large quantity of low pressure air should be used to "sweep clean" the entire inside of the tank.

Every morning a disinfectant would be atomized into the tank to disinfect the top and the still exposed sides of the tank as well as the surface of any syrup. Two types of disinfectants would be used on alternate days; formaldehyde on the first day and any other type of commercial disinfectant on the second day. The reason for utilizing more than one type of commercial disinfectant is to prevent the buildup of resistance of bacteria against a certain type of disinfectant. Syrup can then be kept for prolonged storage, as no bacterial growth can occur when these precautions are taken.

The syrup would be introduced into the tank through a pipe in the bottom in order to prevent formation of foam; foam being a source of bacterial growth. The stored syrup should have a pH range between 6.5 and 7.0. The bottom of the tank would be convex in order to permit total drainage, and the tanks would be thoroughly steam cleaned when emptied.

Each tank should be filled to capacity, leaving no air space at the top. Discharge will take place through a discharge pipe with valves located outside the tank. The syrup can be regarded as being deposited in layers when the tank is being filled. The design of the discharging system will ensure the processing of the oldest syrup at all times. Sample cocks would be located in front of the discharge valves to permit a bacteriological testing at regular intervals.

The inside of the tanks should be coated with Epoxy or other permanent bakelite paint or fiberglas to prevent direct contact between syrup and metal. Contact may discolor and, resultingly, may cause difficulty in the ultimate refining of the sugar.

Maintenance and operational charges per ton of sugar for this type of storage facility would be negligible.

Finally, the syrup would be transported to the storage tanks by tank trucks. These tanks should be made of stainless steel and have provision for cleaning and sterilizing the inside with steam. A small drain cock should also be installed to drain the condensate which should be returned to the processing plant. Materials other than syrup, such as molasses or oil, should not be transported in these tanks.

The capacity of tank trucks to be used will depend on the road conditions. Taking into account the width and length for vehicles presently allowed by Jamaican law, and based on a weight assumption of 11.3 pounds per gallon of syrup, a maximum load of 33 long tons of syrup is considered feasible.

This new transportation scheme utilizing the vehicles and stainless steel tanks is presently in successful operation in Central Palmar, Venezuela. In fact Mr. Delden, a Team Member, has been and continues to be a consultant to this operation.

BY-PRODUCT UTILIZATION

Shortening of the crop duration will require a higher grinding rate and will produce larger quantities of bagasse each hour Also, the establishment of syrup producing units will lower the total process steam requirements of the factories. To maintain steam balance, it may be necessary to reduce live steam requirements proportionately lowering the amount of bagasse utilized by the boilers. This, coupled with the increased grinding rate, will result in considerable amounts of surplus bagasse. Conservative estimates place the excess as being between .65 to 19.84 tons per hour depending on the factory.

During the crop, it is common practice to store certain quantities of bagasse. This is used during mill stoppages in order to maintain steam pressure. It is assumed that approximately ten per cent of the hourly bagasse production is designated for storage. Anything in excess of ten per cent will cause major storage problems for most factories.

A shortened crop duration will utilize approximately 2,520 effective grinding hours. At the excess bagasse rates of .65 to 19.84 tons per hour, stockpiles could conceivably amount to between 1,600 and 50,000 tons and the total quantity for the combined factories could reach 280,000 tons. If collected in one area, it would cover an area of one square mile at a height of four and a half feet. This must be avoided.

A certain amount must be stored, requiring a second handling operation which cannot be avoided. However, once the bagasse exceeds the storage capacities subsequent handling costs will become prohibitive.

Today, bagasse is baled in many parts of the world. Again, the labor and equipment needed to prepare, and later reshred the bales become expensive. However, this method has had some measure of success when a paper or board plant is closely located to the sugar factory. Pelleting also has been fairly successful especially in the preparation of cattle feed, but unless the pelleting plant is situated near the sugar mill, economics of transportation become a factor Neither method should be overlooked until the possibility of their application is studied thoroughly.

A quick, single handling system is to convert the bagasse into electricity through steam generation. The solution, though not simple, should be studied closely, especially in the light of new equipment requirements.

Years ago a few of the factories adopted the American Standard of 60 cycles per second for electric generation. Some had the foresight to convert to 50 cycles since at that time Jamaica was using both the 40 and 60 cycle systems and decided to standardize its system at 50 cycles, the European standard. Thus, the 60 cycle plants cannot be interconnected with the Jamaican power grid.

Two of the 50 cycle factories, Monymusk and Frome, can and have supplied power to the grid when Jamaica Public Service encountered difficulty meeting Jamaica's demands for power.

Other factories generating at 50 cycles, have agreements with Jamaica Public Service to purchase power during the off-crop season while the generating equipment is being maintained, and for an emergency standby during the crop.

Shortening the crop season, increasing the hourly grinding rate, and increasing the excess of bagasse will change the power picture. It may be feasible to install power generation equipment at some of the factories to utilize the excess bagasse; this is especially true since, after review, nine factories may have possibilities for generating power.

Presently, Jamaica Public Service has sufficient power to meet its needs. It probably would reject any thought of purchasing unwanted power. Yet this power would be generated by a seasonal and inexpensive fuel. To allow it to remain in stockpiles or be incinerated would mean a waste of a natural resource. Many other sugar producing nations depend on bagasse for electrical generation. Their power plants are strategically located so bagasse can be transported from the sugar factory to the power plant by conveyor. During the off-crop season, the plants run on fuel oil.

Electric generation is one method of effectively utilizing bagasse. Another possibility is converting it into semi-finished pulp for paper production. Boiler capacity already exists at each factory. Capital costs for depithing the bagasse and the cooking vessels for pulping is moderate. Production costs apart from the purchase of chemicals used during the cooking also will be moderate.

A study made in 1966 evaluated the feasibility of establishing paper making and pulp producing facilities in Jamaica and concluded that bagasse quantities were insufficient to warrant paper production in Jamaica. The projected heavy surpluses may change this outlook.

Today Jamaica utilizes only a fraction of its blackstrap molasses for rum production. The rest is exported to the United States and to Great Britain where it is used mainly in the blending of animal feed. At the same time, Jamaica imports all of its motor fuel. Therefore, conversion of locally produced blackstrap into absolute alcohol should be considered.

Certain countries, notably Brazil, have used a blend of alcohol and gasoline as motor fuel for several decades. This extends the use of a natural resource, and at the same time curtails foreign exchange expenditures for fuel. Jamaica, also, could find this very advantageous.

The boiling pans which would be discarded by the syrup producing units can be converted into a triple effect for concentrating fermented molasses by a simple alteration of the piping arrangement. In addition, a rectifying column producing 190 proof alcohol would be the only new equipment required. Most of the existing molasses and syrup tanks, as well as the crystallizers, may be utilized for fermenters. The additional power required for alcohol production can be provided by a portion of the same excess bagasse.

Another by-product, yeast, may also be recovered. This product would stimulate the broiler and beef industry in Jamaica. Successful yeast recovery has been proven previously in Bolivia.

Minerals cannot be produced from sugarcane or its by-products; only organic compounds such as lactic and citric acids. Production, however, is highly sophisticated and requires a competent pathological staff and microbiologists. The market for these products are too limited in Jamaica to warrant production and,export is practically impossible as large scale facilities in other countries have already captured the existing markets.

Waxes are made occasionally from filtermud, a by-product in itself from sugar production. However, synthetic waxes are less expensive to produce and more consistent in quality.

Furfural production has also been discounted in that an efficient operation would require 500,000 tons of bagasse annually. Transportation of this bagasse to a central location would incur prohibitive costs.

Animal and chicken feed is produced to some extent, using molasses and imported grain. However, utilization of molasses for this purpose is very limited.

Fertilizers are not produced from sugarcane or its products. Sometimes filtercake (aged and seasoned) is used as a nutrient and is spread over the land mainly to ease the disposal problem.

Particleboard is produced by one small plant in the vicinity of Spanish Town. The plant (one of the smallest production units possible) is only in production part time as the local demand for the product is very limited. After transportation, it would be non-competitive elsewhere and can be marketed only in Jamaica.

Some bagasse is used for the production of baseballs near Montego Bay. The factory utilized only 100 tons of bagasse for this purpose last year.

Jamaica should realize that it is blessed with climatic conditions (yearly rainfall and distribution) and soil resources which make the country ideally suited for cane production. The resultant products, carbohydrates in the form of crystallized sugar or blackstrap molasses and fiber, should be included among its natural resources. These overall resources should be utilized to the fullest extent, to benefit the further development of the nation.

ESTIMATED INVESTMENT AND WORKING CAPITAL REQUIREMENTS

The capital costs for the proposed improvements to the industry are summarized below and broken down into a number of specific categories:

- Improvements to sugar processing facilities
- Conversion to syrup producing units
- Central End Factory
- Syrup Storage
- Jamaica Machinery Cooperative
- Cane Transportation Sector
- Working Capital

Improvements to Sugar Processing Facilities

Factory	Primary Elements Involved	Total Estimated Expenditure
Bernard Lodge	Clarification, Filter Evaporator, Crystallizer	$ 100,000
Frome	Juice Heaters, Clarifier Conversion, Syrup and Molasses Supply Tanks	31,000
Monymusk	Evaporation System, Clarifier Filter, Supply-Tanks, Vacuum Pan, Centrifugal	215,000
Appleton	Disassemble Holland equipment, Transport and re-assemble at Appleton	50,000

New Yarmouth	Clarifier, Evaporator, Vacuum Pans, Syrup Supply Tanks	$ 56,000
Sevens	Turbine (1000 H. P.) One Mill, Stainless Steel Tubes, Supply Tanks, Feeder Rolls	186,000
	TOTAL	$ 638,000

Conversion to Syrup Producing Units

Bybrook	Evaporator Vessel & Piping, Flash Evaporator	48,000
Innswood	Pre-Evaporator, Polycell Clarifier, Flash Evaporator	62,000
Grays Inn	Polycell Clarifier, Flash Evaporator	40,000
Hampden	Pre-Evaporator, and Flash Evaporator	42,500
Long Pond	Clarifiers, Evaporator Improvements including Flash Evaporator	71,000
Serge Island	Turbine, Flash Evaporator	80,000
Jamaica Estates	Turbine, Clarifier, Vapor Cell, Flash Evaporator	105,000
Worthy Park	Turbines, Main Gears, Foundations, Clarifier, Flash Evaporator	155,000
	TOTAL	603,500

Central-End Factory

The detailed requirements for the central end-factory are estimated at $3.8 million including construction. In addition the associated power plant will cost approximately $625,000 giving a total factory outlay of $4.425 million.

Syrup Storage

Twenty two syrup storage tanks distributed between Bowden, Salt River, Falmouth, Ocho Rios and the end-factory will be capable of handling 22,000,000 gallons of syrup. Estimated expenditure for these tanks is $1,320,000.

Jamaica Machinery Cooperative

To establish a centralized machinery facility with the benefits to efficiency as mentioned earlier will require approximately $1,250,000.

Cane Transportation Sector

Based upon our experience in other developing countries, we estimated an investment in the transportation sector is approximately $75/ton of daily cane grinding capacity. The combined rate of all factories is 42,336 T.C.D. The investment necessary for improvements in this sector is therefore estimated at $3,100,000.

Working Capital Requirements

The concept of running the end-factory on a year round basis will require the storage of a sufficient quantity of syrup during the 144 day average harvesting season to last for the projected 290 day end-factory production span. As mentioned earlier in the report, it is anticipated that the peak requirement will be approximately 110,000 tons of syrup in storage near the end of June. This storage capacity will effectively supply the working days of the end-factory. It will also create a working capital need for a longer duration than is presently the case.

To estimate the peak working capital requirement it has been assumed that without any improvements it costs, very roughly, about $7 per ton for cane production and about $2.60 per ton to process the cane into sugar. Of this, $9.60, over $8.00 is expended in production, initial processing, and transportation to the storage facilities. The 110,000 tons of in-process inventory of syrup will yield approximately 57,000 tons of sugar. Assuming it takes 11 tons of cane to produce one ton of sugar, approximately $5 million will be required in working capital funds to finance peak in-process inventory costs. (11 x $8.00 / ton x 57,000 tons).

On the other hand the working capital presently tied up on a permanent basis in spare parts inventories will be consderably reduced with the formation of the J. M. C. However, an overall peak working capital requirement of from $6 to $7 million dollars should be anticipated. Also, as the plans are implemented it will evolve that working capital problems, to a large extent will be shifted from the smaller producers to the end-factory Understandably, these are very broad estimates given to indicate the scope of the working capital requirements in this project. A detailed cash flow analysis based upon a detailed cost analysis is essential as part of Phase II to accurately estimate the specific working capital needs.

A common practice of sugar producers is to raise necessary working capital by marketing sugar futures. In brief, a certain percentage of the output, for instance 50 per cent may be sold using the futures medium before it is processed and shipped, thereby providing part of the funds necessary for raw materials, salaries, utilities, spare parts inventories, in-process inventories, etc. This method of financing peak working capital needs could also be used under the recommended plan.

Summary - Estimated Capital Investment

Improvements to Sugar Processing Facilities	$ 638,000
Conversion to Syrup Producing Units	603,000
Central End-Factory	4,425,000
Syrup Storage	1,320,000
Jamaica Machinery Cooperative	1,250,000
Cane Transportation Sector	3,100,000
Permanent Working Capital (excluding peak requirements financed through futures)	3,500,000
Total Estimated Capital Requirement	$ 14,836,000

ECONOMIC AND FINANCIAL CONSIDERATIONS

In the final analysis the success of any plan to improve the Jamaican agricultural picture will be the impact its implementation will have upon improving the nations economic outlook. While experimentation with agricultural diversification can and must be undertaken, sugar is and will remain for many years the dominant agricultural crop. Quite frankly no alternative has yet been found to replace sugar with its intensive requirements for labor and its large income potential. Therefore, it is incumbent that the necessary steps be taken and the necessary capital invested to improve the performance in this ailing sector. A comprehensive practical program such as the one presented in this report must be undertaken to improve efficiency at each level of production.

It is unfortunate that, as an analytical base for production costs and efficiency, 1969 and 1970 were not typical and do not provide representative cost figures. A number of firms including even the comparatively large Frome and Monymusk operations, operated at a loss due to conditions outside their control. In 1969 an unofficial strike, cane fires and flood producing rains during part of the harvest season accounted for the short fall. In 1970 poor climatic conditions contributed to the most unfavourable cane to sugar ratio in years.

Accordingly, instead of spending an excessive amount of time analyzing 1969 and 1970 production costs, the more meaningful cost figures from the detailed Mordecai report of December 12, 1966 have been analyzed to ascertain the relative breakdown of the various cost factors.

During the 1965 crop, the latest one for which detailed data are available, the average production cost per ton of Sugar Cane was reported as follows:

COST FACTOR	DOLLARS/TON		PER CENT OF TOTAL	
PRODUCTION				
*Field Workers	3.73		39.4	
* Supervisory Staff	.77		8.1	
* Sub-Total Production Labor		4.50		47.5
* Equipment maintenance including upkeep of tractors, machinery cars, etc.	1.05		11.1	
Direct Costs (including fertilizers)	.66		7.0	
Overheads	.65		6.9	
* Sub-Total average production costs		6.86		72.5
PROCESSING				
* Factory Workers	0.79		8.3	
* Supervisory Staff	0.36		3.8	
* Sub-Total Factory Labor		1.15		12.1
* Spare Parts	0.42		4.4	
Machinery	0.15		1.6	
Depreciation	0.27		2.9	
* Sub-Total all machinery	.84		8.9	
Overheads (Insurance, F.A.S. taxes, office supplies, etc.	0.61		6.4	
Sub-Total average processing cost	___	2.60	___	27.5
TOTAL COST	9.46		100%	

*Note: These factors will be improved with the implementation of the recommendations in this report.

Adding the total costs of production and processing reveals an average cost of $9.46 expended per ton of cane during 1965. The Figures above represent average costs involved. However, it must be noted that there was a great variation in production costs between the various estates. This was essentially due to the broad range of size, management expertise, and relative efficiency. As such, the cost for producing a ton of cane, while averaging $6.86 actually ranged between $5.21 and $8.04, a difference of $2 83 per ton. Thus, if we assume a ratio of 11 tons of cane per ton of sugar, the impact on the end cost of a ton of sugar could be as much as $31.13.

Similarly, the cost of cane processing ranged between $2.35 and $3.30 per ton This was predicated upon plant size efficiency and management expertise. Again assuming the 11 to 1 ratio, the end cost of a ton of sugar could have further varied by as much as $10.45. Such wide variations in production and processing costs figures per ton of sugar indicate a great deal of room for efficiency improvement. Through the broad base program recommended in this report, production and processing costs will be reduced significantly.

From the reported data it is apparent that this is a highly labor intensive product and that labor constitutes the major cost factor.

Insiders often quote the following reasons for low productivity of labor in Jamaica:

- Inefficient supervision
- Featherbedding methods of the unions
- Lack of adequately trained personnel
- The reluctance of labor to adapt labor saving innovations.

In light of this high labor intensive product, the high percentage of costs attributable to labor emphasizes the critical importance of improving labor productivity. It is absolutely essential for the Jamaican Sugar Industry to increase labor efficiency at every possible stage in order to reduce its overall labor cost and to remain competitive and indeed, even to survive. As the major proportion of the labor cost is attributed to cane cutting, the recommendations in this study call for a gradual mechanization of cane harvesting with harvesting equipment being financed and maintained by the J. M. C.

Another factor important to the future of the industry is the need for considerable investment . Another factor that is vital to the future of the industry is the need for meaningful investment in training. The extensive training program recommended in this report will have a significant and needed impact on productivity.

The Sugar Industry Welfare Board with the cooperation of the Estates and farmers, makes a very useful contribution particularly in the fields of housing and medical care. However, consideration must be directed to upgrading environmental conditions -- notably social amenities, housing and especially nutritional standards. Cane cutting and loading requires men of stamina and endurance. No machine, human or mechanical, can operate suffessfully without adequate energy.

The public image of the sugar industry has improved over recent years, mainly due to the efforts of the Sugar Manufacturers Association. The industry's contribution to the national economy is now appreciated. The strengthening of this image hopefully will help stimulate a sufficient labor pool in the future.

The cost figures stated earlier also highlight the need for improvements in the maintenance and factory processing cost components Specific requirements for significantly improving these costs have been spelled out at length in other sections of this report and are therefore not repeated in this section

Regarding the sources of capital investment for the plan outlined it is anticipated that the Government of Jamaica will have to be involved to a substantial degree in the equity in order that an attractive project package can be developed and presented to interested lenders. A reasonable example would be the equity component at 40% to 50% of the capitalization with perhaps the government supplying half the equity. In developing the specific requirements a fully detailed cost and financial analysis will be necessary in Phase II of the project. Some of the potential sources of the investment funds which could be explored during this analysis and once it has been completed, include the Jamaica Development Bank, the World Bank and its affiliate the International Finance Corporation, the International Banking Sections of several Major

U. S. Commercial Banks, the Caribbean Development Bank, the Inter American Development Bank, Bolam-Barclays Finance Corporation, Barclays Overseas Development Corporation, and others. Working closely with and soliciting the advice of knowledgeable local commercial bankers during the financial analysis will help to assure that all pertinent areas have been covered. The importance of developing a sophisticated investment project proposal must be reemphasized particularly since the industry under consideration is at present of marginal profitability.

BENEFITS

The short term benefits from the recommendations of the report are threefold:

Increase in sugar production by the shortening of the crop season and fully utilizing scarce land resources.

Increase in productivity per man hour for factory operations by taking advantage of large economies of size in the central end-factory.

Increase cane quality and annual sugar productivity by improving the transportation system for cane.

Had every factory reduced its crop season to the proposed time span during the past crop (1970), Jamaica would have increased its output by about 16,000 tons of sugar. In monetary terms this would have meant an increase of some $1.5 million.

Taking advantage of the large economies of scale in the central end-factory would increase productivity per worker per time unit. Also, the improvement in sugar production together with the greater savings possible from central warehousing of parts and with the improved quality of repairs would not necessarily increase the variable cost per ton of sugar produced.

To some extent the benefits derived from shortening the crop season (or stated differently, from the increase in daily cane grinding capacity for optimizing the sugar production per acre per annum) are quantified. A daily increase in the cane supply will be required to realize this shortening of the season. As a result, an effective cane transportation system must be developed to serve this goal.

This improved system will result in reducing the time between cane burning and grinding, and in turn will improve the quality of cane to be processed. Assuming this improvement in quality amounts to a reduction of about one ton of cane needed per ton of sugar produced, for the 1970 crop season, such a reduction would have realized a gain in excess of 36,500 tons of sugar yielding approximately $3.4 million.

Summarizing the benefits to be gained through implementation of this program, and based on the foregoing 1970 figures, an additional and immediate $4.9 million in cash in-flow would have accrued to the economy of Jamaica. In addition, the direct cost savings resulting from training, amalgamation, centralization of maintenance, and improving production and processing efficiency will be substantial and will have a tremendous impact on the profitability of the industry and its contribution to the economy.

ESTIMATE OF PRESENT SUGAR PRODUCTION AND EXPEC
SUGAR PRODUCTION AFTER SHORTENING OF THE CROP
DURATION, AND THE RESPECTIVE RETURNS, 1970

	Monymusk	New Yarmouth	Appleton	Bernard Lodge	Frome	Worthy Park	Jamaica Sugar Estates	Gray Inn
Cane Ground During 1970, Tons	734,275	280,611	142,725	433,536	779,134	154,803	209,839	127
Total Crop Duration 1970, Days	220	219	191	215	189	176	197	
Projected Crop Duration, Days	130	134	134	135	140	148	120	
Actual Capacity, Tons/hour	203.7	89.0	67.5	133.6	252.9	50.8	77.5	[illegible]
Projected Capacity, Tons/hour	312	120	65	178	312	60	97	
Actual Sucrose in Cane, Percent	10.33	10.66	12.64	9,90	12.27	12.50	10.24	
Projected Sucrose in Cane, Percent	11.03	11.23	12.76	10.45	12.79	12.59	10.83	
Sugar Projected In 1970, Tons	59,178	24,105	15,596	33,392	78,279	17,180	17,283	
Sugar Expected rom Shortened Crop, Tons	63,188	25,394	15,744	35,247	81,596	17,303	18,279	
Actual Sugar Value, Dollars	5,592,321	2,277,922	1,473,822	3,155,440	7,397,366	1,623,510	1,633,243	8
Expected Sugar Value, Dollars	5,971,266	2,399,733	1,487,808	3,330,841	7,710,822	1,635,133	1,727,365	9
Gain from Shortened Crop, Dollars	378,945	121,811	13,986	175,401	313,456	11,623	94,122	

SECTION 1

PRODUCTION AND EXPECTED
RTENING OF THE CROP
E RETURNS, 1970

orthy Park	Jamaica Sugar Estates	Gray's Inn	Sevens	Long Pond	Innswood	Hampden	Serge Island	Bybrook	Holland	Total Or Average
4,803	209,839	127,918	342,529	255,674	220,709	202,132	88,461	175,098	84,421	4,213,865
176 148	197 120	212 137	258 139	212 151	222 118	206 136	169 155	226 184	180 134	206 140
0.8 60	77.5 97	56.0 60	89.7 130	83.6 95	65.2 100	63.3 83	46.0 46	53.3 60	44.2 45	91.81 118
12.50 12.59	10.24 10.83	9.62 9.93	10.90 11.26	10.57 10.72	10.01 10.84	10.77 11.18	12.32 12.36	11.37 11.75	10.99 11.42	11.01 11.41
17,180 17,303	17,283 18,279	9,283 9,807	27,465 28,165	20,367 20,656	16,557 17,930	17,336 17,996	8,571 8,599	16,476 17,026	7,110 7,388	368,396 384,318
23,510 35,133	1,633,243 1,727,365	897,844 926,761	2,595,442 2,661,592	1,924,681 1,951,992	1,564,636 1,694,385	1,638,252 1,700,622	809,960 812,606	1,556,982 1,608,957	671,895 698,166	34,813,316 36,318,049
11,623	94,122	28,917	66,150	27,311	129,749	62,370	2,646	51,975	26,271	1,504,733

SECTION 2

CONCLUSIONS

This investigation has revealed the Jamaican sugar plants to be in such condition that optimum sugar production at a cost competitive with other major world sugar producing areas cannot be achieved in their present state. This major source of foreign exchange revenue may be lost unless well planned and detailed steps for improvement are undertaken.

The plan of action proposed in this report is practical as it will utilize the portions of the existing factories for cane processing while economies of scale can be obtained from the large centrally located sugar crystallization unit. The plan will quickly place Jamaica in a competitive position with other sugar producing nations and change the Jamaican sugar industry from a liability to an asset for the future development of the Island. At the same time, the expected increase in annual production, coupled with more effective and efficient production facilities, will dictate an increase in annual wages. Increased production will also enable Jamaica to utilize fully its sugar quota as allotted by the International Sugar Agreement.

For increased sugar production to materialize, capital expenditures are necessary in the milling, clarification and evaporation stations of most plants converting to syrup production. Some investments must also be made to upgrade the plants which are to remain sugar factories. More cane transportation equipment may also be needed when adapting the higher daily cane grinding rate. Presently, the utilization efficiency of this equipment is low. In addition, capital investments are required for construction of the centrally located crystallizing plant, for syrup storage and bulk storage sugar facilities, as well as for transportation modes.

The concentration and crystallization processes now undertaken at the individual plants will revert to the central end-factory.

The central end-factory will require essentially the same number of persons now employed during the crop season by one factory to perform the crystallization, centrifugal and sugar storage operations. Labor savings for the eliminated processing operations will be effected, but the workers presently employed in these sections can maintain and operate the remaining portion of the factories, easing the technical worker shortage. Maintenance costs in the end-factory will be lower than the combined maintenance and repair costs in the present sugar factories.

A factor that is difficult to quantify in monetary values is the effect which training will have on total sugar output. A combined effort in training, spare parts inventory control, and the formation of the JMC has been recommended, and should eventually prove very beneficial and profitable to the Jamaican sugar industry. Training should be regarded as an integral part of the overall effort.

The plan for the establishment of the centrally located end-factory is geared toward reducing costs, increasing production, and making Jamaica competitive in the export market. The formation of JMC is aimed at these objectives.

Eventually, the processing machinery of the syrup plants will have to be replaced as most of it is antiquated. When this occurs, numerous milling plants should be replaced by diffusion units, especially when cane is harvested by totally mechanized means.

In the future, sugarcane harvesting will be totally mechanized throughout the world. Jamaica should not be an exception. This will mean that large quantities of mechanical field equipment and highly skilled workers will be needed to produce the annual sugar output. It will also mean that annual production may drain the Balance of Payments unless the machinery can be manufactured in Jamaica. This is feasible under licensing agreements coupled with the training objectives of the JMC.

To reach this goal, it will be necessary to combine education with production of equipment and parts. As a result, existing facilities such as Kingston Industrial Works, Ltd. will be unable to meet the future needs of the industry since they only provide a non-specialized training program. A revitalized Jamaica sugar industry could support its own central repair and training facility and undertake fabrication of simple and essential equipment for factory and field operations. Whether or not these parts are manufactured under license, by their very nature as being of local origin, they reduce the deficit on the Balance of Payments and so benefit the national economy.

Although total mechanization of the harvesting operation should be postponed and the need to purchase new loading and transportation equipment may prove too heavy a financial burden for the industry at this time, it must be realized that harvesting mechanization is inevitable. Total mechanization will depend on the progress in machinery development and on the progress of diversification of crops contributing to Jamaica's agricultural sector. When the time arrives, sloping areas now acceptable for cane growing will prove unsuitable for harvesting mechanization. These areas will have to be utilized for crops other than sugar. Therefore, the initiation of total mechanization may result in reduced annual outputs unless fallow areas, or areas growing crops other than sugarcane, can be adapted to sugar and are suitable for mechanical harvesting.

In summary, to revitalize the Jamaica sugar industry will require a capital investment approximating $15.0 million.

PROGRAM CONTINUITY

Phase One of the UNIDO assistance program to the Jamaican Sugar industry was essentially a fact finding mission and has resulted in a positive plan of action to revitalize this industry. Phase Two would entail its implementation. To this end, suggestions are now offered to execute Phase Two as effectively as possible.

The professional disciplines responsible for the execution of the fact finding mission should be augmented by the following:

An economist specialized in micro-economics to determine precisely the anticipated costs and returns on investment recommended in Phase One.

A transportation engineer to untangle the cane transport system. He would be responsible for the design of a system for cane transportation, syrup transportation, as well as the loading and unloading of syrup and sugar.

A sugar technologist to assist with the design of every plant converting to syrup production. He would also develop the centrally located end-factory.

A civil engineer.

An electrical engineer specializing in steam generation to fully investigate the use of bagasse as fuel for electric generation.

Three management experts specialized in either inventory control, computer science or technical training.

An agronomist or agricultural engineer to assist the transportation engineer and the management specialists.

A mechanical engineer with some training experience to develop the Jamaica Machinery Cooperative with present as well as future work loads in mind. He would also assist in quantifying the value for re-utilization of equipment in the end-factory.

Trained technicians of Jamaican nationality to fully comprehend the nature of the program.

Phase Two will be a large undertaking possibly ranging from eight months to a full year. At its conclusion the Government of Jamaica would have a master plan for developing the industry over the next 15 years.

In most developing countries much data and information is available but it is not assembled properly nor readily accessible. In order to save time and to increase the efficiency of the Team, the Government of Jamaica should take the following steps prior to the commencement of Phase Two.

Prepare a detailed list, by factory, covering the spare parts used in each factory. The list should be specified according to the fabrication stations and possibly be placed on computer cards for easy retrieval.

Prepare a detailed listing of new equipment ordered by the sugar industry during the past decade to establish the extent of the production facilities needed by JMC.

Initiate a preliminary study and discussion to see whether electricity production from bagasse would be in the national interest.

Decide whether additional refinery facilities would be desirable. Such a decision will be based on whether Jamaica is to remain a supplier of raw sugar or should vigorously engage itself in the search for markets using refined sugar; a plan which may be advantageous in the event Great Britain enters the Common European Market.

Discuss with the sugar producers and Estate owners the possibility of introducing mechanical harvesting.

Consider the Sugar Industry Authority as the vehicle to coordinate and assemble this information.

Many times a study is made, a report is prepared and read with interest but contains no methodology for implementation. It becomes just another report.

The first phase report on Jamaican Sugar Industry cannot be allowed to fall into this category. The machinery to begin the second phase, namely, that of developing the detailed plan of action necessary for revitalizing the industry, must be set in motion.

A comprehensive recommendation for the execution of Phase Two was just offered. However, the point in time when work on Phase Two might actually commence is indeterminate at this time. During this interim period from Phase One completion to Phase Two start, it is essential that some form of continuity be provided in Jamaica. A continuing effort is necessary to develop the plans and to provide a market place from which to glean new ideas and concepts for ultimate fruition. For this reason an interim program, one of providing such continuity, appears highly desirable and should be strongly considered.

This Interim Continuity Program would essentially involve itself with developing the approach to revitalize the Jamaican sugar industry; an approach that would be acceptable to all parties - the cutter, the owner, the industry in general, and the Government. This program would also lend assistance to the industry in formulation of certain management techniques such as inventory control, transportation, scheduling of manpower and equipment, maintenance, and so forth.

The program's ultimate goal would be the formulation of a viable and totally acceptable framework for beginning Phase Two. For indeed, for Phase Two to be absolutely effective, this meaningful Interim Continuity Program is critical.

EXHIBITS

EXHIBIT A

PERCENTAGE CONTRIBUTION OF THE SECTORS TO GROSS DOMESTIC PRODUCT AT FACTORY COST (CURRENT PRICES) 1965-1969 ($000)

Industrial Sector	1965	1966	1967	1968	1969
Agriculture, Forestry and Fishing ..	11.6	11.6	11.4	10.3	9.0
Export Agriculture ..	4.8	4.7	4.7	4.2	3.2
Domestic Agriculture ..	3.8	3.9	3.7	3.3	2.9
Livestock, Hunting and Fishing ..	2.6	2.6	2.6	2.4	2.5
Forestry and Logging ..	0.4	0.4	0.4	0.4	0.4
Mining, Quarrying and Refining ..	9.7	9.6	9.6	9.6	11.6
Manufacturing ..	15.0	15.4	14.9	15.3	14.6
Construction and Installation ..	10.7	10.7	10.8	12.5	12.9
Electricity, Gas and Water ..	1.3	1.4	1.4	1.3	1.3
Transportation, Storage and Communication ..	7.4	7.5	7.4	7.6	7.4
Distributive Trades ..	14.4	14.1	13.9	13.5	13.6
Financial Institutions ..	4.4	4.6	4.6	4.6	4.7
Ownership of Dwellings ..	3.4	3.4	3.3	3.0	3.0
Central and Local Government ..	7.5	7.8	8.9	9.2	9.3
Miscellaneous Services ..	14.4	13.9	13.8	13.1	12.6
	100.0	100.0	100.0	100.0	100.0

Source: Economic Survey, Jamaica, 1969.

EXHIBIT B

SUGAR PRODUCTION AND EXPORTS: 1965-1969

Year	Crop Year				Calendar Year		
	Canes Milled			Sugar Produced	Sugar Produced	Sugar Exported	
	Cane Farmers	Sugar Estates	Total				
	'000 tons	'000 tons	'000 tons	'000 tons	'000 tons	'000 tons	$'000(f.o.b.)
1965 ..	2,399	2,317	4,716	506	489	424	31,266
1966 ..	2,391	2,493	4,884	482	500	408	32,886
1967 ..	2,072	2,365	4,437	456	449	352	30,176
1968 ..	2,016	2,383	4,399	456	445	383	34,004
1969 ..	2,016	1,988	4,004	360	383	302	28,584

Source: Economic Survey, Jamaica, 1969.

EXHIBIT C

AVERAGE EXPORT PRICE OF SUGAR: 1964-1969

($ PER TON)

Destination	1964	1965	1966	1967	1968	1969
United Kingdom ...	94.52	86.31	90.68	90.82	91.62	91.20
U.S.A.	97.12	84.67	88.94	96.46	114.49	120.50
Canada	89.75	44.36	38.70	39.07	46.75	54.70
Average Net Price ..	96.72	76.32	80.62	85.66	88.80	94.79

Source: Economic Survey, Jamaica, 1969

EXHIBIT D
BALANCE OF PAYMENTS: 1966-1969
CURRENT ACCOUNT
($ MILLION)

	1966			1967			1968			1969*		
	Credit	Debit	Net	Credit	Debit	Net	Credit	Debit	Net	Credit	Debit	Net
GOODS	164.2	203.2	−39.0	165.4	217.2	−51.8	184.8	276.9	−92.1	217.7	319.3	−101.6
Merchandise (f.o.b.)	164.2	203.2	−39.0	165.4	217.2	−51.8	184.8	276.9	−92.1	217.7	319.3	−101.6
Non-Monetary gold	..	..	..	..	..	..	..	..	..	..	..	.
SERVICES	114.4	118.0	−3.6	121.4	132.8	−11.4	146.8	153.5	−6.7	157.6	157.1	0.5
Freight and other transportation	16.0	34.2	−18.2	18.2	42.0	−23.8	22.8	54.1	−31.3	24.9	59.8	−34.9
Merchandise Insurance	..	2.4	−2.4	..	2.6	−2.6	..	3.2	−3.2	..	3.7	−3.7
Travel	56.4	8.4	48.0	57.8	8.6	49.2	73.4	10.4	63.0	77.9	12.5	65.4
Investment Income	6.6	40.2	−33.6	8.0	44.0	−36.0	10.6	49.8	−39.2	11.1	55.7	−44.6
Government (not included elsewhere)	8.0	2.2	5.8	9.2	2.0	7.2	9.7	2.0	7.7	10.8	1.2	9.6
Other Services	27.4	30.6	−3.2	23.2	33.6	−5.4	30.3	34.0	−3.7	32.9	24.2	8.7
(i) non-merchandise insurance	9.4	19.8	−10.4	10.4	21.2	−10.8	11.6	23.1	−11.5	12.0	13.1	−1.1
(ii) other	18.0	10.8	7.2	17.8	12.4	5.4	18.7	10.9	7.8	21.0	10.9	10.1
TRANSFERS	15.8	5.4	10.4	15.6	5.6	10.0	16.2	6.0	10.2	19.0	8.1	10.9
Private	14.0	1.0	13.0	13.8	1.0	12.8	14.3	1.0	13.3	17.1	2.4	14.7
Official	1.8	4.4	−2.6	1.8	4.6	−2.8	1.9	5.0	−3.1	1.9	5.7	−3.8
TOTAL CURRENT ACCOUNT	294.4	326.6	−32.0	302.4	355.8	−53.2	347.8	436.4	−88.6	394.3	484.5	−90.2

*Provisional

Source: Economic Survey, Jamaica, 1969

EXHIBIT E

HOURS LOST IN GRINDING DUE TO FAILURE OF MACHINERY DURING 1970

Factory	Time Lost, Hours	Per Cent of Total	Time, Hours
Monymusk	280	7.8	3,607
New Yarmouth	288	9.1	3,153
Appleton	197	9.3	2,114
Jamaica Sugar Estates	323	11.9	2,708
Bernard Lodge	583	18.0	3,246
Frome 1	303	10.4	2,923
Frome 2	127	3.9	3,237
Worthy Park	52	1.7	3,048
Gray's Inn	209	9.1	2,288
Sevens	355	9.8	3,618
Long Pond	246	8.0	3,090
Innswood	394	11.6	3,305
Hampden	128	3.9	3,312
Serge Island	157	4.8	1,922
Bybrook	297	9.0	3,283
Holland	266	13.9	1,911

Source: Sugar Producer's Association of Jamaica - Annual Factory Report 1970.

EXHIBIT F

COMPARISON OF RANGES FOR DAILY WAGE RATES BETWEEN THE SUGAR AND OTHER INDUSTRIES, JAMAICAN DOLLARS, 1969*

JOB DESCRIPTION	Sugar Estates	Bananas	Building	Govt. Agriculture	Bauxite Agricultural Operations	Bauxite & Alumina Production	General Manufacturing
Daily Paid Workers (Male)	1.08 - 1.50	0.65 - 1.08	2.36	1.85 - 2.00	1.43 - 3.60	6.64 - 6.80	1.20 - 7.12
Tractor Drivers (Heavy Units)	1.65 - 3.59	1.96 - 2.88	6.88	3.33	2.16 - 4.56	11.12 - 13.60	2.40 - 7.36
Mechanics	1.48 - 3.50	3.28 - 8.38	3.93 - 6.40	2.90 - 4.00	3.84	9.36 - 12.96	1.92 - 12.00
Carpenters	1.35 - 3.50	-	4.00 - 6.00	2.90 - 4.00	-	7.28 - 10.64	2.00 9.84
Electricians	1.48 - 3.50	-	4.00 - 6.00	-	-	9.04 - 12.96	3.28 - 11.84

* Per 8-hour Day

EXHIBIT G

WAGE RATE STRUCTURE WITHIN THE SUGAR INDUSTRY - 1969
(JAMAICAN DOLLARS)

The data below represent the minimum and maximum rates among the 16 estates operating in 1969; they do not represent a range or scale applicable to all estates.

All figures are obtained from the compilation of 1969 Wage Rates which is the most up-to-date source available.

Field

Job	Rate
Manual Cane Cutting (Green Cane)	$0.53-0.58 per ton
Manual Cane Cutting (Burnt Cane)	0.60-0.63 per ton
Manual Cane Loading	0.42-0.46 per ton
Tractor Drivers (Wheel)	1.65-2.75 per 8-hour day
Tractor Drivers (Crawler) (D4 Unit and Larger)	1.80-3.59 per 8-hour day
Mechanical Loader Operators	3.00-4.00 per 8-hour day
Railway Drivers	2.54 per 8-hour day

Factory

Job	Rate
Sugar Curer	1.30-2.96 per 8-hour day
Mill Engine Operator	2.70-3.40 per 8-hour day
Electrician	1.48-3.50 per 8-hour day
Welder	1.58-3.50 per 8-hour day
Carpenter	1.35-3.50 per 8-hour day
Cane Hoist Operator	1.70-3.03 per 8-hour day

There is an increasing trend toward payment by results, replacing hourly paid rates. For instance, on many estates mechanical loader operators are paid as follows:

Mechanical Loader Operator	3.50 for first 100 tons plus 0.03 per ton thereafter.

An average operator will load 300 tons in an 8-hour day.

EXHIBIT G (Continued)

Average daily earnings in the Sugar Industry:

In Crop:	
Factory	$2.96
Harvesting	2.55
Cultivation	2.68
Out-of-Crop:	
Factory	2.66
Cultivation	1.71

In the derivation of the above, data on the average number of man-days in a man-week was necessary. This was obtained from a survey of attendance records covering 42 per cent of workers employed by estates.

In Crop:	
Factory	$5.33 man-days per man-week
Harvesting	4.61 man-days per man-week
Cultivation	4.52 man-days per man-week
Out-of-Crop:	
Factory	4.38 man-days per man-week
Cultivation	4.51 man-days per man-week

A more representative method of expressing a diversity of wage rates is by weighted averages, rather than by selecting only the very highest and the very lowest rates in the industry, for a particular job.

The data below as derived from the 1969 compilation of Wage Rages.

Points to Note: Factory rates were weighted using the total in-crop factory non-staff employment figure for each estate.

Field rates were weighted using the total in-crop reaping non-staff employment figure for each estate.

Where a range exists, e.g. Crane Operator, it indicates that at least one estate has a wage range for that job.

EXHIBIT G (Continued)

Wage rates are expressed throughout in Jamaican Dollars, and represent remuneration per 8-hour day unless otherwise stated.

Job	Rate per Day
Cane Handling at Factory	
(a) Cane Yard Foreman	$2.19
(b) Crane Operator	2.33-2.38
(c) Others	1.29-1.78
Milling	
(a) Mill Foreman	1.95-2.98
(b) Mill Feeder	2.11
(c) Other	1.38-1.89
Generation of Steam	
(a) Boiler Foreman	3.81
(b) Boiler Attendant	2.48-2.58
(c) Other	1.58-1.88
Clarification Evaporation and Crystallization, etc.	
(a) Pan Supervisor	2.38
(b) Pan Boiler	3.00-3.06
(c) Evaporator Attendant	2.33-2.35
(d) Others	1.55-2.00
Cleaning Vessels	
Cleaning Evaporators	1.58-3.21 per vessel
Curing Sugar	
(a) Curing Foreman	2.80
(b) Centrifugal Attendants	1.88-2.02

EXHIBIT G (Continued)

Sugar Store		
(a) Marking, Bagging, etc.		$0.24 per ton
(b) Laborers		1.13-1.22
Laboratory		
Sampler		1.35-1.53
Rum Distillery		
(a) Distillery Foreman		3.10-3.43
(b) Still Attendant		1.98-2.17
(c) Setting Wash		1.46-1.51
(d) Fermenting Loft Attendant		1.36-1.37
(e) Can Pit Attendant		1.43-1.53
(f) Other		1.35-1.75
Tradesmen		
Chargehands - All Trades		3.75
(a) Welder	I	3.14-3.28
Welder	II	2.60
Welder	III	2.18
(b) Electrician	I	3.31-3.28
Electrician	II	2.67
Electrician	III	2.21
(c) Plumber	I	2.89
Plumber	II	2.46
Plumber	III	2.07
(d) Tinsmith	I	2.89
Tinsmith	II	2.23
Tinsmith	III	2.00
(e) Blacksmith	I	2.89
Blacksmith	II	2.46
Blacksmith	III	2.07

EXHIBIT G (Continued)

(f) Machinist	I	$3.25
Machinist	II	2.63
Machinist	III	2.21
(g) Mechanic	I	3.08-3.13
Mechanic	II	2.54-2.55
Mechanic	III	2.12-2.13
(h) Carpenter	I	3.02-3.04
Carpenter	II	2.52-2.55
Carpenter	III	2.12
(i) Mason	I	1.96-3.03
Mason	II	2.51
Mason	III	2.06
(j) Riggers	I	3.30
Riggers	II	2.91
Riggers	III	2.20
(k) Painters	I	2.61
Painters	II	2.34
Painters	III	1.99
(l) Coopers	I	2.86
Coopers	II	2.54
Coopers	III	2.23
(m) Fitters	I	3.00
Fitters	II	2.33
Fitters	III	2.07
(n) Assistants		1.68-1.74
(o) Helpers		1.33-1.56
Reaping Operations		
Manual Green Cane Cutter		0.55 per ton
Manual Burnt Cane Cutter		0.63 per ton
Manual Cane Loader		0.43 per ton
Tractor Driver (Wheel)		2.29-2.34
Tractor Driver(Crawler-D4 and larger)		2.65-2.77
Mechanical Loader Operator		3.32
Railway Driver		2.54

Source: Private Communication with the Sugar Producers Federation of Jamaica.

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