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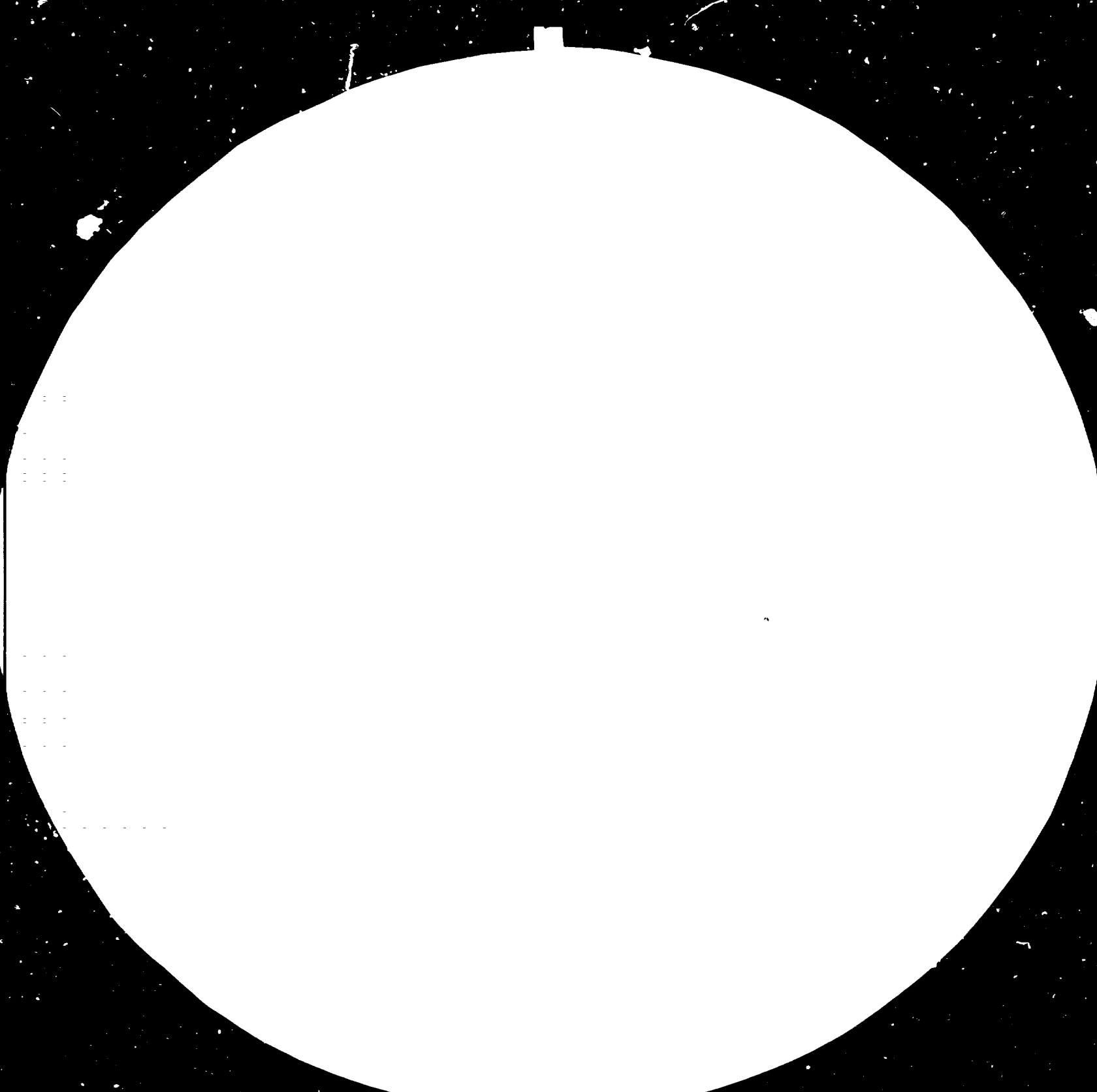

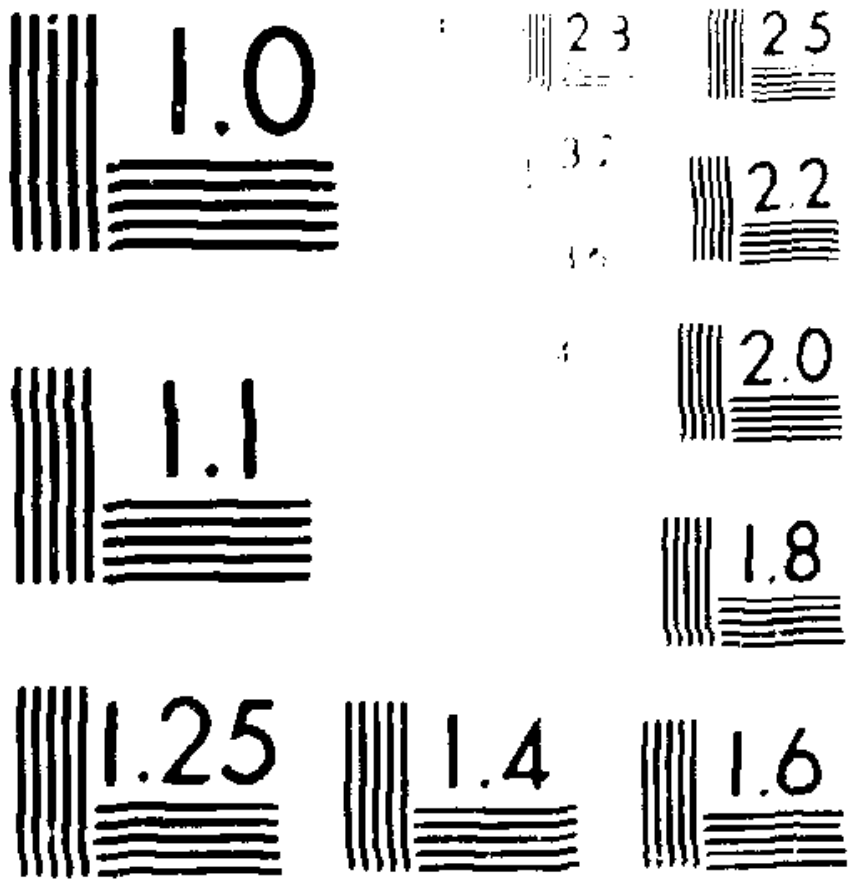
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# PREPARATORY PHASE IN THE ESTABLISHMENT OF A REGIONAL PROJECT IN THE AREA OF MAINTENANCE AND REPAIR IN LATIN AMERICAN AND CARIBBEAN SUGAR MILLS

Report of a preparatory mission *

prepared by

the Engineering Industries Section,
Division of Industrial Operations

838

* This document has been translated from an unedited original.

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## EXPLANATORY NOTE

At the request of the Group of Latin American and Caribbean Sugar-Exporting Countries (GEPLACEA), UNIDO provided technical and financial assistance under project UC/RLA/82/034 for the preparatory phase of a project aimed at introducing efficient modern systems and techniques for the maintenance of sugar-cane mills in Latin America and the Caribbean.

UNIDO was assisted by Mr. Fernando Vera and Mr. Göte Frederickson, both engineers and experienced international experts in this field, and also Mr. Eduardo Casanova, Assistant Scientific Director of the Cuban Institute of Sugar Research (ICINAZ), who was kindly seconded by the Institute.

This document sets out the results of the work carried out by these specialists over a period of three months, during which they visited 12 countries in the region. The information gathered is analysed and recommendations are made for launching the regional project.

The project proposal contains long-term recommendations for implementation with the possible assistance of the United Nations Development Programme (UNDP) and UNIDO (development and application of a regional maintenance system for the sugar industry).

With the direct assistance of our Section and in collaboration with the specialists an alternative proposal was drafted for the first phase of the proposed regional project (research, development and application of a maintenance system for the sugar industry - first phase).

In view of the complexity of implementing regional projects, our Section recommends that a prior study be made of the advisability of beginning the project with this first phase.

Engineering Industries Section IO/ENG

## Report prepared by the experts

### Acknowledgements

It should be noted that the mission's objective of evaluating, within a very short period of time, the situation of maintenance in Latin American and Caribbean sugar mills and assisting the countries visited in preparing their national reports could not possibly have been attained without the co-operation of the Permanent Secretariat of GEPLACEA. On arrival in each of the 12 countries visited, we found that the national institutions officially linked with GEPLACEA had already organized and co-ordinated the mission's programme and that arrangements had already been made to satisfy the three requirements stipulated for the mission, namely:

The appointment of an institution or person to prepare a national report on the maintenance of sugar mills on the basis of an outline drawn up by the mission;

The appointment of persons familiar with the problem of sugar-mill maintenance in their countries to discuss the matter with the mission;

The selection of two sugar mills for visits by the mission.

These three requirements were met in every detail. The mission would like to express its gratitude to the Executive Secretariat of GEPLACEA for its valuable assistance and to thank the co-ordinating bodies in each of the countries visited, the managements of the sugar mills kind enough to receive us and all the distinguished professional persons in each of the countries who were most frank and open in their discussions with us.

Lastly, so as not to overlook anyone, we would like to express our very sincere gratitude to each and every one of the institutions and persons who in one way or another collaborated with us in carrying out our undertaking.

Introduction

The mission was undertaken with a view to accomplishing the task set by the United Nations Industrial Development Organization (UNIDO) of preparing a regional report as quickly as possible on the present situation of and outlook for maintenance work in Latin American and Caribbean sugar mills, collaborating with those countries in drawing up their individual national reports and then preparing a draft regional project for the development and application of a maintenance system for the Latin American and Caribbean sugar industry. Having consulted GEPLACEA and the Government of the Republic of Cuba, UNIDO came to the conclusion that the most direct and viable way of attaining this objective would be to appoint a mission of technical experts who would visit at least 10 countries in the area (to be determined by GEPLACEA in accordance with the funds available for this purpose) and that a maximum of three months was available for the two planned tours. During that time the activities of the mission should be co-ordinated with each of the countries selected, the necessary arrangements made regarding visas and travel, documents prepared preliminary to the visits, a joint meeting organized with the representatives of the countries visited, a document prepared to be discussed at the meeting, a draft regional project for the maintenance of sugar mills in Latin America and the Caribbean drawn up and a preliminary report prepared for each of the countries visited, together with a final report summarizing activities. The following professionals were appointed to carry out the work described above:

Mr. Eduardo Casanova, Assistant Scientific Director of the Cuban Institute of Sugar Research (ICINAZ);

Mr. Göte Frederickson, Consultant and Senior Adviser for UNIDO project CUB/77/007 for Research into Sugar Mill Maintenance;

Mr. Fernando Vera, GEPLACEA Consultant and, under the present project, expert in technology transfer and TCDC.

At the request of GEPLACEA, the Republic of Cuba, a member country of GEPLACEA, was designated as the host country for the project. For almost three years Cuba has been successfully implementing a national maintenance programme with the assistance of the United Nations and, in co-ordination with GEPLACEA, has been providing non-destructive testing services on a

co-operative basis to countries requesting such services. To date, three countries - Bolivia, Panama and Nicaragua - have received such assistance and in some cases repeat visits have been made at the express request of the recipient country.

Strategy

Once the experts taking part in the mission had been selected, the group met in Havana in May (at the expense of GEPLACEA and the Cuban Government) and arrived at the conclusion that in order to carry out the activities planned in the short time available the following strategy would have to be adopted:

1. By the time the programme has been launched, GEPLACEA (at least in the countries considered in the first tour) should have:

Appointed an institution in each of the countries to co-ordinate the project and mission activities and obtained the names of the persons to be contacted within those institutions;

Appointed an institution or persons in each of the countries to be visited to prepare a national report on the maintenance of sugar mills on the basis of an outline prepared by the mission;

Appointed persons familiar with the problem of maintenance in their respective countries to discuss the matter with the mission and to provide the information needed for the preliminary national reports to be prepared by the mission;

Selected two mills in each country to be visited by the mission with a view to supplementing the information gathered verbally and more closely evaluating the maintenance situation in the countries visited.

2. Bearing in mind considerations of economy and time, a list was drawn up of approximately 15 countries, 10 of which were to be covered in two tours, both starting out from Havana. GEPLACEA designated the following countries:

First Tour:

| | | |
|---|---|---|
| Bolivia | - | Santa Cruz |
| Peru | - | Trujillo |
| Colombia | - | Cali |
| Panama | - | Panama City, Chitré |
| Nicaragua | - | Managua |
| Mexico | - | Mexico City, Córdova |

Second Tour:

| | | |
|---|---|---|
| Jamaica | - | Kingston |
| Barbados | - | Bridgetown |
| Guyana | - | Georgetown |
| Trinidad and Tobago | - | Port of Spain |
| Costa Rica | - | San José |
| Cuba | - | Havana |

Details of these tours and visits are given in the annexes to the preliminary national reports.

3. On agreement between officials of UNIDO, GEPLACEA and the Cuban Government, so that the project might commence on 1 September, Mr. Vera was asked, from 1 to 4 September, to review the co-ordination of all activities and the contacts provided for under paragraph 1 of this section and to prepare the outlines to be used as a basis for drafting the reports on individual sugar mills and the national reports contained in annexes 1 and 2 to the present report.

4. In case there should be no informant forthcoming at the national level, the precaution was taken of preparing outlines which, when fleshed in, would yield exhaustive reports on each mill. All these, along with other factors covered by the outline concerning the national context, would yield the national report requested by UNIDO in project UC/RLA/82/034.

These outlines were given to the co-ordinating bodies in each of the countries visited with instructions that they be forwarded to the Secretariat of GEPLACEA for the necessary processing.

5. A checklist was drafted of questions which the mission would ask in each country with a view to compiling the preliminary national reports.

6. On the basis of the discussions held in each of the countries visited, the notes and documents collected and, in particular, the assessments made in the course of the visits to the sugar mills in each country, together with other information obtained and existing documents, a basic document would be prepared for discussing maintenance at the meetings on technological subjects to be held at the GEPLACEA Assembly at Mazatlan, Mexico. A member of the mission would be appointed to present the report and participate in the discussion of it (see annex 1).

7. After approval and/or revision of the report in the light of the discussion of it, the draft regional project requested by UNIDO would be prepared, this latter document being chiefly composed, except for the introductory comments, of sections on the background and justification, objectives, outputs, activities and inputs which should be contemplated by the regional project.

8. At the end of the tours the mission should meet at Havana, Cuba, from 13 November in order to prepare the preliminary country reports.

In addition, the mission should prepare the final report and the draft regional project requested (see annex 5).

General appraisal and comments

In addition to the effective collaboration of promotion and development bodies, the initiation of a regional maintenance project also requires the active participation of the countries concerned. The mission determined that each country found different aspects of the project's objectives to be of interest. The catastrophic situation of this industrial sector is such that without the support of international institutions such as the United Nations it would be impossible to attain any of these objectives.

Quite apart from the country evaluation contained in the report, it is important to note that technical assistance is essential to both the sugar mills and their umbrella institutions in the process of identifying and selecting, at home and abroad, the most appropriate ways and means of utilizing the resources allocated for these programmes.

In view of the absence in some countries of a central body representing all the country's producers, it will first of all be necessary to draw up inventories of their needs, determine their common problems and then arrange for their participation in the aspects of the project exclusively directed towards practical solutions.

This initial regional activity is intended to lead to the drafting of a project which at the Latin American and Caribbean level will provide an evaluation and diagnosis of the present situation in respect of maintenance in the region and, above all, will result in recommendations of activities and measures aimed at solving the most pressing problems affecting the maintenance of sugar mills in the GEPLACEA area. This would be a valuable contribution to the region's sugar industry, making for improved productivity in terms of the equipment and mills and thereby reducing the cost of producing cane sugar.

This is borne out by the experience which the United Nations has gained in the project which it has been running jointly with the Government of Cuba for almost three years with a view to establishing a modern maintenance system in Cuba's sugar mills, which has even made it possible to offer assistance to other countries.

The geographical distribution and different climates of the countries in the region are such that maintenance systems in the mills and at the national level in each case have their own distinctive features. Generally speaking, however, there is an urgent need for assistance in modern maintenance systems, which would improve operating conditions in this industrial sector, and, at the very least, represent a step in the direction of the benefits which other production activities have derived from the development of maintenance systems.

In all the countries visited the interests expressed were in line with the various matters to be covered by a maintenance project for the sugar industry, as reflected in the reference document prepared by the mission before embarking on the tours.

Execution of the mission

The mission's objectives as set out in project UC/RLA/034 were attained by keeping to a strict schedule which made no allowance for holidays or daily working hours, 12 countries and 26 sugar mills being squeezed into the 40 days or so of travel. Detailed information on the countries visited is given in the national reports (see annex).

Before the tours started four documents were prepared:

A mill report outline;

A national report outline;

A summary of maintenance activities;

A checklist of questions to serve as a basis for drafting the preliminary reports on the countries visited.

The first three items were given to the co-ordinating bodies in each country with instructions that, once they had been filled in, the first two should be forwarded for processing to the Secretariat of GEPLACEA, thus providing a primary source of more detailed information on developments in the field of maintenance in the countries visited by the mission.

The mission gave the Executive Secretariat of GEPLACEA the document to be discussed by the representatives of GEPLACEA member countries at the meeting to be held from 8 to 11 November at Mazatlan, Mexico (see annex).

The main objectives set out in this document were explained by a member of the mission at the technology meeting. It was approved without amendment and the General Assembly of member countries recommended that the Secretariat of GEPLACEA take the necessary steps to implement the project.

At this Assembly the delegations of Brazil, Honduras, the Dominican Republic and Venezuela invited the mission to their countries with a view to taking an active part in the project.

Starting on 13 November the mission met at Havana, Cuba, in order to prepare the preliminary reports for each of the countries visited in the form indicated in the introduction to the present report. Also, using the document presented at Mazatlan as a basis, the draft regional project attached to the present report (see annex) was prepared. An alternative regional project for the first implementation phase lasting two years was also drafted.

These documents were submitted to the Havana meeting held from 26 November to 4 December and on the 29th, which was attended by Mr. Florentino Chacon from UNIDO, Vienna, and Mrs. Altagracia Rivera de Castillo, the Deputy Secretary for Technology at GEPLACEA, in addition to the members of the mission.

Recommendations

In the interests of avoiding unnecessary repetition, the mission considers that the recommendations resulting from the visits to the various countries correspond to the objectives and outputs set forth in the draft regional project (see annex), as summarized below:

(a) Reduction of production costs and improvement of equipment and mill productivity;

(b) Harmonious rationalization and optimization of energy consumption;

(c) Study of the protection, reconditioning and manufacture at the national and/or regional level of equipment, parts and components;

(d) Planning and programming of maintenance;

(e) Study and analysis of the quality and applications of materials, tools, machine-tools and workshops;

(f) Standardization of equipment, parts, components and methods;

(g) Problems of corrosion, abrasion and lubrication;

(h) Full dissemination of information on the present situation, technological advances in the various production and maintenance sectors and the need for training at all levels.

The mission considers that the project should seek national-level solutions to maintenance problems. The project would thus be enhanced by the information gathered from each country's experiences, while, in carrying out their own programmes, the latter would in turn benefit from the insights and results obtained by the regional project. It is therefore recommended that the United Nations and, in particular, its agencies (UNIDO, UNDP, UNCTAD, etc.) regard any individual maintenance project implemented in the Latin American and Caribbean region as part of this regional project.

The mission considers that the results and experiences gained in connection with the project in any country or group of countries should be incorporated in a document which could ultimately take the form of a maintenance manual for the use of all the countries in the region.

Diagnosis and conclusions

To return to a point made earlier, in view of the short time spent in each country the mission feels that its findings should be regarded as general in character, relating to the area as a whole and highlighting the most characteristic aspects of the regional situation. Their conclusions can be summarized in the following points:

The region lacks integrated standardized national maintenance systems, except in Cuba and Mexico, the latter country being in the process of introducing such a system;

With rare exceptions, maintenance procedures are not based on fault-detection by means of non-destructive tests;

There are no systematic studies on problems related to lubrication, corrosion and abrasion;

The region has little experience in the practice and techniques of reconditioning of parts and components;

In almost all the countries of the region there is insufficient training in the various skills required for maintenance and repair work;

The region has no information and extension centre for the various types of maintenance work to enable mills, countries and personnel in the sugar sector to share their technical expertise;

Warehouse and inventory control are computerized in only a few of the countries in the region. Cuba and Mexico are in the process of installing computerized systems for the monitoring of repairs between sugar harvests;

It should also be noted that the present requirements with respect to the maintenance of precision and control instruments will increase considerably when a new maintenance system is installed. This kind of service, which is at present virtually non-existent in the region, will therefore need to be developed;

The mission feels that a number of comments should be made on possible contributions to the project by the countries visited, the nature of the contribution depending on the stage of sophistication reached in the various branches of maintenance in each country.

Bolivia

Bolivia has expressed its interest in participating in a regional maintenance project. However, in view of its low level of development in this area, its assistance would be logistical in nature, involving the provision of facilities and secretariat services and the financing of national technical personnel participating in any activity carried out in the country.

Barbados

No way was found in which Barbados could contribute to a regional project.

Colombia

This country could share the insights gained from its experience at the Central Cauca S.A. in the organization, planning and monitoring of maintenance, activities which are at a fairly advanced stage of development in Colombia. Mills with similar conditions, i.e. harvest seasons lasting 11 months, could therefore benefit greatly from Colombian experience.

Costa Rica

In view of the interest shown by Costa Rica in the establishment of enterprises for designing and manufacturing parts and components, it could no doubt provide logistical support, premises and some technical personnel for this type of work in connection with the project.

Cuba

With its Sugar Research Institute, which, in collaboration with the United Nations, has for three years been carrying out a national maintenance project, its national training centre for the sugar industry and its two faculties of sugar research at the Universities of Havana and Santa Clara, Cuba is exceptionally well qualified to provide the headquarters of the technical advisory committee for the project.

The Cuban Sugar Research Institute (ICINAZ) has stated its readiness to assist the project by making the following available:

A maintenance laboratory constructed for the national project;

A laboratory for the study of corrosion and new materials;

Workshops equipped with pan-repair machines for the construction of prototypes and the reconditioning of parts and components;

An experimental sugar mill with a capacity of 1,000 tonnes of cane per day;

An instrument-analysis laboratory.

At present ICINAZ has 150 university-educated technicians professionally employed in the field of sugar research.

Guyana

Guyana could contribute to the maintenance project under discussion in the reconditioning of parts and components.

At present Guyana has one workshop, the only one of its kind in the region, using sophisticated techniques for the reconditioning of parts and components, which also has a training programme for Guyanese workers.

Given the collaboration between the English-speaking Caribbean countries through the University of the West Indies and other similar organizations, the establishment of scientific and technical collaboration in the field of maintenance between the countries of the region might also be contemplated.

Jamaica

The local authorities in Jamaica operate a small Institute for Technological Research which carries out training programmes in collaboration with the University of the West Indies. This material and technical basis could be used by the countries of the area in a regional maintenance programme.

Mexico

In the context of co-operation between Mexico and Cuba, Mexico's National Commission for the Sugar Industry (CNIA) is currently engaged in a programme to introduce an integrated maintenance system geared to national conditions for its sugar mills, as well as the computerization of warehouse inventories and repair monitoring on the basis of systems developed in Cuba.

The experience gained in establishing a modern integrated maintenance system could be made available to the other countries in the region as an important contribution to the regional project.

Nicaragua

Nicaragua's sugar industry is currently undergoing a total reorganization, a task which is hampered by insufficient technical personnel and material resources. This reorganization is being carried out in close collaboration with the Cuban sugar industry, which has provided technical services through the national maintenance project implemented in Cuba.

Nicaragua could provide logistic support and the necessary infrastructure for any activity deriving from this regional project carried out in Nicaragua itself.

Panama

The Corporación Azucarera la Victoria is extremely eager to take an active part in a regional maintenance project.

In this connection, the mission has been informed that Panama would be willing to finance any activities carried out on its own territory and to provide logistic support, premises and technical personnel.

Peru

Peru does not as yet have a central institution representing all its sugar producers. Before embarking on any kind of activity in this sector it would therefore have to set up a body at the national level, which could co-ordinate any kind of participation in a project in this field.

Nevertheless, a number of sugar mills in the country have large machine shops, workshops and foundries which could serve as a solid basis for activities relating to the construction of components and parts.

Furthermore, Peru's Sugar Research Institute could be involved in various activities related to the project, including training.

Trinidad and Tobago

This country seems to be the only one in the English-speaking Caribbean area to have installed a modern computerized system for financial and warehouse controls. It could therefore serve as a training centre for those countries in the region interested in this type of development, with possible application to maintenance.

UNITED NATIONS DEVELOPMENT PROGRAMME

Project of the Group of Latin American and Caribbean Sugar-Exporting Countries (GEPLACEA)

(Names of the countries participating in the project)

PROJECT DOCUMENT

Title: Research, development and application of a regional maintenance system for the sugar industry (first phase)

Number: Duration: 2 years

Primary function: Direct assistance

Secondary function: Service

Programme classification: Industrial and institutional services

Code: 3530

Government implementing agency: GEPLACEA - Ministry of the Sugar Industry of the Republic of Cuba - Cuban Sugar Research Institute

Executing Agency: UNIDO

Estimated starting date: July 1983

Government inputs: _____ (local currency) (in kind) UNDP inputs: $US 600 000

_____ (local currency) (in cash)

Government cost-sharing (if any): _____

Signed:

_____ Date: _____

On behalf of the host Government

_____ Date: _____

On behalf of the Executing Agency

_____ Date: _____

On behalf of the United Nations Development Programme

PART I - LEGAL CONTEXT

This Project Document shall be the instrument referred to as such in article 1, paragraph 1, of the Basic Assistance Agreement between the United Nations Development Programme and the Governments of the participating countries which have signed that Agreement. For those participating countries which have not signed the above agreement this Project Document shall be the instrument referred to as the Plan of Operation in article 1, paragraph 2, of the Agreement concerning assistance under the Special Fund sector of the United Nations Development Programme between the United Nations Development Fund and the Governments of the participating countries which have signed the above-mentioned Agreement.

PART II - THE PROJECT

Introduction

This Project Document constitutes the first phase of a regional maintenance project in which the participants are Latin American and Caribbean sugar-exporting countries, members of GEPLACEA.

Its objective is the development and implementation of a modern maintenance system of sophisticated repair techniques for sugar mills.

The project is designed to constitute an initial phase lasting two years, which will lay the foundations for the development of maintenance-related activities and yield the first results of project implementation. This first phase will be carried out on the basis of technical co-operation programmes between developing countries in the region. These will involve applied research aimed at improving the efficiency of maintenance operations in the region's sugar mills and, above all, the training of technical personnel.

Once this phase has been completed, it will be possible to implement more advanced phases of the project, enabling the participating countries to develop optimum maintenance and repair procedures in their sugar mills.

(a) Development objectives

1. To modernize the maintenance and repair systems employed in the region's sugar mills, using the most sophisticated technologies;

2. To train maintenance and repair staff in the countries of the region in the most sophisticated techniques in their specialized fields;

3. To lay the foundations of a regional information system relating to maintenance and repair work.

(b) Immediate development objectives

1. To train specialists from the participating countries by means of seminars, courses and on-the-job training in all aspects of sugar-mill maintenance and repair work covered by the project, including the mastery of new technologies, the use of integrated maintenance systems and the organization of support services and workshops.

Training will be directed towards: the use and interpretation of non-destructive tests in diagnostic maintenance, the implementation of techniques for the reconditioning of parts and components, the application of corrosion-prevention systems and methods, the use of techniques for the maintenance of instruments and the introduction of integrated modern systems for the maintenance and repair of sugar mills.

2. To develop effective technical collaboration between the countries in the region with respect to the maintenance and repair of sugar mills with a view to making fuller use of the region's trained personnel, the experience accumulated by the participating countries and their technical resources and facilities.

3. To develop lines of scientific research to respond to the problems highlighted by the project, with a view to practical evaluation and the dissemination of the results between the participating countries; also, to provide the technical consultancy necessary to apply those results in the region's sugar mills.

   Research and development work will be directed towards diagnostic maintenance and the reconditioning of parts and components, the design of systems for the maintenance of instruments, the study of the use of new materials and protection against corrosion and the introduction of computerization in the organization and monitoring of maintenance.

4. To develop integrated maintenance systems for sugar mills and provide advice on their installation in accordance with the conditions prevailing in the region and with particular regard to the following: planning, organization and the methods to be employed in the technical and economic control of activities in this sector, including services provided by auxiliary workshops and warehouses.

5. To set up a regional centre to collect and process information relating to maintenance in the sugar industry and to disseminate information on the results obtained from the project and other sources. This centre would establish the necessary channels of communication between national documentation centres and international data banks. It would process and supply statistical

data on the production and consumption of equipment, parts and components at the national and regional levels for dissemination among the participating countries. It would also serve as a channel for technical co-operation between the developing countries in the region (TCDC).

(c) Special considerations

This project, to be implemented in several phases, is intended as a regional effort aimed at the development of the Latin American and Caribbean sugar industry through the establishment of modern maintenance systems and techniques.

In addition to the objectives mentioned throughout this document, the project also responds to two of the global targets assigned priority by the Governments and authorities of UNDP and GEPLACEA, namely:

The promotion of methods and systems for technical co-operation between developing countries through mutual transfers of technology between mills in the region. In this connection it is planned to use national experts whenever possible.

The raising of maintenance standards with a view to increasing operating efficiency, thereby saving energy in the industry and using the fuel it produces itself as effectively as possible.

(d) Background and justification

In terms of technology and equipment, the sugar industry in the region has remained at the same level for much more than 50 years. None the less, the region produces over 32 per cent of the world's sugar and accounts for over 52 per cent of world sugar exports. It has approximately 700 sugar mills valued at approximately $US 20 billion. It should be added that the annual cost of maintenance and unscheduled shutdowns of these sugar mills amounts to the equivalent of $US 1 billion in the various national currencies.

In almost all the region's sugar mills it is customary to take advantage of two types of shutdowns in order to carry out maintenance work. These shutdowns are due to:

(a) The cyclical nature of sugar production, mainly attributable to climatic conditions prevailing for almost six months of the year. Here, consideration should be given to those few countries in the region where, for reasons other than the climate, sugar mills set aside a period of 20 to 60 days each year for the sole purpose of carrying out maintenance work;

(b) Production stoppages owing to equipment failures or problems unrelated to maintenance.

In the former case (a) all the equipment and machines at the sugar mill are completely dismantled, a system which is extremely costly and for much of the equipment unnecessary into the bargain. In the latter case (b) the equipment is inspected, after which light maintenance work is carried out. In both cases inspection is chiefly visual owing to the lack of suitable instruments and techniques. The attempt to carry out difficult diagnoses with the naked eye often leads to breakdowns and then to shutdowns, which in many instances may last several days with the consequent impact on production and increases in fuel consumption and operating and maintenance costs.

Furthermore, sugar industry operations are found mainly in developing countries. Despite being a fully processed product, sugar encounters the same obstacles to marketing and prices as do raw materials - and possibly even greater ones. In many of these countries sugar is the main source of foreign currency and of jobs; any fluctuation on the international market therefore has a direct effect on the economic situation in the sugar-producing countries. The efforts made throughout this century to keep sugar prices in line with the prices of other products and with world economic trends have failed even to stabilize sugar prices. This situation is aggravated by the ever-rising price of the equipment, components, spare parts and materials used in the various stages of sugar-based agro-industry.

Any effort or initiative to alleviate the alarming situation facing most of the sugar-producing countries and, in particular, to promote the development of this agro-industrial sector would be welcomed not only by the producing countries themselves but also by the bodies whose function it is to promote human welfare.

Finally, the large number of countries involved in this sector, the considerable size of the workforce employed in sugar growing and processing, the quality and quantity of the product, together with all the reasons given above point to the need to implement within as short a time as possible a regional project aimed at providing the cane-sugar-producing countries of Latin America and the Caribbean with the most sophisticated systems and techniques for the maintenance and repair of industrial equipment.

The implementation of a project of this kind would ensure that the industry developed in an organized way towards practical forms of technical co-operation between the developing countries of the region.

The project would make it possible to carry out the necessary research in the various branches of maintenance, to train local technical personnel, and to develop an information system enabling specialists to keep abreast of the most up-to-date techniques.

(e) Outputs

In all the areas of development covered by the project the outputs expected from activities relating to the training of technical personnel in the participating countries will be among the most important ones.

The outputs expected from the project are as follows:

Research and development:

The technical and scientific testing of equipment, parts and components, in the context of a system of diagnostic maintenance, using techniques and instruments designed to reduce the need to dismantle machinery completely in repair work between harvests.

The development of recommendations and guidelines on the reconditioning and protection of parts and components and of the equipment and instruments used in the system.

The preparation of guidelines and recommendations on the maintenance of monitoring equipment and instruments used in the sugar mills.

The preparation of recommendations on a corrosion-protection system and on the use of new materials.

Laying of the groundwork for a computerized system for the planning, organization and monitoring of maintenance.

The organization and planning of maintenance:

The drafting of a maintenance manual for use in all sugar mills; this manual would include an organizational chart of the maintenance and repair service, guidelines and recommendations on the planning of scheduled, preventive and operational maintenance, the establishment of models for the control of operations, inventories and costs, together with recommendations on questions such as the qualifications required for prospective technical staff.

Information:

The establishment of a regional maintenance and repair information exchange system, which will also provide a means of channelling technical co-operation between developing countries (TCDC).

(f) Activities and mode of operation

This document concerns the first implementation phase of the regional project for research into, and the development and application of, a regional maintenance system for the sugar industry. In this first phase, lasting two years, the groundwork will be laid for the regional project. During this period the participating countries will assimilate the basic results obtained and derive the first benefits. This will pave the way for further development in the succeeding phases of the project.

1. Mode of operation

Personnel training involving courses, seminars and programmes will be regarded as basic components in each area of the project's activities. The Technical Advisory Committee will provide for all training-related activities in its work plans and make the necessary arrangements for their co-ordination.

The results of the research and development work conducted under the project will be evaluated and approved for publication by the Technical Advisory Committee, which will suggest action to be taken to ensure that the results are applied in the sugar mills.

The technical sub-offices will work on regional tasks in accordance with the guidelines issued by the Technical Advisory Committee and in co-ordination with the latter.

The national committees will be responsible for distributing all the technical documentation produced in connection with project operations in the relevant national institutions and the sugar mills in each country.

2. Activities

As mentioned above, the basic components of the project will be training and the application of the results obtained from applied research and development. Within that general context, the following activities will be given priority:

Research and development:

The use of non-destructive tests to improve the utilization of instruments for diagnostic maintenance, thereby helping to minimize dismantling of machinery during repairs between harvests.

The development and use of techniques for reconditioning parts and components.

The development of techniques for instruments maintenance.

The development of corrosion-protection methods and the undertaking of studies on the use of new materials.

The undertaking of studies with a view to the computerization of maintenance and repair systems.

The organization and planning of maintenance:

The compiling of a maintenance manual for use in all the region's sugar mills, covering, broadly speaking, the organization, programming, planning and control of a modern maintenance system based on technical and scientific principles.

The formulation of recommendations on the equipment best suited to the industry's needs, together with guidelines and standards relating to the organization and rational operation of auxiliary maintenance workshops.

Information:

The establishment of an information centre to serve as a basis for a regional information-exchange system in the field of maintenance and as a channel for TCDC activities.

All the activities scheduled in the above-mentioned areas will include components designed to improve the technical qualifications of personnel in the participating countries and will be directed towards promoting co-operation between developing countries (TCDC).

(g) Inputs

GEPLACEA will provide all the technical and auxiliary staff necessary for implementation of the project, together with the infrastructure and logistical support required. These facilities will be provided by the Permanent Secretariat of GEPLACEA and by the countries participating in the project.

Inputs provided by the participating countries

The inputs to be provided by the countries which will participate in the implementation of this regional project and enjoy its benefits are listed below:

Each country will:

Provide a co-ordinator responsible for the project at the national level who shall supervise the activities conducted by and in the country.

Provide technical and auxiliary staff, along with office facilities to be determined in accordance with the activities carried out by each particular country.

Pay the salaries of the staff it sends on training courses, seminars and programmes, both at home and abroad.

Pay for the tickets of national staff travelling by air to attend training courses, seminars or programmes in connection with the project as far as the airports served by the country's national airlines.

Provide logistical support, translation and reproduction services, premises and other facilities for the training courses, seminars and programmes conducted in the country as part of the regional project.

Bear the costs (including air tickets, meals, accommodation and pocket money) incurred in respect of the technical assistance missions which the country requests of other participating countries in the context of technical co-operation between developing countries (TCDC).

Be prepared to send or receive technical staff for on-the-job training programmes, which should be co-ordinated with the project in advance. Travelling expenses, accommodation and meal costs and pocket money should be paid by the country of origin of the trainee; the receiving country will in turn provide the necessary facilities for such training.

Provide laboratory facilities and premises for the activities undertaken in the country as required.

Bear the costs incurred through the holding of national seminars, courses and technical meetings sponsored by the national committees.

Inputs provided by the host institution

The institution hosting this project will provide the following:

A project co-director with a university degree in engineering and more than ten years of experience in the sugar industry.

Six technicians with university degrees and experience in different branches of maintenance.

Six technicians at the middle-management level with experience in different branches of maintenance.

One secretary, two office assistants and a driver.

One designer and one draftsman.

Maintenance, assembly, construction and workshop assistants.

Equipment for maintenance and corrosion laboratories and for testing of new materials.

Transport facilities for the experts engaged in project activities in the country.

Technical assistance to the participating countries at the latter's request and upon the prior agreement of the parties.

An experimental sugar mill and auxiliary workshops.

UNDP/UNIDO inputs

Description of the inputs supplied to the project by these organizations.

| | Staff | Duration |
|---|---|---|
| (a) | A Chief Technical Adviser with a university degree, professional qualifications and experience in the organization and direction of maintenance and repair work and the techniques involved (CTA) | From the start of the project |
| (b) | Research and development experts in the various branches of maintenance | Nine man-months |
| (c) | A data-processing expert | Three months |
| (d) | An expert in maintenance organization | Three months |
| (e) | Other experts in unspecified fields | Nine months |

Equipment, staff training, meetings and other inputs.

| Description | Quantity and duration |
|---|---|
| Missions | As dictated by the progress made in the project |
| Staff training | Fellowships, courses and seminars |
| Equipment | Instruments and equipment for measuring, monitoring, applications and mechanical testing of tools and other equipment and materials |
| Miscellaneous | Various |

(i) Development of support communications

The results obtained from the project in the participating countries will be transmitted to the other member countries by means of reports, direct resumés from the interested parties to the relevant regional authorities and requests for advisory assistance, training, missions for the exchange of experience and through other channels to be agreed upon at a later stage.

(j) Institutional framework

The institutional framework of the project will be composed of the four bodies listed below with details of their members and more general functions.

1. Administrative Council

This Council will be composed of the Executive and Technology Secretariats of GEPLACEA and representatives of the participating countries.

Functions: to ensure that the project progresses according to plan, to define development policy, to co-ordinate co-operation between the countries and assist the latter in making reciprocal arrangements.

2. Technical Advisory Committee

This Committee will be composed of the co-directors of the project, the host institution, the co-ordinators of the sub-offices and the Technology Secretariat of GEPLACEA.

Functions: to act on the decisions of the Administrative Council regarding the implementation of the project, to draw up work programmes, to evaluate the project's progress and to formulate and execute the scientific and technical work involved in the project.

The Technical Committee shall formulate work plans for submission to the Administrative Council with a view to implementation of the Council's development policy. These work plans shall be submitted at the intervals considered appropriate.

3. National committee

Each participating country will set up a national committee composed of the national institutions involved in the project.

Functions: the national committee will be responsible for the implementation, evaluation and monitoring of all the project activities in the country concerned and for the relevant co-ordination with the Technical Advisory Committee.

4. Technical sub-office

This will be part of the national committee of the country in which it is located.

Functions: to provide the executive apparatus for the development of the regional scientific and technical activities defined within the framework of the project.

These sub-offices will be technical organs under the Technical Advisory Committee.

The Resident Representative in _____ is appointed as Chief Resident Representative for the project. He will be the main channel of communication with the central office of UNDP, the implementing agency and the resident representatives in the other participating countries. The channel of communication for the national committees will be the UNDP office in the country concerned.

(k) Prior obligations and prerequisites

This project is multinational in character, its participants being the member countries of GEPLACEA which wish to take part and undertake to comply with the obligations agreed upon under the project.

Each participating country will set up a national committee in accordance with the definition given under the heading "Institutional framework".

Each participating country will notify the appropriate UNDP office of its intention to participate in the project, according to the procedure established.

The Technical Advisory Committee will be established.

The Administrative Council will be established.

The technical staff provided by the participating countries will be selected and assigned to the project.

The Project Document will be signed by the Chief Resident Representative of the project on behalf of UNDP, and UNDP assistance to the project will be granted subject to UNDP receiving satisfaction that the prior obligations and prerequisites listed above have been fulfilled or can be expected to be fulfilled.

(1) Future UNDP assistance

This project, intended as a first phase lasting two years, will lay the foundations for future development. GEPLACEA and the participating countries, after assimilating the initial outputs of this first phase, will determine what future UNDP assistance they require and then request such assistance for the implementation of subsequent stages.

PART III - SCHEDULES OF MONITORING, EVALUATION AND REPORTS

A. Tripartite monitoring reviews: technical reviews

In view of the length of this project, a tripartite review will be held after the first 18 months. Technical reviews will be held when necessary. The tripartite meetings and technical reviews will be held in accordance with the policies and procedures established by UNDP for this purpose.

B. Evaluation

Should difficulties arise in the course of the project, it will be subject to evaluation in accordance with the policies and procedures established by UNDP. The organization, terms of reference and timing of the evaluation will be decided by consultation between the Government, UNDP and UNIDO.

C. Progress and terminal reports

The project directors shall prepare six-monthly reports in accordance with the forms established by UNDP and shall submit a terminal report upon completion of the project.

The progress and terminal reports shall be submitted in accordance with the time schedule and other procedures established by UNDP for this purpose.

UNIDO

# PROJECT BUDGET/REVISION

ANNEX 1
BUDGET

| 3. COUNTRY | 4. PROJECT NUMBER AND AMEND. | 5. SPECIFIC ACTIVITY |
|---|---|---|
| | UC/RLA/82/034 | |

10. PROJECT TITLE

Establishment of modern, productive systems and techniques for the maintenance of sugar mills

| 16. 10. 11 PROJECT PERSONNEL EXPERTS / Post title | 18. TOTAL m/m | 18. TOTAL $ | 17. m/m | 17. $ | 18. m/m | 18. $ | 19. m/m | 19. $ | 20. m/m | 20. $ |
|---|---|---|---|---|---|---|---|---|---|---|
| 11-01 Chief technical adviser | 24 | 132 000 | 12 | 66 000 | 12 | 66 000 | | | | |
| 02 Research and development expert | 3 | 16 500 | 3 | 16 500 | | | | | | |
| 03 " " " " | 3 | 16 500 | 3 | 16 500 | | | | | | |
| 04 " " " " | 3 | 16 500 | | | 3 | 16 500 | | | | |
| 06 Information expert | 3 | 16 500 | 3 | 16 500 | | | | | | |
| 06 Expert in maintenance organization | 3 | 16 500 | 3 | 16 500 | | | | | | |
| 07 Other experts, unspecified | 9 | 49 500 | 5 | 27 500 | 4 | 22 000 | | | | |
| 08 | | | | | | | | | | |
| 09 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 11 | | | | | | | | | | |
| 12 | | | | | | | | | | |
| 13 | | | | | | | | | | |
| 14 | | | | | | | | | | |
| 11-99 SUBTOTAL: | 48 | 264 000 | 29 | 159 500 | 19 | 104 500 | | | | |

21. REMARKS

Form/FS 83/Rev 3 (10 78)

UNIDO

# PROJECT BUDGET/REVISION

2. PAD NUMBER

| 4. PROJECT NUMBER | 16. TOTAL | | 17. 1984 | | 18. 1985 | | 19. | | 20. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | m/m | $ | m/m | $ | m/m | $ | m/m | $ | m/m | $ |
| 12.01 OPAS Experts | | | | | | | | | | |
| 13.00 Support Personnel | | | | | | | | | | |
| 14.00 Volunteers | | | | | | | | | | |
| 15.00 Experts Travel | | | | | | | | | | |
| 16.00 Other Personnel Costs | | 3 000 | | | | 3 000 | | | | |
| 17.01 Locally hired Experts | | | | | | | | | | |
| 17.02 Locally hired Experts | | | | | | | | | | |
| 19.00 Total Personnel Component | 48 | 267 000 | 29 | 159 500 | 19 | 107 500 | | | | |
| 20. SUBCONTRACTS | | | | | | | | | | |
| 29.00 Total Subcontracts Component | | | | | | 3 000 | | | | |
| 30. TRAINING | | | | | | | | | | |
| 31.00 Fellowships | | 10 000 | | 5 000 | | 5 000 | | | | |
| 32.00 Study Tours, UNDP G. Training/Meetings | | 13 000 | | 6 500 | | 6 500 | | | | |
| 33.00 In-service Training | | 5 000 | | 2 500 | | 2 500 | | | | |
| 34.00 Group Training (non-UNDP) | | | | | | | | | | |
| 35.00 Meetings/Consultations (non-UNDP) | | | | | | | | | | |
| 39.00 Total Training Component | | 28 000 | | 140 000 | | 140 000 | | | | |
| 40. EQUIPMENT | | | | | | | | | | |
| 49.00 Total Equipment Component | | 300 000 | | 200 000 | | 100 000 | | | | |
| 50. MISCELLANEOUS | | | | | | | | | | |
| 51.00 Operations — Maintenance | | | | | | | | | | |
| 52.00 Reports | | 2 000 | | 1 000 | | 1 000 | | | | |
| 53.00 Sundries | | 3 000 | | 1 500 | | 1 500 | | | | |
| 55.00 Hospitality (non-UNDP) | | | | | | | | | | |
| 59.00 Total Miscellaneous Component | | 5 000 | | 2 500 | | 2 500 | | | | |
| 99. GRAND TOTAL: | | 600 000 | | 376 000 | | 224 000 | | | | |

BARBADOS

1. General information

Organizations visited (26-28 November 1982):

Barbados Sugar Factories Ltd., St. Michael, Barbados

Represented by:

Mr. Michael T. Gooding, Assistant, Board of Directors
Mr. Stuart J. Fountain, Engineering Division

The mission team explained the purpose of its visit and the proposal of an expanded and improved regional programme on investigative maintenance, training and implementation based on the project sponsored by the United Nations.

Barbados has six operating sugar mills, all of which belong to Sugar Factories Ltd.

Approximate total output: 100,000-120,000 tonnes per year.

Refined sugar is not produced.

The group visited the sugar mills, all of which have an approximate capacity of 500 tonnes of sugar cane per hour.

2. Organization of maintenance

Each sugar mill operates as a separate unit with its own works manager, assistant manager, four shift foremen, two or three production officers and three laboratory supervisors.

The works manager is responsible for maintenance and repairs and is assisted by one engineer, who works independently.

Each mill has its own operating methods.

No standardized maintenance systems have yet been introduced.

3. Planning of maintenance

There is no standardized and organized planned maintenance.

The organization and distribution of jobs varies from mill to mill.

Maintenance programmes are carried out at the discretion of the person in charge of maintenance work.

As there is no standard document for such programmes, they vary from mill to mill.

During the sugar harvest season maintenance and repair equipment is operated by the regular production workers. In the case of more complicated repairs, they are assisted by the staff of the maintenance workshops.

There are no written control cards for planned, systematic maintenance.

4. Control

The types of control carried out are exclusively administrative.

There are no staff specifically assigned to prepare technical control cards.

No standardization or normalization techniques have been introduced.

Administrative controls are applied to the costs of distribution, labour, materials etc.

Before the sugar harvest begins, the machinery and individual units are briefly tested.

Checklist systems are not used.

The current cost of repairs and maintenance is estimated at approximately 35 per cent of the total value of production.

Cost control in the central warehouses is largely computerized, but minimum and maximum storage levels have not been established.

Each mill has an estimated part-storage capacity.

There is no computerized maintenance programme, but the officials we talked to were aware of the usefulness of such a system. As soon as the sector has gained enough economic strength and there is adequate trained personnel, a computerized system will be installed.

5. Preventive, emergency and diagnostic maintenance operations

Preventive and diagnostic systems, which can be regarded as a single complete system, have not been introduced.

Maintenance staff rely entirely on the catalogues and manuals provided by the equipment manufacturers, wherever these can be obtained.

In most of the repair and maintenance work carried out, the mechanic, foreman or engineer in charge of the work has to rely on his own skills and expertise.

The systems and methods applied depend on the competence and experience of the maintenance team and on other factors such as the tools and equipment available.

The staff in charge of the maintenance work are also responsible for carrying out inspections, for which they have to rely on their own skills, since, apart from the details given in the manufacturers' manuals, there are no written checklists to assist them.

In dismantling and assembling the machinery and equipment the maintenance staff have to rely on their own expertise and skills and on the equipment and tools available for such work.

Lubrication systems can be classified according to whether they are manual, semi-automatic or fully automatic.

Both oils and greases are used in lubrication. The Shell 7222 lubricant system has been used with very good results for the lubrication of crushers.

Unfortunately, the tasks of training personnel in charge of lubrication and providing them with the required information have been neglected.

There are no systems for protecting against rust and corrosion.

Correct guidance has not been given on the best way of preparing surfaces for painting.

Energy-saving maintenance procedures and systems have not been developed, nor have non-destructive tests been devised for any of the systems.

Some of the sugar mills have vibration testers and penetrating dyes, which they use in the normal way.

6. Workshops

General repairs are carried out in periods when the mill is not operating.

The type of workshop varies according to when the mill was built and when the basic fittings and tools were bought and installed.

All the mills have separate specialized workshops: mechanical, electrical, instruments, etc.

There are private companies which can carry out work.

Components for steel structures and tanks can be manufactured on the island.

The reconditioning of parts and components has not been developed although worn parts are welded.

All the tools and machinery have to be imported.

Generally speaking, all types of raw materials have to be imported.

Consequently, the quantity and quality depend largely on the hard currency available.

Almost every year technicians and mechanics are sent abroad in order to be trained to use the machinery and instruments purchased from various companies.

7. Outlook

Repair and maintenance work in the sugar industry suffers greatly from a lack of skilled personnel able to handle all the maintenance and repair work required in the industry.

The representatives of the sugar industry expressed great interest in any kind of activity which might help to solve the problems facing them regarding maintenance and repairs.

They also expressed an interest in any national or multinational enterprise manufacturing equipment, units and spare parts of benefit to the industry and the country.

Lastly, they expressed a keen interest in taking part in a regional programme on maintenance research, training and implementation.

8. Conclusions

There is a close co-operative relationship between the Barbados sugar industry and that of the other Caribbean islands. The latter are able to take part in the training and educational programmes offered at the University of the West Indies and in higher-level courses sponsored by the Sugar Association of the Caribbean (SAC). However, the capacity of these training programmes is very small by comparison with demand and the needs of the sugar industry.

Consequently, Barbados is in great need of international assistance in the development of its sugar industry.

# BOLIVIA

## 1. General information

Co-ordinating institution (10-14 September 1982):

Unión Agroindustrial de Cañeros S.A. (UNAGRO)

Persons met with:

Roberto Barberi, President, UNAGRO
Héctor Justiniano Paz, General Manager, UNAGRO
Edgar del Río, Assistant General Manager, UNAGRO
Rudiger Trepp, Manager of the Guabirá Sugar Mill

Bolivia has five mills, three private and two State-owned.

The mission visited the Santa Cruz mill, which belongs to UNAGRO, and the Guabira mill, which is State-owned.

Total output: 200,000 tonnes of unrefined sugar per year.

## 2. Organization of maintenance

In general terms the maintenance carried out in Bolivian mills seems to be of the "captive" type, with a production manager who supervises the workshop foremen, the production department being in charge of the operation of the mill as well as its maintenance.

In the State-owned mills we were informed that there are mechanics employed in each section of the mill, subordinate to the operations chief of the section. In private mills the situation is different in that all the mechanics and maintenance staff are stationed in their particular workshops and are sent to the different sections at the request of the sections.

There are no maintenance foremen as such. Instead, the foremen of the individual sections, together with the chief of the production department, are responsible for maintenance work, which is in turn approved by the production manager and carried out by the workshops. The section foremen are in charge of the programming and planning of maintenance services, while the chief of laboratory and his assistants take over these functions during the periods between harvests.

3. Planning of maintenance

Services are organized and distributed in the harvest period by means of a work order issued by the section foreman to the corresponding workshop foreman together with a job description; the work carried out is recorded.

Work to be carried out in the between-harvests period is planned by operations chiefs of the sections and is subject to the production manager's approval. For more extensive work of this nature a budget must be submitted to the accounts department. The total of budgets submitted forms the general between-harvests maintenance budget, which is finally approved by the board of directors of the enterprise. If the budget exceeds available finance, the board returns it, and it must be tailored to the approved sum.

What are considered to be the most important sections, such as mills, electrical maintenance and the power station, are inspected daily in accordance with the following schedule:

Mills

Shift reports include not only production parameters, but also incidents in operation, repairs needed and repairs carried out.

Electrical maintenance

Hourly records of instrument readings are carried out and observations made on action needed and action taken.

Power station

Hourly checks on operating parameters and observations on action needed or action taken.

Weekly shutdowns are used for the maintenance work decided on by section foremen for the period under study, as found from the work orders; in less complex cases the channel used is oral communication to the workshop foremen who will carry out the work.

There are different kinds of technical file cards for pumps and motors and others for equipment in general but in no case is a history of repairs and their costs kept.

4. Control

Control of maintenance work in the harvest season is the responsibility both of the foreman of the workshop doing the work and of the foreman of the executing section, the work orders being confirmed by the receipt and

delivery signatures of the corresponding foremen. Also, the costing foreman checks the cost of the work on the same work order pattern broken down by labour per hour, materials, outside work and sundries.

In the between-harvests period the laboratory foreman and his assistants check the progress of repairs as measured in planned man-hours. A weekly progress report is issued by each department and section of the works listing the basic features of each job carried out.

Dummy tests and tests with cane are run before the harvest begins.

Through the agency of its costing department, finance management checks all repair costs from stores' vouchers and man-hours reported for the work.

Cost control and the state of stores, but not maintenance as such, are computerized in the Santa Cruz mill; this is not so in the country's other mills.

Computerization of all stocks in store ensures accurate stock control including coding and value.

Due to the undeveloped state of Bolivia's mechanical engineering industry, no less than 90 per cent of all necessary parts and spares have to be imported, and because of the country's geographical isolation and financial difficulties delays in reception may be as much as 24 months. It is therefore impossible in practice to determine a real minimum stock.

Maintenance costs are around 10 per cent of production costs.

5. Preventive, emergency and diagnostic maintenance operations

There is no proper preventive maintenance or diagnosis and an example of this is that it is normal practice to dismantle equipment completely preliminary to between-harvests repairs. The only occasion when this is not done is when an item of equipment behaves exceptionally well during the harvest season.

For purely financial reasons complete dismantlings are not being undertaken during this harvest season for lack of the necessary spares. At Bolivia's request a team of technicians with instruments of the Cuban National Maintenance Project made a study of the technical condition of the Santa Cruz and Guabirá mills with the aim of minimizing maintenance work during the next repairs. Bolivia had never previously experienced anything along these lines.

No action is taken to reduce corrosion and lubricating systems are conventional.

6. Workshops

Most factories have mechanical engineering and electrical shops and rudimentary instrumentation and pan shops.

The workshops carry out all plant maintenance and repair work but are subject to the operations departments, which originate planning and control.

Nearly all repairs are carried out with the mills' own resources, but in the case of turbines, high-power electric motors and electronic instrumentation help is sought from other countries, mainly Argentina and Brazil because they are near at hand.

From 8 to 10 per cent of total spares are reconditioned by the workshops, always by conventional methods, but there is no production of equipment and parts.

Machine tools, all of foreign origin, are conventional and are repaired in their own workshops.

7. Outlook

At present there are no plans for training personnel, but some people are occasionally sent to other institutions unconnected with the sugar industry.

Interest in participating in central maintenance stations and national and/or multinational design, engineering and manufacturing undertakings making parts and spares will depend upon the results of a technical and economic study.

There is keen interest in participating in a regional maintenance project.

8. Conclusions

The Bolivian sugar industry is part of a country with a very undeveloped mechanical engineering industry which, in the absence of design and planning facilities, makes it impossible for the country to produce technological equipment.

The country is therefore totally dependent on foreign sources for its technological development and the supply of parts.

The financial crisis has aggravated the situation, making it impossible for domestic industry to carry out any of even the most conventional operations associated with maintenance and repair work.

Nor is there any possibility of cadres being trained in Bolivia, which therefore depends upon foreign institutions, a situation which at present imposes severe limitations for economic reasons.

COLOMBIA

1. General information

Co-ordinating institution (19-23 September 1982):

Association of Colombian Sugar Cane Growers (ASOCAÑA)

Persons interviewed:

Vitaliano Izquierdo, Administrative Manager of ASOCAÑA
Jesús Eduardo Morero G., Supervisor of the Canca, S.A. mill
Isaac Ramos C., Head, Industrial Division, of the Castilla S.A. mill
Luis F. Franco, Supervisor of the Providencia S.A. mill
Gerardo Ortiz, Supervisor of the Manuelita S.A. mill

There are in all 16 mills, all privately owned.

The mills visited were Canca S.A., with a daily capacity of 8,000 tonnes, Castilla S.A., with a daily capacity of 7,000 tonnes, Providencia S.A., with a daily capacity of 7,000 tonnes and Manuelita S.A., with a daily capacity of 5,000 tonnes.

Colombia's production is approximately 1.2 million tonnes of raw sugar and its milling capacity is 55,400 tonnes/day. Raw, white and refined sugars are produced.

2. Organization of maintenance

Location of service in enterprises.

ASOCAÑA is mainly a professional and administrative body for growers and industrialists in the sugar cane sector; it acts at home and abroad as an advisory organ on general policy and has as yet no technical branches. It therefore arranged visits to four mills to enable the mission experts to obtain the information they required by direct talks with the heads of maintenance of various mills, from the preliminary national report and from the results of the mission's assessment.

The four mills visited were all at the same level of organization, although very independent, since the sugar industry is privately owned.

There is a general superintendant directly responsible for four sections each headed by a chief engineer, namely the laboratory section, the processing section, the operations and maintenance section and the electrical section. Although it is not a general rule some mills have departments of design and engineering drawing, a masonry department, an assembly department, a costing department and an instrumentation department.

The head of maintenance is also head of milling and in the large mills has under him three shift engineers providing round-the-clock supervision and control of maintenance operations. He is also in charge of the machine tool shop, the mill roller shop, the general engineering maintenance shop and the tool store. Some mills also have maintenance operations supervisors and an officer responsible for reconditioning and scrap.

The suggestions of the head of processing form the basis for scheduling and planning maintenance, and the respective supervisors help to organize the monitoring and control work; the fact that they come directly under the superintendent at the same level as other heads makes them independent and responsible, so that the service is self-contained.

3. Planning of maintenance

Maintenance is usually carried out on the basis of, on the whole, fairly carefully prepared programmes and planning is based on technical considerations embodied in documents, with daily, weekly and monthly monitoring and checks; the system used involves printed forms for work orders, cards for each item of equipment, service sheets including all installations, equipment and parts given preventive maintenance, and check and follow-up cards. The work orders are very detailed. They start with the information necessary for computer processing, followed by a section comprising job calculation, department carrying out the work, job description and estimates in respect of labour, duration and materials. Then comes a section for noting work actually done, actual job time and who received the job. The final item is a summary of actual direct labour and materials costs and of indirect costs; if work outside the mill is involved it is assessed and included to give the final total cost of the work.

For the reasons given in the first part of this report the annual down time of sugar mills is no more than 30 days, and so the work carried out during the 24-hour weekly shutdowns is done very carefully. Daily incidents and continuous monitoring of equipment and machinery by maintenance and processing personnel are included in the weekly servicing scheduling. The weekly jobs are reflected in the history card of the equipment, so that jobs can be scheduled and maintenance planned for the annual shutdown period.

Canca S.A. is an exception since as well as the graphical representation of the annual programme of maintenance and its planning there is a chart which contains, at the same level as the graph, the history card of every

single item on the mill inventory needing some form of maintenance at whatever frequency (daily, weekly, annual, etc.). The practical value of this important graph is that merely by looking at it one can draw conclusions about the work or servicing which will be needed by any element, the whole system being based on strings and coloured tags.

The other mills are interested in maintenance organization and planning and are therefore very open to any suggestions on the subject.

Maintenance is preventive, and the fact that it is carried out on a weekly basis and with great care means that work scheduling for the annual shutdown is not very difficult to plan. However, the annual maintenance programme and its planning, duly budgeted, must be discussed by the heads of the mill and the mill superintendent. The programme is then submitted to mill management for approval and/or amendment.

Processing personnel are assigned to weekly and annual jobs, but responsibility, follow-up and quality control are matters for the maintenance operations and supervision staff, the head of electrical maintenance having overall responsibility for the programme and for satisfactory operation of the equipment and mill. A person in charge reports directly to the superintendent of the mill; in most mills the instrumentation departments and, where they exist, design, costs, assembly and other departments report to the superintendent's assistant engineer.

An important point is that in mills where detailed checks are made on work orders, the names of staff able to do a job are noted in order that they may regularly do the same jobs and become specialized in them.

4. Control

Technical control

All jobs, both weekly and annual, are planned on an individual job and team basis and the person responsible for the quality and deadlines of the jobs programmed, and the supply and quality of parts, spares and materials is the head of the maintenance department, although processing personnel co-operate in the carrying out of the work. The supervisory personnel of the maintenance department collaborate in checking, follow-up and progress-monitoring and must make out the relevant reports periodically (daily, weekly, etc.).

Administrative control

Every work order is signed by the head of the department; in the absence of administrative personnel it is filled in and monitored by supervisors and the respective stores values for material and spares are added to it. These figures plus evaluation of the man-hours give the costs of the department and their total; in some cases annual cost and its relation as a cost factor in total sugar cost is computed. In some mills this check is very superficial and the effect of maintenance on sugar costs is unknown, as in the case of the Manuelita mill, where the only shutdowns for the last three years have been the weekly 24-hour ones.

The reports we obtained show that maintenance costs vary; for instance, they are 8 per cent of sugar costs in the Canca mill, 3 per cent in the Castilla mill and between 10 and 30 per cent in the Providencia mill, while ASOCAÑA's last annual report gives an average of 8.63 per cent of total sugar costs.

Efficiency tests

In Colombia as in most mills every job is, as a rule, checked by the respective supervisor and head of department. During the annual shutdown an exhaustive efficiency test is carried out to remedy any possible defects.

Stores were well stocked with parts and spares. Stock ordering times are about 30 days for domestic items, due to the nearness to Cali, but vary between one and two years for imported equipment because of national bureaucratic procedures and delays on the part of makers and distributors. All have coded stores, some of them computerized. We noted many duplicate items of equipment ready for operation.

Because of the complex nature of equipment at both mill and national level, nothing has been done about technical standardization, but there is an awareness of the importance and need for it as an indispensable means of improving maintenance.

5. Preventive, emergency and diagnostic maintenance operations

In most mills maintenance scheduling and planning is well documented and there is a consistent follow-up using printed forms and check graphs. The department is organized for preventive maintenance, which is carried out rigorously once a week, and for emergency maintenance. Because of the care with which the weekly maintenance inspections are carried out, a total

dismantling is unnecessary for the annual maintenance and only those items of equipment and machinery are dismantled which seem from the weekly checks to need it. All weekly and annual maintenance work is carried out exclusively by mill personnel.

Some of the mills visited had facilities for non-destructive testing such as a dynamic balance, ultrasonic thickness meter, leak detector, etc., but they are not found frequently, nor are logical methods such as the planning of a diagnostic maintenance service used.

No research has been done on lubrication or on the characteristics of elements experiencing friction. The most that has been done in this direction is a codification of lubricating oils, but solely with the aim of avoiding problems of nomenclature.

With regard to corrosion all that has been done is to use substitutes for some materials, but on the basis of strength reference data and not as the result of previous study and research.

With regard to energy, there is an awareness of the need to optimize energy use, but no study or maintenance work has been done with this aim.

Abrasion, particularly in mills processing mechanically cut cane, is a very difficult problem and technical aid on the point would be welcome.

6. Workshops

All mills have their own workshops, some of course better equipped than others, although in general almost 90 per cent of repair jobs are carried out in the mill workshops.

Electrical and engineering shops are adequately staffed, but greater capacity is needed in order to improve their efficiency.

Most parts and spares are produced in the mill workshops from domestic and/or imported materials, both purchased on the domestic market.

7. Outlook

Training

This factor is of great concern to the mills. At present it is catered for, but not to the required extent, by courses and seminars of the National Apprenticeship Service (SENA), usually outside the mills. Staff are also sent on courses organized by a few commercial firms. They would be interested in maintenance courses and seminars.

There is at present a trend for small workshops to disappear, and so the idea of maintenance centres could be useful in Colombia.

Some mills at present have their own design shops for parts and spares and would therefore be interested in participating in national and/or multinational design and engineering concerns making parts and spares. There is reconditioning of parts and spares in most mills and there is an interest in learning modern high-efficiency techniques.

8. Conclusions

Although ASOCAÑA does not have a technical department able to make a decision on these aspects, when there is an urgent need to tackle them it does so by way of a consensus of the competent authorities of the mills; consequently, ASOCAÑA has sufficient power to amalgamate shared interests in maintenance and would satisfy the interest of the mills in active participation in this project.

We found that Colombia, particularly the Canca S.A. mill, had the best system of organization, programming, planning, follow-up and documented checking of maintenance in the region except for Cuba.

Colombia would probably be interested in participating in multinational undertakings for the design, engineering and production of equipment, parts and spares, training, reconditioning of parts and spares, installation of a diagnostic maintenance facility and energy-saving techniques.

COSTA RICA

1. General information

Co-ordinating institution (1-4 November 1982):

Sugar Cane Agro-Industry League

Persons interviewed:

Adolfo Shadid Chaina, Executive Secretary of the League
Antonio Ruiz and Nelson Morera, Department of Agronomy of the League
Rodrigo Velarde, Manager of the Taboga Mill
Rafaél E. Cartín, Maintenance Foreman of the Victoria Co-operative

All the mills are privately owned.

Mills visited: Taboga Mill (installed capacity: 4,000 tonnes/day); Victoria Co-operative (installed capacity: 2,400 tonnes/day).

National production amounts to approximately 450,000 tonnes (raw). Raw, white and refined sugar is produced.

2. Organization of maintenance

Position of the maintenance service within the enterprise

The mills are managed by a general manager and/or mill superintendent. The production, machinery, and laboratory heads are all hierarchically on the same level and all report to the manager (or superintendent). The machinery head is also responsible for milling operations, the generation of steam and electricity, and for maintenance throughout the mill. At some mills, there is a separate foreman, directly subordinate to the superintendent, with responsibility for the generation of electric power and, hence, for the operation of the electrical repair shop.

All the mills have various foremen who report to the maintenance foreman, except in the case of mills where there is an electrical foreman and where, accordingly, the electrical workshop does not fall under the maintenance foreman.

Generally speaking, there is a great desire to introduce comprehensively organized maintenance systems to ensure smooth and, above all, efficient service.

3. Planning of maintenance

Maintenance operations are carried out, on a continuing basis, by the maintenance service staff. When the mills are idle, crews are formed, which may be strengthened by processing personnel. Normally, these shutdowns are scheduled on an annual basis, at which time approximately 40 to 50 per cent of the mill's permanent workforce is involved in maintenance. At some mills, the work is supervised by maintenance engineers assigned to the various sections of the mill; at others, the processing shift foremen work together with the maintenance service and during the annual shutdown function as maintenance supervisors in their respective areas. At the head of each maintenance crew is a foreman.

Normally, the maintenance service operates on the basis of a work plan for daily, weekly and annual routine activities. However, once the harvest period has begun, certain mills omit the weekly maintenance periods and carry out their maintenance and repair of defective equipment only when stoppages occur for reasons not connected with maintenance. Obviously, this means that at such mills motors, pumps, and the like must be kept ready near the equipment which, if it failed, would result in a disruption of the production process.

At the present time, there are virtually no control and follow-up documentation, no work order forms as such and no performance records for equipment and machinery. Originally, some but not all of these documents did exist. At some mills, performance cards exist only for the most important equipment units. The mill operators recognize that without this documentation there can be no effective technical and administrative control, but they claim that the reason for this abnormal state of affairs lies in the critical situation currently facing the world sugar industry. They are aware that, when they are able, they must do something about this problem, to which they ascribe the highest priority.

A properly budgeted work plan is submitted by the head of the maintenance service. The planning for the service includes annual and (where they exist) weekly programmes along with an emergency service. There is also provision for preventive maintenance by mill area. This plan is discussed with the general management with the participation of the production head.

With the exception of the electrical shop at mills where it operates independently, the workshop personnel are under the instructions of the maintenance head. These personnel play a key role in the planning and scheduling of the maintenance system, especially with regard to repairs.

4. Control

Technical control

Despite the fact that during the weekly servicing period, and especially during the annual shutdown (outside the harvest season), a high percentage of the production personnel participate in the work of maintenance, the maintenance head bears sole responsibility for the quality and timeliness of the work, its monitoring and testing. In these activities, he is assisted by the technicians and engineers permanently assigned to the maintenance service, and where such people are not available, by the production shift foremen, who, as we have already noted, function as maintenance supervisors during the non-harvest period.

At this time, there are no technical-control or work-progress documents. The supervisors, who are familiar with the work plan and the budget, endeavour in an approximate way to ensure compliance both with the scheduling and with the allocation of materials, spare parts and man-hours.

Administrative control

Since there is hardly any documentation, there is virtually no follow-up and monitoring of the work. At some mills, only major maintenance operations or specific zones (e.g. boiler installations) are monitored, while at the remaining mills there is no such monitoring and certainly not for individual equipment units. In its approved and budgeted version, the annual plan reflects the expenditure both in materials and man-hours for each area of the mill, so that at the end of the year the amount invested in maintenance in a given area can be estimated and the total maintenance expenditure for the entire mill can be arrived at by simple arithmetic. However, these are, we repeat, merely approximate estimates, which do not provide very reliable figures. For this reason, and especially because of economic distortion (fluctuations in the rate of exchange), there is no truly accurate way of knowing just how much maintenance accounts for in the production costs of sugar.

Following the conclusion of the maintenance and repair work, some ten days before the beginning of the next harvest, the mills carry out what is known as "efficiency testing". The entire mill is placed in operation, a tour of the various areas is made, and the equipment and machinery is closely inspected so that any faults or anomalies that may not have been eliminated or which have come to light through this testing can be eliminated.

So far, no kind of computerized maintenance control system has been introduced.

Most of the warehouses stocking spare parts, parts, components and materials have codified their operations and will soon introduce computer-assisted inventory control systems. Some 20 per cent of the items handled by the warehouses is imported, and in certain extreme cases 18 months may be required for the delivery of imported items, although in emergency situations a telephone call to the United States will bring results in four or five days. As a general rule, the warehouses have more or less a year's stock on hand, even though these may be domestically manufactured parts and replacements.

With respect to standardization, so far nothing has been done, even though it is recognized to be of critical importance to improved maintenance.

5. Preventive, emergency and diagnostic maintenance operations

Maintenance operations are carried out in accordance with the approved and budgeted annual plan. Since work orders are not issued and for the most part the plan is broken down by areas, the individual area heads carry out the plan and supervise the work involved. This is no obstacle to the maintenance and repair of equipment, parts and components found to be defective during the dismantling of the machinery. At some mills, the equipment is only partially dismantled because, in the case of certain units, the weekly maintenance indicates that full dismantling is unnecessary.

The maintenance operations, which are largely of the preventive type, are in some cases monitored and controlled by maintenance engineers and, in others, by the area heads, who supervise the maintenance work in their respective areas during the non-harvest period. As already noted, this work is performed by crews consisting of the permanent maintenance staff, which depending on the mill, accounts for from 25 to 50 per cent of the mill's total personnel. During non-harvest periods, many of the technical personnel of these mills travel to North America for work in the mills there, returning to Costa Rica just in time for the beginning of the next harvest.

No type of non-destructive testing is in use, and when dynamic balancing of any kind has been necessary, the equipment has had to be sent to specialized shops. The result is that there is total ignorance with respect to diagnostic maintenance.

In the area of lubrication, there have been no studies or research aimed at analysing the behaviour of materials and components subject to friction, or at inquiring into the quality and characteristics of the lubricants available. All that is done is to follow the directions and recommendations of the manufacturers, both of the equipment and of the lubricants.

There has been no experimentation with anti-corrosion and anti-abrasion techniques. Because of the proximity of the sea, some of the mills have experienced certain problems of rusting, which have been remedied through the use of traditional methods of painting.

In their maintenance operations, the mill managers are constantly looking for ways to reduce their consumption of energy. Some of these mills use no oil at all, but burn all of their bagasse; others purchase as much as 50 per cent of the electric power they consume, with the consequence that they are extremely interested in any measures to reduce the consumption of energy.

6. Workshops

All the Costa Rican mills have their own mechanical, electrical and instrumentation workshops, but none has its own casting shop. The way these shops are equipped depends very much on the capacity of the mill in question.

The jobs performed by the shops are scheduled according to the priority assigned them by the mill maintenance foreman. Each shop's internal organization is the responsibility of the shop head.

Almost all the work is performed in the shops themselves, with only very specialized jobs sent out. Some of the shops even manufacture all the machinery needed for machining and lathing operations, and formerly some of them sold their services to other branches of industry. The shops have adequate personnel, but they require additional training. The tools and machine-tools are imported, some of them being slightly obsolescent. A good many equipment units, parts and components are reconditioned using traditional methods.

The shops have no problems in purchasing the materials they require locally, while for imported items they need stock no more than a six-month supply.

The maintenance of the workshops and of their machinery and tools is the responsibility of the shop personnel themselves.

Responsibility for pneumatic control equipment (instrumentation) lies with the specialized staff of the mill.

7. Outlook

The mills make it a practice to send members of their staff to training courses inside and outside the country, but as in other countries, these courses are nearly never in the area of maintenance, and for this reason the operators are interested in participating in courses and seminars on this subject. Actually, some technicians at certain mills have received training in the management and operation of measuring devices at Mexican sugar mills, evidently on the basis of agreements concluded between the Costa Rican Sugar Cane Agro-Industry League and the Mexican National Commission of the Sugar Industry (CNIA).

Given the interest not only of Costa Rica but of the entire Central American region, the League is eager to take part both in maintenance centres and in national and/or multinational enterprises for the design, engineering and manufacture of equipment, parts and components for the sugar industry.

8. Conclusions

In view of the fact that the Costa Rican sugar industry is privately owned and nationally organized through the Sugar Cane Agro-Industry League, it is extremely likely that the country will wish to participate in this project. Evidently, the areas of greatest interest to Costa Rica would be the organization of a system of maintenance, with particular emphasis on planning and control, non-destructive testing and the reconditioning of parts and components.

CUBA

1. General information

Co-ordinating institution:

Cuban Institute for Sugar Research

Persons interviewed:

Jorge Lodos, Director of the Cuban Institute for Sugar Research
Carlos Borges, Director of Maintenance, Ministry of the Sugar Industry of the Republic of Cuba

In all, there are 153 sugar mills in the country, and four others are being built. All are State-owned.

Mills visited: The "Pablo Noriega" Experimental Facility (1,000 tonnes of cane a day); the "Camilo Cienfuegos" Sugar Enterprise (5,000 tonnes of cane a day).

Total production: 8 million tonnes of raw sugar a year (estimated figure).

UNIDO project CUB/77/004, Sugar Mill Maintenance Research, has been in progress for three years in this country. Together with the effort undertaken by the national sugar industry authorities, this project has contributed to radical changes and major advances in the area of repair and maintenance in the sugar industry.

The progress achieved in the various areas of maintenance has enabled Cuba, through its National Maintenance Project and at the request of the regional member countries of the Group of Latin American and Caribbean Sugar-Exporting Countries (GEPLACEA), to provide technical co-operation in diagnostic maintenance through non-destructive testing to Bolivia, Panama and Nicaragua. The possibility of meeting the requests of other area countries is currently being studied.

2. Organization of maintenance

Under the Office of the Assistant Minister of the Sugar Industry there is a National Directorate of Maintenance. Subordinate to this Directorate are the assistant provincial maintenance officers, who in turn oversee the work of repair and maintenance at the mills, which is the direct responsibility of the head of each production unit.

Also subordinate to this same Assistant Minister are the national enterprises engaged in the manufacture of equipment, parts and components. These enterprises belong to the Ministry of the Sugar Industry and, within their production planning, meet more than 50 per cent of the country's needs. As much as 70 per cent of the requirements are handled by the country's steel and engineering industry.

Operating on a centralized basis within the Office of the Assistant Minister are also the central and provincial workshops at which major repairs on such equipment as turbines and high-power electric motors are carried out.

Other related organizations are the Mechanical Design Enterprise, the Planning Institute and the Cuban Institute for Sugar Research, all of which offer the highest level of scientific and technical competence in dealing with production-related problems which the mills, relying on their own equipment and personnel, would be unable to tackle.

At the individual mill level, the machinery foreman has prime responsibility for, and is directly involved in, equipment maintenance during harvests and repairs between harvests; he is also the head of the machine shop, the boiler shop, and the repair shops for instrumentation and electrical systems. In addition, during harvest periods there are locally available mechanics who are able to handle routine and scheduled maintenance.

The supervision of this work is the responsibility of the Area Operations Chief and the head of the workshop taking on the job, both of whom work through the mill's machinery and maintenance foreman.

3. Planning of maintenance

During harvest periods, maintenance is based on technical inspections which are carried out on a shift schedule and by area, and which are entered in a log. These entries form the basis for the planning of the maintenance which is either to be carried out immediately or which, because of its complexity, will have to await the shutdown of the machinery for cleaning, which, depending on the technical condition of the equipment, is carried out every 10 or 15 days.

Relatively simple maintenance work is performed by the maintenance personnel of the area in question, while for more difficult operations work-order requests are sent to the appropriate workshops.

The planning and assignment of the necessary personnel for maintenance work to be carried out during cleaning periods is based on the nature of this work, and, wherever possible, whatever supporting workshop operations may be necessary are performed in advance.

The programme for repairs between harvests must be submitted one month before the harvest in progress ends and consists of two basic parts: (1) the new investments planned for the five-year period and a statement of the items needed and other requirements which have come to light during the previous harvest; and (2) the repair programme as such, discussed by area of operation and maintenance, respectively.

This entire programme is entered on the appropriate forms, which cover all aspects ranging from the planning of the materials and man-hours required to the requests for supplies to be sent to the provincial and/or national supply depots and the work-order applications for forwarding to the central workshops.

4. Control

The technical supervision of the work of maintenance and repair is basically a responsibility of the foreman performing the work and of the area chief for whom the work is being carried out. Only after both parties have agreed, is the work regarded as completed and the service accepted. This control function is based on compliance with pre-established technical standards for the performance of the maintenance and on the work standards and parameters for the operation of the equipment in question.

The costs involved are administratively controlled in two ways. One way is by the personnel department, which, in co-operation with the brigade foremen, the workshop heads, etc., computes the man-hours actually worked and, on that basis and on the basis of the hours planned, issues the advance; the second way is by the bookkeeping department, which, in co-operation with the warehousing and purchasing departments, charges the materials vouchers for each work item to the appropriate expenditure and services account for each job.

Much stricter controls, at all levels from the Ministry to the individual enterprise by way of the provincial authorities, apply to repairs carried out between harvests. This ensures the proper national distribution

and use of the existing resources and the installed workshop capacity so that allocations can be made and priorities assigned as needed to produce the best possible technical and economic results.

Equipment units handed over as repaired are accompanied by a certificate signed by the person responsible for the work. This equipment is restored to the production unit as ready for use in milling only after it has successfully passed both no-load testing and testing with cane.

5. Preventive, emergency and diagnostic maintenance operations

As a result of its efforts through the National Maintenance Project, Cuba is in a position to perform diagnostic non-destructive testing to determine the need for the maintenance and/or replacement of equipment, parts and components. This testing is planned on a centralized basis in order to promote the more rational use of both equipment and skilled personnel, but in addition non-destructive testing may be directly requested by any province or sugar enterprise that regards it as necessary.

Preventive and emergency maintenance operations are based on the technical inspections carried out by the shifts in each area, are logged, and are analysed by the area chief and maintenance foreman. The practice thus far has been to dismantle the equipment completely for repairs between harvests; the observations made at this time are used to prepare the full repair programme. It is reported that at the present time research is under way aimed at minimizing the need to dismantle the machinery by using non-destructive testing when planning repairs between harvests.

6. Workshops

The country's mills have well organized workshops, most of which are well equipped with machine-tools capable of performing a high percentage of all maintenance and repair operations.

In addition, there are mechanical plants, foundries and central workshops which service the entire industry. The efficiency of these facilities is proven by the fact that more than 60 per cent of the components used at the mills that have already been built or are being built can be produced within the country. This entire effort is backed up by the Mechanical Design Enterprise, the Planning Institute and the Cuban Institute for Sugar Research.

In recent years, with the help of the National Maintenance Project, the sugar industry has been making greater use of the practice of reconditioning parts and components, although all the possibilities inherent in this approach have yet to be exhausted.

7. Outlook

There are extremely ambitious present and future training plans based essentially on courses for managerial personnel with the aim of introducing more advanced systems, and also post-graduate courses, seminars, and other forms of training for high-level technicians.

There is great interest in the country in maintenance centres, and the fact is that several such centres, for specialized maintenance and repair, are already in operation in various regions of the country, although the competence of these establishments must be even further improved.

There is also interest in participating in national and/or multinational enterprises engaged in the design, engineering and manufacture of equipment, parts and components. In fact, work along these lines is already well advanced, and currently a large assortment of equipment and parts are available for sale to the countries of the region.

The Cuban Government is interested in participating in a regional maintenance project, its major areas of interest being:

The use of non-destructive testing in the planning of repairs between harvests.

The introduction of computer techniques in maintenance.

The saving of energy through more effective maintenance with respect to the generation and use of steam.

The development of techniques and standards for the maintenance of both commercial instruments and instruments for use in non-destructive testing.

The design and manufacture of equipment for non-destructive testing.

8. Conclusions

Cuba is pursuing a consistent policy aimed at achieving greater efficiency and reducing costs at the national level. This is clear both from the prompt application of the results produced through the National Maintenance Project,

and from the careful attention given to the research and development and the application of comprehensive maintenance systems and to the training of personnel at different levels.

These achievements have been shared with other countries which have expressed an interest in receiving assistance of some kind. Under a regional project, exchanges of this kind could become much more beneficial by reaching new users.

GUYANA

1. General information

Organizations visited (28 October - 10 November 1982):

Guyana Sugar Corporation Ltd.

Represented by:

Carl A. Sylvester, Chief Engineer
Stephen N. Changlee, Planned Maintenance Engineer and Energy Co-ordinator

The group explained the purposes of its visit and the idea of an expanded and improved regional programme on investigative maintenance, training and implementation along the lines of the United Nations-sponsored project.

Guyana has ten sugar mills, all of which belong to this Corporation, and all of which are administered as independent properties in all respects.

They produce no refined sugar.

Total sugar production is approximately 300,000 tonnes a year.

The group visited the following:

(1) La Bonne Intention Estate

Represented by:

Mr. Jai Sing, Administrative Director
Mr. Winston Gittens, Mill Manager
Mr. Gregory Sanford, Deputy Mill Manager (Engineering)

Approximate production: 27,000 tonnes/year.

(2) Enmore Estate

Represented by:

Mr. C. A. R. Sylvester, Administrative Director
Mr. L. L. H. London, Mill Manager
Mr. N. Rahamat, Deputy Mill Manager (Engineering)
Mr. C. O. Bennet, Deputy Mill Manager (Production)

Approximate production: 30,000 tonnes/year.

(3) A workshop specializing in the salvaging and reconditioning of parts and components for the industry.

2. Organization of maintenance

Every sugar mill is part of an agricultural holding and has its own administrative director, who is responsible for both the agricultural and the industrial aspects of the operation.

In addition, each mill has a manager, deputy managers (for engineering and production), four shift supervisors, plant and process foremen, a planning engineer, a process engineer, section and shop foremen, etc.

The chief engineer, with the assistance of the engineering staff, is responsible for the repair and maintenance of the equipment.

Each plant is obliged to follow the same standards for repair and maintenance.

3. Planning of maintenance

Guyana is one of the few countries which have established and introduced a number of standards for repair and maintenance at all its sugar mills.

Since a certain amount of time is always required before a new system can be put into practice, the results so far achieved with these standards vary from mill to mill.

Specific routine procedures have been set up to govern the organization and distribution of posts both for the daily work and for future operations and tasks, whether during the harvest or the months when the mill is idle.

Methods have been worked out for the planning of repair and maintenance activities on the basis of established patterns. The regular service is performed by the production shifts with the help, where necessary, of workshop personnel. Organized and planned preventive maintenance is carried out in accordance with established procedures and on the basis of work orders and instructions.

4. Control

A planning engineer has the responsibility both for the planning and for records-keeping in accordance with established procedures.

The establishment of technical standards and norms is currently in progress.

Costs, materials consumption, etc. are administratively monitored according to established procedures.

A brief period of time is set aside before each harvest for the checking of each machine and each production unit. This is done using standard checklists.

It is estimated that repair and maintenance costs currently amount to 35 per cent of the total cost of the milling and production process.

Cost control operations at the warehouses are largely computerized, but there is no determination of minimum or maximum inventory levels. The warehouses of each sugar mill are supplied from a central warehouse.

There are no computerized maintenance programmes in use, but there is an awareness of the usefulness of systems of this kind, and as soon as the economic conditions in the industry and the availability of trained personnel permit it, such programmes will be introduced.

5. Preventive, emergency and diagnostic maintenance operations

Preventive and diagnostic systems have been established in what may be regarded as a comprehensive maintenance approach. In a relatively short time it has been shown that these systems produce considerable savings in both time and money.

These maintenance systems follow established procedures and rules, but still depend in large measure on the skill of the individual worker, the tools available, the equipment, etc.

Supervision depends on the available staff and their competence. Written checklists do not yet exist in all cases, since a considerable amount of time is required for their preparation.

The assembly and dismantling of each machine and unit depends, in the main, on the competence and skill of the personnel carrying out this work as well as on the tools and equipment available to them for this task.

The lubrication systems in use cover the entire spectrum: manual, semi-automatic and automatic. Oils and heavy greases are employed in the greasing systems. Shell's No. 7222 grease is used for the lubrication of the crushers with very good results. Unfortunately, not enough attention is given to the training and information of the personnel responsible for lubrication work.

No anti-rust or anti-corrosion systems are in use.

The proper preliminary methods of treatment prior to painting have not been introduced.

In terms of cost-effectiveness, good results have been achieved in testing to reduce incrustations.

So far, no energy-saving maintenance procedures or systems have been developed.

The consultants are studying these areas, and it is expected that they will submit appropriate recommendations in the near future.

No system of destructive testing has yet been established. A number of private companies offer instruments for testing of this kind for lease, but they are not available for regular use.

6. Workshops

There is great variety in the kind of workshops one finds, since this depends on how long ago the mill was built and when the basic machinery was purchased and installed.

All the mills have separate workshops for specialized kinds of work: mechanical work, electrical work, tool work, and so forth.

Since not many spare parts can be produced in the workshops, they mostly have to be imported.

Simple steel structural elements, tanks and a variety of cast parts are now being, or could be, produced locally.

A new workshop has been built for the reconditioning of parts and components using modern welding and liquid-metal spraying equipment. This was the most modern and complete workshop that the group was able to see. Within a relatively short time this shop has demonstrated its importance to the sugar industry, which it is expected will realize considerable savings because of it.

Tools and machinery of every kind must be imported, and the same is also normally true of any raw materials, which must also be purchased from abroad. As a result, the quantity and quality of these goods depend mainly on the availability of foreign currency for these purchases.

Centralized workshops have been established to work on tools and instruments, mechanical and electrical systems, diesel equipment, etc. These same shops also handle repair and maintenance work and calibrations.

Repair services are also available from some private companies.

There are plans to assign two engineers to each region who will work with the shops in inspecting, calibrating and repairing both pneumatic and electric instruments, and in other tasks as well.

7. Outlook

The Guyana sugar industry suffers greatly from the lack of trained personnel capable of performing repair and maintenance work with a high level of competence and responsibility.

There is a shortage of supervisory personnel at all levels.

Sugar industry spokesmen expressed keen interest in any kind of action that would enable them to improve their current poor situation with regard to repair and maintenance, and in any national or multinational enterprise manufacturing the related equipment, units and spare parts which might be of benefit to both the industry and the country. Further, these representatives indicated great interest in participating in a regional programme in the areas of maintenance, research, training and implementation.

8. Conclusions

Guyana appears to be introducing a very good preventive maintenance programme in its sugar industry; nevertheless, several years will be required before a broader basis of experience covering all the mills yields any well documented results.

The new workshop engaged in reconditioning used parts is of potentially great importance for the future.

The sugar industry is working actively to increase the number of new technicians, mechanics and specialized engineers qualifying. Post-graduate courses have been arranged in co-operation with the University of the West Indies, colleges of the arts and sciences and technological institutes. Jamaican participation has been enlisted for the operation of workshops and the training of instrumentation specialists and mechanical engineers, the purpose being to provide more skilled personnel with professional qualifications for maintenance work in the sugar industry. Unfortunately, the schools have only a very limited capacity to meet today's needs for more qualified sugar industry personnel.

There is an acute shortage in Guyana of the convertible currency needed to purchase new machinery and spare parts, which in turn leads to higher repair costs.

For all these reasons, Guyana needs international aid and assistance to improve its sugar industry at a time when the sugar price is at a near-record low.

JAMAICA

1. General information

Organizations visited (22-26 November 1982):

Sugar Industry Authority, Kingston 5

Represented by:

Mr. Frank G. Downie, Director and Secretary

Sugar Industry Research Institute, Factory Technology Division, Kingston 5

Represented by:

Mr. John Holms, Deputy Director and Manager, Engineering Services
Dr. Helmut Bourzutschky, Head of Sugar Technology, Director of Research and Development

National Sugar Groups of Companies, Kingston 5

Represented by:

Mr. W. P. Meany, Development Engineer

Jamaica has 11 producing sugar mills, seven of which are State-owned and four of which belong to private industry.

The total production is put at approximately 200,000 tonnes a year.

No refined sugar was produced last year.

2. Organization of maintenance

Each mill has its own plant director, production chief, shift foremen, and section and workshop heads.

One engineer has responsibility, in addition to his normal duties, for maintenance and repair, relying in this area on his own experience.

Each plant has its own working methods.

So far, there are no standardized maintenance systems in use.

3. Planning of maintenance

Scheduled maintenance is one of the greatest weaknesses. Although work was once begun on the preparation of a programme of scheduled maintenance that was to have been the same for the entire sugar industry, for a variety of reasons this project was never completed.

The organization and distribution of posts varies from one plant to the next.

Maintenance programmes are carried out according to the best judgement of the person in charge of the work, and since there is no uniform programme, there are variations from plant to plant.

During harvest time, the repair and maintenance crew is made up of regular production workers, who can call on the assistance of workshop personnel for more difficult repairs.

There is no system of printed control cards on which to base a planned and organized maintenance schedule.

4. Control

The only kind of control carried out is of an administrative nature.

No personnel are assigned to the establishment of a technical control card system.

There are no standards and/or norms techniques.

The costs of distribution, labour, materials, etc. are subject to administrative control.

Before the beginning of the harvest, the machinery and various production units are briefly tested. No checklist systems are in use.

Cost control at the central warehouses is in the main computerized, but no levels have been established for minimum and maximum storage.

Repair and maintenance costs are the highest that they have been in many years, being estimated at 50 per cent of the total value of production.

There is no computerized maintenance system, but there is an awareness of the usefulness of such a system, and as soon as the economic situation in the industry and the availability of trained personnel make it possible, a computerized system will be introduced.

5. Preventive, emergency and diagnostic maintenance operations

No preventive or diagnostic maintenance systems that might be regarded as constituting a comprehensive approach have been introduced. Maintenance is based only on the manuals and catalogues received - assuming that they can be obtained at all - from the various manufacturers of the equipment.

In most cases, the quality of the repair and maintenance work performed depends on the skill and knowledge of each mechanic, engineer or foreman responsible for the job. Similarly, the systems or methods used in each situation are determined by the skill and experience of the personnel and the tools and equipment available to them.

Since there are no written checklists, except for points which may be covered in the manuals accompanying the equipment, supervision is a responsibility of the persons performing the work and will depend on their skill.

The determining factor in the assembly or dismantling of any machine or piece of equipment is the skill and knowledge of the personnel involved, together with the tools and other apparatus available for the job.

Manual, semi-automatic and automatic lubrication systems are in use.

Both oils and heavy greases are used in the greasing system.

The Shell 7222 grease system is used for greasing the crushers and has produced very good results. Unfortunately, not enough attention has been given to the necessary training and information of everyone responsible for lubrication work.

No systems are in use to combat rust and corrosion, nor are staff correctly informed regarding the most suitable way to prepare surfaces before painting.

No energy-saving maintenance systems have been developed.

No system of destructive testing has been established.

Some private firms have test instruments that can be leased, but not used on a regular basis.

At some mills there are a few vibration testers, and also penetration ink, which are in current use.

6. Workshops

The type of workshop encountered varies, depending on how long ago the mill was built and when the basic equipment was purchased and installed.

Most of the mills have separate workshops for special kinds of work: mechanical work, electrical work, tool work, etc.

It is estimated that 60 per cent of all the spare parts required can be locally produced; the remaining 40 per cent consists of more sophisticated parts which either cannot be manufactured locally or whose production would not be economically justifiable.

There are certain private companies which can perform certain kinds of work. For example, roller casings have been cast in Jamaica for many years.

Other steel structural elements, tanks, piping and various cast parts can be or are being produced on the island.

The reconditioning of parts and components is not very well developed, although worn parts are rewelded.

Tools and machinery of all kinds must be imported, and the same is normally true of raw materials, which must be purchased from abroad. Consequently, the quantity and quality of these goods depends primarily on the availability of foreign currency for these purchases.

Almost every year, mechanics and technicians are sent abroad for training in the operation of machinery and equipment sold and supplied by various companies.

7. Outlook

The sugar industry is suffering the adverse effects of a shortage of the kind of trained personnel who can carry out repair and maintenance operations with the competence and the sense of responsibility required.

The industry lacks supervisory personnel at all levels.

Sugar industry spokesmen expressed keen interest in any kind of action that would enable them to improve their current situation with respect to repair and maintenance, and in any national or multinational enterprise manufacturing the related equipment, units and spare parts that might be of benefit to both the industry and the country. Further, these representatives indicated great interest in participating in a regional programme in the areas of maintenance, research, training and implementation.

8. Conclusions

Jamaica appears to have taken the first steps towards a well established training programme at its Sugar Industry Research Institute, which has its own pilot plant, an operating miniature sugar mill.

This Institute organizes training courses in co-operation with the University of the West Indies. There are degree courses at the post-graduate level involving arts and sciences colleges and mechanical workshops, along with training in instruments, manufacturing (mechanical) engineering, etc., all directed at the same objective of graduating more qualified personnel for maintenance positions in the sugar industry.

The majority of these courses and schools admit students from the other English-speaking countries of the Caribbean area. However, the schools have only a very limited capacity to satisfy the requirements for qualified specialists for the sugar industry.

# MEXICO

## 1. General information

Co-ordinating institution (1-6 October 1982):

National Commission of the Sugar Industry (CNIA)

Persons interviewed:

Jorge Tena, Manager for Industrial Development, CNIA
Sergio Martínez, Technical Manager, CNIA
Mario Morales, Head, Maintenance Section, CNIA
Miguel Chávez, General Plant Superintendent, "Tres Valles" Sugar Mill

The country has a total of 69 mills, of which 51 are State-owned, 16 are privately owned, and two are run as co-operatives.

The following State-owned mills were visited:

| | |
|---|---|
| El Potrero | 11,000 tonnes of cane per day |
| Tres Valles | 7,000 tonnes of cane per day. |

Total production: 2,606,000 tonnes of raw sugar per year (average figure for the past ten years).

Under the 1979 Agreement on Economic, Scientific and Technical Co-operation between Mexico and Cuba, CNIA signed an Agreement on the Organization of Maintenance in December 1980. In the two ensuing years Cuba has transmitted to Mexico much of its experience in this area, including a maintenance system covering the periods both during and between harvests, the organization of workshops and the computerization of the repair control function. This sytem has been introduced at five mills located in different regions of the country and selected as pilot facilities. However, once the system has been studied, assimilated and adapted to Mexican conditions, it may be extended to the country's remaining mills.

Considering that this emerging system is the one towards which all the Mexican mills are gravitating, it has been thought useful to describe it briefly in this report.

## 2. Organization of maintenance

Directly under the General Superintendent there is an office of maintenance which is responsible for the organization, planning and monitoring of maintenance and repairs both during and between harvests. Accordingly, this may be classified as an autonomous service.

The machine shops, mechanical shops and boiler shops are assigned to the office of machinery, while the instrumentation shop falls under the office of instrumentation.

3. Planning of maintenance

Maintenance during harvests begins with technical inspections which are arranged by shifts and involve a systematic tour of the equipment during which the operation both of the equipment itself and of those of its components defined ahead of time as critical is noted in a log. After a number of such inspection tours have been carried out, technical reports are prepared on the operational condition of the machinery, equipment and control systems throughout the plant.

A shutdown schedule is prepared in order that, as required at each mill, the repair crews may carry out the necessary maintenance work and any other operations due, eliminate the faults that have been identified, and attend to whatever other performance-related needs may be necessary to extend the service life of the equipment.

On this basis, it may be said that both preventive and emergency maintenance is planned in co-ordination with the area heads and the office of maintenance.

All these activities are regulated in writing by means of malfunction report forms for each section of the plant, a breakdown log, maintenance work request forms, and finally work request forms for forwarding to the appropriate workshop.

4. Control

Through the use of pre-established technical standards and the system of repair work requests by item of equipment and plant area, repair operations can be controlled, and the quality certificates issued for each of the items of equipment by area and for the mill as a whole ensure that there is adequate supervision.

This control function is carried out in writing using forms on which scheduled repairs and the planned work performed by each workshop are marked.

In addition, for the main items of equipment there is a technical data card which records both the repairs that have been carried out and their cost.

Work progress is further monitored by checking the number of man-hours actually worked against those originally planned. These data, together with the warehouse vouchers, enable the bookkeeping unit to keep track of the costs.

The sequence of steps built into the system requires the filling out and revision of the repair control certificates, which in addition serve as work orders and as reference documents for verifying the actual performance of the repair work. Subsequently, once the certificates from all the areas have been compiled and checked, the officials in charge of the different areas and their immediate supervisors submit guarantee forms. In turn, the General Superintendent informs the mill manager in writing that the mill is "ready for operation", after which the manager notifies his regional manager and/or the National Commission of the Sugar Industry that his unit is ready for the beginning of the harvest, at the same time reporting all the details of the repair work performed.

This system also includes the computer processing of warehouse inventory information along with data on the progress in carrying out the work planned for each area in order that the critical points and the areas which are lagging most may be immediately identified.

Persons interviewed assured the group that at those mills selected as pilot plants for this system maintenance costs have been reduced to the point where they currently account for about 8 per cent of the cost of production.

5. Preventive, emergency and diagnostic maintenance operations

The method of maintenance and repair as well as the handling of the orders involved have already been described in section 3 above.

The repair work is scheduled one month before the end of the harvest. At the completion of the harvest, the equipment is totally dismantled and serviced in accordance with the established technical standards. In this way, the scope of the repair work can be determined and the programme adjusted accordingly.

While the mills are running, proper attention is given to the lubrication of the equipment, for which purpose a weekly lubrication schedule is prepared covering the work to be done every day.

The Commission has some non-destructive testing units that it can make available to the mills it operates.

6. Workshops

The machining and boilermaking shops are subordinat to the office of machinery, whereas the electrical and instrumentation workshops report to their corresponding offices.

These shops plan their work on the basis of the maintenance work requests which they receive for scheduled maintenance and inter-harvest repairs as well as in the form of malfunction reports.

There is also a monthly maintenance schedule for the workshop machinery.

Comprehensive annual programmes for the manufacture of parts and components ensure that maintenance operations can be performed with maximum efficiency and that an adequate supply of basic and critical replacement parts is maintained.

Another important point worthy of mention is that, along with the introduction of the maintenance system we have been describing, valve and pump workshops have been established as part of the policy of reconditioning parts, which has had a direct effect on general costs.

In general it is fair to say that there are no major problems in the supply of materials and equipment, a sizeable proportion of which are in any case locally manufactured.

The workshops attached to the mills are able to perform nearly all the necessary work, although in the case of electronic instrumentation the services of third parties are employed.

7. Outlook

The Mexican Government is interested in participating in the regional maintenance programme mainly as it concerns subjects connected with preventive maintenance, non-destructive testing, reconditioning of parts and components, and the introduction of computer-assisted maintenance procedures.

8. Conclusions

The introduction of the maintenance system discussed above will make it possible, in the near future, to standardize maintenance operations procedures. This experience, together with the first steps in the direction of computerized maintenance and repair systems, places Mexico in a position to make a valuable contribution to the other countries which may participate in any regional project.

# NICARAGUA

## 1. General information

Co-ordinating institution (26-30 September 1982):

Sugar Office, Ministry of Agricultural Development and Agrarian Reform

Persons interviewed:

Eduardo Jérez, Director, Sugar Office
Raúl Baca, Head, Industrial Department
Marcos Novoa, Mill Superintendent
Wilfredo Murich, Mill Superintendent

Nicaragua has a total of seven sugar mills, six State-owned and one private.

The following mills were visited: Julio Buitrago, Javier Guerra and San Antonio.

Total production is put at 190,000 tonnes of raw sugar a year.

## 2. Organization of maintenance

Maintenance is a responsibility of the machinery foreman, who is in charge of the work of the extraction area. This same individual is also in charge of the plant workshops, although in certain situations these may come directly under the industrial superintendent.

The organization of maintenance depends to a large degree on the specific conditions at the plant in question, but in the majority of cases it is inefficient. One exception to this rule is the San Antonio Mill, which is privately owned; at this mill, maintenance is very well organized and involves planning and control by means of modern methods, which at some stages are computer-assisted. All the information given in this report reflects the situation at the State-owned mills.

There is no programming and planning of maintenance, although it appears that this type of organization did exist and was discontinued when the more experienced technicians left the plants together with the former owners.

## 3. Planning of maintenance

The frequency of maintenance during the harvest is determined by the stoppages for cleaning and, operationally, by emergency stoppages because of malfunctions.

Repair work between harvests is planned by the machinery and process foremen, who then jointly submit the plan to the plant superintendent for execution.

Both during and between harvests, repairs and maintenance operations are carried out by the Department of Maintenance and the appropriate workshops. The operations chief for the area in question is responsible for monitoring the performance of the work and certifying it technically when completed.

No preventive work of any kind is carried out, nor is there any documentation governing maintenance operations. All communications regarding these operations are oral.

There has been talk about introducing a system developed in Cuba, but for the time being there are neither the trained personnel nor the kind of structures that would make that possible.

4. Control

The only technical control exercised is by the head of the area in question.

No budgetary system has been established, and only at the privately owned mill are any cost-control procedures in use.

No-load tests are conducted at the beginning of the harvest; if these prove satisfactory, the equipment is tested with cane for a period of from three to seven days.

No minimum stock level is established, and the supply situation is determined by the repair budget, so that very often difficulties in supply arise because of financial problems.

At the privately owned mill the planning function and the monitoring of warehouse inventories are computerized. Even here, however, the efficiency is questionable, since the figures offered for the cost of maintenance as a percentage of the production cost ranged between 18 and 20 per cent, this being much above the normal range (8-10 per cent) for this industry.

5. Preventive, emergency and diagnostic maintenance operations

There are no preventive maintenance or work order systems at the State-owned mills, and all communications on this subject at these facilities are oral only.

The machinery is completely dismantled, and the repairs regarded as necessary are carried out on the basis of what is observed at this time and the problems encountered during the harvest.

Conventional lubrication systems are used for the journal bearings, reduction gears, etc.

No anti-corrosion procedures of any kind have been adopted, nor have any specific energy- and fuel-saving maintenance methods been introduced.

On a number of occasions at the request of the Nicaraguan Government, equipment and personnel have been despatched from the Cuban National Maintenance Project to provide technical assistance in the area of diagnostic maintenance through non-destructive testing.

6. Workshops

The mills have the necessary workshops for machining, electrical work, boilermaking and instrumentation to perform virtually all the maintenance operations required, although contracts are awarded to third parties for the repair of high-power motors, certain kinds of turbines and electronic apparatus.

The workshops at the Julio Buitrago mill are such that, with some expansion, they could serve as the central workshops for the national sugar industry in its present form.

The workshops have no programmes or work plans on which to base their activities. The work is performed on the basis of oral communications and as needs arise, with the result that very often the installed capacity is under-utilized because of the lack of proper management.

The use of techniques to recondition parts and components is limited to blades, certain types of shafts, and to pumps and pump drive systems.

The impression is that there are appropriate workshops with enough machine-tools, but that because of obsolescence their technical condition is poor.

No machine tools are manufactured in Nicaragua.

The local shops are capable of maintaining their own machinery and, generally speaking, of handling the repair requirements of the mills with their own means, except in the case of large-sized parts. They do not

have the ability to produce more technically sophisticated equipment (evaporation units, vacuum pans, etc.) for lack of tools of the necessary size (drills, sheet-benders, etc.).

The difficulties in obtaining materials and equipment are basically rooted in financial problems.

7. Outlook

Personnel are currently being trained in Cuba since Nicaragua lacks the necessary training institutions.

The Government is keenly interested in the development of maintenance centres and in participation in national and/or multinational enterprises for the design, engineering and manufacture of equipments, parts and components.

It regards its participation in a regional maintenance project to be of the greatest possible importance.

8. Conclusions

Of all the countries that need a regional maintenance project, Nicaragua needs it most. This is true mainly for the following reasons:

The country lacks a maintenance organization of the kind that will permit planning and control;

There are not enough trained cadres to manage the industry from either the technical or the administrative point of view.

The Nicaraguan sugar industry can be regarded as a kind of virgin and uncultivated land where assistance in any area of the maintenance problem cannot but yield great fruit.

# PANAMA

## 1. General information

Co-ordinating institution (23-26 September 1982):

La Victoria Sugar Corporation

Persons interviewed:

Darier Ayala, Director of the Corporation
Aurelio Herrera, National Director of Manufacturing of the Corporation

There are a total of seven mills in the country, some of which are State-owned.

Mills visited: Ingenio Azuero and Ingenio La Victoria.

National production: The mills produce raw and white sugar. Annual raw production is approximately 250,000 tonnes.

## 2. Organization of maintenance. Position of the maintenance service within the enterprise

The mills are managed by a superintendent, to whom the foremen for machinery and electrical systems and the process foreman report. The machinery foreman is the head of maintenance and is in turn responsible for the milling area and the mechanical maintenance service for the entire mill. He supervises the activities of the mechanical, machine and instrumentation workshops, while the electrical workshop is subordinate to the electrical systems foreman. On this basis, the mechanical maintenance system may be said to be autonomous, since the head of the service is in charge of the planning and actual work. The mills also have their own drafting department. Although there are no problems in terms of co-ordination and operation with the present maintenance system, the Sugar Corporation is interested in studying the possibility of adapting modern maintenance techniques with a view to making this system more efficient.

## 3. Planning of maintenance

For all practical purposes there is no planning for the maintenance service; rather there are certain directives regarding cleaning and maintenance operations, which are performed weekly according to a schedule jointly prepared by the maintenance and process foremen. On the average, these operations require eight hours a week.

There are no standards or documentation indicating how the work is to be performed; that is, no use is made of servicing sheets; work orders; progress, follow-up or acceptance reports; quality control; etc. All the work is performed on the basis of verbal orders.

The main work of maintenance and repair is scheduled between harvests, but since the machinery is totally dismantled, the work actually carried out depends on what the dismantling of the equipment reveals. This annual maintenance service, which is performed "on site" or in the mill's workshops as required, is carried out by the maintenance service's permanent staff and by the processing personnel in their respective areas. This method of organizing the personnel for maintenance activities applies to both the weekly and the annual work.

Since there are no preventive maintenance standards and, as already mentioned, similarly no control documents for either the maintenance operations or the equipment, the equipment and machinery must be completely dismantled between harvests.

Because of the absence of any documentation, there is no evaluation of the maintenance operations performed nor is there any cost control. The progress of work during the repair period is assessed in a purely empirical manner and on the basis of the experience of the chief engineer of the plant area in question.

Some work, such as painting, is contracted out to third parties, and although this is not the custom it is continuing. However, there is concern to have this kind of work also performed by maintenance service personnel, as in the recent case of turbine repairs, which were formerly contracted out to third parties but are now being performed by in-house staff.

4. Control

Technical control

As already indicated, there is virtually no maintenance planning or scheduling. The head of the maintenance service is assisted by processing area staff in supervising and monitoring the work, since the chief engineers in these areas are responsible for checking the actual maintenance. All of this, however, is based on observations and experience, and it is important to emphasize that all the equipment is tested once the work has been completed.

The criterion employed, for example, in determining whether a piece of equipment should be replaced is how the unit performed during the previous harvest. This approach clearly reflects the lack of any preventive maintenance.

Administrative control

Because there are no work orders or other documentation, there is also no administrative control. As a result, just as maintenance costs are not calculated, so also the percentage weight of maintenance as a cost factor in the total cost of the sugar produced is unknown.

All operations, including outgoing orders, of the supply and spare-parts warehouses have been coded and computerized. This should make it easy to introduce administrative control of the maintenance function.

So far, no minimum stock of materials, spare parts and components has been established, and only the inventory control function has been computerized.

Because of the proximity of the United States and the large number of distributor firms operating in Panama, there are no problems with regard to spare parts, except when they are not available on the market; in these cases, the delivery time may be as much as 24 months, since they have to be manufactured.

The Sugar Corporation follows no technical standards apart from whatever recommendations and instructions may be provided by the manufacturers of the equipment, parts and components.

No thought has been given to the possibility of introducing a single system of standardization, although in the case of certain equipment types - e.g., boiler pumps - which are particularly troublesome, an effort at standardization has been made at the Corporation's three largest mills. Still, looking ahead in this area it is believed that standardization might come when the rising volume of cane processing makes it necessary to replace the equipment.

5. Preventive, emergency and diagnostic maintenance operations

As has already been pointed out, maintenance is based on verbal instructions. During the scheduled weekly shut-down of the machinery, the maintenance staff performs those servicing tasks that were found to be necessary during the working days of that same week, apart, of course, from work related to problems which may have caused a stoppage due to malfunction or

were temporarily handled by the emergency maintenance crew. All these emergency operations and the recommendations of the processing personnel are taken into account when carrying out maintenance during periods between harvests, but, let us repeat, the work performed is determined by the maintenance and repair requirements that come to light when the equipment is dismantled, since this dismantling is total. The work crews are made up of the personnel permanently attached to the maintenance service and such personnel as may be assigned to this work from their respective areas.

No non-destructive testing is performed, and as a consequence the benefits of diagnostic maintenance are not being reaped. When it has been necessary, the services of other State organizations have been sought, but only for assistance in dynamic balancing.

There is an established lubrication schedule for the machinery and equipment, but no studies along these lines have been prepared. There is some attention to combating corrosion through the surface treatment of a number of equipment units (e.g. juice and steam conduits), but nothing in the way of research has been carried out.

No particular efforts have been made to develop maintenance procedures to save money and fuel, and the same can be said of the problem of abrasion.

6. Workshops

Regardless of their production capacity, Panamanian sugar mills have their own metalworking and machining workshops, along with shops for mechanical, electrical and instrument-related work. The work they perform is directly related to the size of the mill. Except for the electrical shop, they are under the direct orders of the maintenance foreman, who, in co-ordination with the heads of these shops, determines the priority and organization of the work and the services to be rendered. The instrumentation workshops service pneumatic but not electronic systems. There are currently plans to upgrade the quality of the workshops by replacing the old machine-tools with new ones. The mills have no casting shops, and as a consequence the rolls are imported especially from Cuba.

All the machine-tools are imported. The reconditioning of equipment, parts and components is based on the use of special powder metallurgy alloys and the recommendations of the makers of these products.

The supply and purchase of materials for the maintenance, manufacture and repair of equipment, parts and components present no problems, since these materials are available in the domestic market and, where they are not, can be easily brought in from abroad.

The maintenance of the workshops and of their tools and machine-tools is handled by the personnel of these shops themselves.

On the other hand, there are problems with respect to the spare parts necessary for the instrumentation workshop, since these parts are supplied from Costa Rica, which is where the representatives of the various firms have their offices. As far as the electronic apparatus is concerned, the preference is to replace it by pneumatic systems when faults arise.

7. Outlook

There are serious problems with respect to technical personnel because Government salaries, especially in the sugar industry, are low, so that the technicians tend to move on to other areas of industry in search of better pay. This also means that the Sugar Corporation loses money through its investments in training programmes.

There has been virtually no maintenance training, and as a result there is great interest in participation in national or regional training programmes, provided that such programmes were economically affordable.

There is a shipyard in Panama which has offered to increase the capacity of the workshops of the co-operative and of individual sugar operators, especially in the area of casting, in addition to establishing a maintenance centre and, most important, becoming involved in the series production of parts and components for the sugar sector.

This indicates an interest in participating in national and multinational programmes for the design, engineering and manufacturing of equipment, parts and components for the sugar industry.

Finally, Panama would be interested in actively participating in a regional project as regards establishment of a system of preventive and diagnostic maintenance in its mills, backed up by non-destructive testing and training of personnel, in order that the maintenance service might be given an efficient technical and administrative organizational structure.

## 8. Conclusions

Given the particularly dominant position of the La Victoria Sugar Corporation and its concern for the welfare of the country's private sugar producers, it is very possible that Panama would participate in this project, considering the interest shown by the Corporation's management.

The points which would appear to be of greatest interest to the country have to do with the establishment of a national maintenance system, with particular emphasis on the administrative aspects of maintenance, training of personnel and diagnostic maintenance.

PERU

1. General information

Co-ordinating institution (15-19 September 1982):

Sugar Research Institute (IIA)

Persons interviewed:

Jorge Camen, Head, Department of Industrial Research
Enrique Pardo, Superintendent, Casa Grande Mill
Carlos Campos, Superintendent, Cartavio Mill

The country has 12 mills, all of which are operated as agricultural co-operatives.

Mills visited: Casa Grande (installed capacity: 10,000 tonnes/day). Cartavio (installed capacity: 5,000 tonnes/day).

The country produces raw, white and refined sugar. The total production volume is approximately 1 million tonnes (raw).

2. Organization of maintenance. Position of the maintenance service within the enterprise

With the exception of the Casa Grande mill, at most of the mills the maintenance service is of the mixed or "captive" type. However the service is organized, it is under the direction of a professional (university graduate), who in all cases plays an active role in the planning and scheduling of maintenance and repair operations.

Despite the fact that the present sugar-producing co-operatives formerly belonged to the same institution, the Peruvian Sugar Co-operatives Central Organization (CECOAP), there is no national maintenance plan, with the consequence that throughout the country there are a wide variety of maintenance systems in use in the sugar industry. Nevertheless, the mill operators indicate a willingness to introduce modern organizational methods in their maintenance services.

3. Planning of maintenance

As a general rule, regardless of the way maintenance is organized, it is performed according to plan and on the basis of printed forms which specify by areas and equipment the work to be carried out during each scheduled shut-down.

Because of climatological factors and, therefore, irrigation-related considerations, the Peruvian sugar mills operate on virtually a year-round basis, with each co-operative scheduling its annual idle period (which may last from approximately 20 to 45 days) according to personnel requirements and the status of the crop. This makes it necessary to keep on duty nearly all the operating and maintenance personnel for the maintenance activities, and to operate with more than one work shift a day.

For these reasons, the weekly scheduled maintenance must be performed with great care and as completely as possible. Similarly, during idle periods scheduled for reasons other than maintenance, the work is carefully scheduled and planned, with the time available for maintenance used to optimum effect.

At most mills, the maintenance service is based on the use of servicing sheets, and the work orders are administratively monitored so that performance history cards may be prepared for the equipment units and machines. A graph, albeit not a very detailed one, indicating the frequency of repair and maintenance operations is established.

The workshop maintenance personnel and, at mills where a general maintenance service is available, all maintenance personnel are under the orders of the maintenance department head; the personnel assigned to the various sections of the mill may, in some cases, report to the maintenance foreman and, in others, to the processing foreman of the area in question.

At nearly all the mills, maintenance is preventive in nature and is performed on a daily, weekly and annual basis according to work orders and servicing sheets.

Maintenance activities are planned and scheduled according to the comments and reports of the maintenance foreman and the heads of the processing areas. This is a routine operation, regardless of the frequency and duration of the work involved.

As for the annual shutdown, the planning, scheduling and budgeting of the maintenance work are discussed by an oversight committee consisting of the mill's general manager, general superintendent and the maintenance and processing foremen. This committee produces a document describing in detail the work and the materials required, the systems for progress and quality control and the necessary performance testing.

4. Control.

Technical control

Both during the weekly shutdowns and during the annual idle period, responsibility for the quality and timing of the work scheduled and for the quality of the materials, components and spare parts employed rests with the head of the maintenance service. He is assisted in this control function by the heads of the processing areas and by the maintenance supervisors whom he himself assigns to the various areas where the work is to be performed. The work is planned by area and by equipment unit.

Administrative control

Administrative control is based on the work orders which in turn derive from the "master" work plan prepared in advance. These orders, which are signed by the maintenance head, indicate the work to be performed, the man-hours planned and actually worked, the materials and spare parts used, and the supplies furnished by the warehouse in order that the cost of these factors may be evaluated as accurately as possible for charging to the overall production cost of the sugar.

It is important to note that because of the precarious economic situation currently facing all the Peruvian sugar-producing co-operatives, whose liabilities exceed their assets, it is almost impossible to carry out the controls described above because their warehouse stocks are currently at zero. The control functions we have described were formerly in effect; as for today, however, it is fair to say that, owing to inadequate resources and administrative problems, there is no maintenance but merely patching.

As a cost factor, maintenance is estimated to account for approximately 8 per cent of the total cost of the sugar.

Performance testing

Under the prime responsibility of the area heads and, secondly, of the maintenance foreman, each equipment unit repaired is performance-tested. In addition, at the conclusion of the work scheduled for the annual shutdown and before the mill is restarted, performance tests are carried out with a view to correcting any problems that may persist.

Regarding the organization and management of the warehouses, there are servicing sheets and systems to ensure that inventories are kept to a minimum. It should be possible to employ these systems when spare parts and components can again be purchased.

There is a national institution for technical standardization, but the sugar industry as such, although it recognizes the importance of standards to its operations, has so far not been involved in this effort.

5. Preventive, emergency and diagnostic maintenance operations

As has already been pointed out, maintenance operations are based on the use of servicing sheets and work orders. All work is documented and verbal instructions are not accepted.

Even emergency maintenance operations are documented by special forms that exist for this purpose.

Once it has been planned and scheduled, both weekly and annual preventive maintenance is performed by special crews who report on their progress to the head of the service for verification and evaluation. Although this depends on a great many factors, the annual repair and maintenance normally involves the complete dismantling of the equipment, the work being performed both on the spot or, where necessary, the parts or the equipment itself being sent to the appropriate workshops. It is not the normal practice for Peruvian sugar mills to hire the maintenance services of specialized firms.

It is generally true to say that no non-destructive testing is employed and that when such testing is required for a particular piece of equipment specialized firms are approached for these services, which are very expensive. At the Casa Grande Mill there are two or three electronic units that can be used for this purpose.

No studies have been made regarding the lubrication of equipment and machinery at the mills, with respect to either the characteristics and quality of the lubricants or the behaviour of the materials and systems for lubricating parts subject to friction. We were told that the same holds true with regard to corrosion.

There is interest in energy-saving and fuel-economizing maintenance procedures, but so far no suitable economic policy has been established in this area.

Abrasion is a general problem at sugar mills, but because of economic limitations it has not been possible to conduct research into new materials or systems to improve this situation. However, at the cost of a very considerable investment, the Casa Grande Mill has its own cane-washing station, which, although it has not eliminated this problem, has at least alleviated it.

.6. Workshops

All Peruvian sugar mills, depending on their size and importance, have their own shops for mechanical, electrical and instrument work, and in some cases, where they require such facilities and their installations can accommodate them, their own foundries and carpentry and model-making shops for their own needs and for sales to third parties. The workshops are staffed by personnel who have acquired their experience through their work there and who generally start as apprentices.

Planning, organization and management of the workshops is the responsibility of the maintenance foreman in co-operation with the heads of the various shops.

Depending on the kind of shop involved, these workshops handle between 70 and 100 per cent of the repair work needed, i.e., the least well equipped of them take care of 70 per cent of the mill's requirements. Most of the shops can produce almost all the parts and components needed, and some of them their own equipment. Because of the limited number of orders received from the mills themselves, the costs at some of these workshops are very high. The situation which arose in the wake of the Second World War and the desire for independence with respect to supplies of parts, components and some types of equipment prompted the designers of these mills in some cases to install very complete workshops. These shops, which were at that time technically and economically efficient, today stand virtually idle because of faulty management, problems with the trade unions and, above all, the low prices for sugar and the limited size of the areas they serve.

Because of the current situation, the shops operate with systems which permit the maximum reconditioning of parts, components and equipment, but again because of the precarious economic conditions in the sector, they paradoxically still lack modern reconditioning techniques and methods.

Although built some time ago, the workshops are generally equipped with efficient machine-tools, either domestically manufactured or imported or, in many cases, produced in the shops themselves. The maintenance of these tools and machine-tools is the responsibility of the shop personnel.

Most of the materials and supplies required for repairs and the manufacture of parts and components are produced in Peru, while the imported materials required are obtained locally from the appropriate dealers.

7. Outlook

Personnel training

A number of personnel training courses have been organized within the existing limitations, but none in the area of maintenance. In view of the decisive importance of this area to the effective operation of the mills, an effort will be made in the future, with the necessary assistance, to participate in national and/or multinational programmes in the maintenance area.

Because of the complex and heterogeneous situation surrounding the operation of the workshops, most of which are too large, for the time being there is no interest in maintenance centres. Conversely, there is keen interest in participation in national and/or multinational enterprises engaged in the design, engineering and manufacturing of parts, components and equipment for the sugar industry.

Since at the present time each mill is independently managed through its own co-operative, the identification of an area of interest common to all of them that should be nationally developed is not an easy task, but one which will require a consultation meeting to define the relevant requirements. Nevertheless, the Sugar Research Institute, as an institution, would very much like to participate in a regional project, especially in the area of personnel training and, most particularly, in the area of non-destructive testing, since this would enable the Institute to expand the scope of its activities and the services that it is currently offering the Peruvian sugar industry.

8. Conclusions

Following the demise of CECOAP as the umbrella organization for the Peruvian sugar-producing co-operatives, it is recommended that national talks be held with the participation of all the co-operatives in order to

identify the areas of common interest shared by these mills with respect to maintenance that would enable them to take part in the project.

It should be pointed out that the Casa Grande Mill, the mill with the largest production capacity in Peru and reputedly one of the biggest in the region, has a unit where the cane is cleaned before it is received for grinding. It is also the only mill equipped with a diffusor and possibly the only one with its own iron foundry shop producing all the rollers, pumps and other cast parts and components used at the mill. In addition, it has its own bronze casting shop, joinery and model-building shop, and engineering and metalworking shop, the latter too large for its own requirements.

It is clear that there is interest in participation in enterprises engaged in the design, engineering and manufacture of parts and components and in anti-corrosion research, and, through the Institute, in the establishment of a non-destructive testing centre.

# TRINIDAD AND TOBAGO

## 1. General information

Organization visited (1-4 November 1982):

Sugar Producers' Association, Puerto España

Represented by:

Yacub Khan, Director and Executive Secretary; Secretary of the Caribbean Sugar Association

Trinidad has four producing sugar mills. Approximate capacity: 350 tonnes of cane per hour. The mills operate approximately 120 days a year, from January until mid-June. During this period they have about 2,500 employees on their payroll. Trinidad has a sugar refinery which operates the year round.

The sugar industry in Trinidad has seen its production decline by 25 per cent in recent years, due mainly to the infrastructural changes that have occurred on the island.

The bankruptcy of the railway system led to a transfer of all transport to the roads, overloading the network and giving rise to difficulties in hauling the cane from the fields to the sugar mills.

The sharp increases in the price of oil resulted in the availability of fewer technicians and skilled workers on the island, as the petroleum industry, with its higher wages, absorbed most of the country's qualified sugar industry personnel. The result has been that, in recent years, the sugar industry has had to replace as much as 70 per cent of its most highly qualified personnel, giving rise to a virtually untenable situation. The industry has been forced to increase wages considerably, and this at a time of plummeting world sugar prices. The losses which the sugar sector has suffered as a result have confronted the Government with a difficult problem.

Anywhere from 250,000 to 300,000 persons depend, directly or indirectly, on the sugar industry for their income.

In 1975, the group visited the Brechin Castle Estate, Ltd., at Caroni, represented by Mr. Russel Wotherspoon, the Director General. Approximate production: 35,000 tonnes/year.

2. Organization of maintenance

Each mill has a director, a head of production, shift foremen and section and workshop supervisors.

The responsibility for repair and maintenance rests with a chief engineer, who attends to this work in addition to his normal duties. In the performance of his maintenance tasks the engi ·er relies on his own professional experience.

Each mill has its own operating systems, and so far no kind of standardized maintenance system has been introduced.

3. Planning of maintenance

There is nothing in the way of pre-planned maintenance.

The organization and distribution of the various operating positions among the existing mills.

The repair and maintenance programmes are determined by the person in charge of this work, and, since there is no standardized documentation governing how this work is to be performed, the programmes vary from mill to mill.

During grinding, repair and maintenance crews are formed from among the regular production workers and are assisted by workshop personnel in the case of more difficult repairs.

There is no scheduled maintenance based on the use of control cards.

4. Control

All forms of control are of an administrative nature only.

The sugar industry has acquired and installed a sophisticated computer. Although it has so far been used only for financial and administrative purposes, it has capacity for processing maintenance control systems.

No personnel have been assigned to develop any kind of technical control card system.

There are no technical standards or norms.

The costs of labour, materials, etc. are administratively monitored.

Before the mills begin operation, each machine is briefly tested.

In testing the various systems, checklists are not used.

Currently, repair and maintenance costs are the highest they have been in many years. It is estimated that they account for as much as 65 per cent of total costs.

Cost control operations at the main warehouses are computerized, but so far no minimum or maximum inventory levels have been established. Management believes that warehouses inventories are enormous and could be reduced through proper planning.

No computerized maintenance programme is in use, although there is an awareness of the need for such a system and, therefore, a willingness, when the industry's financial condition permits it, to train the required personnel and computerize the maintenance programme.

5. Preventive, emergency and diagnostic maintenance operations

No diagnostic or preventive maintenance procedures of the kind that might be considered a complete system have been introduced.

Maintenance operations are based exclusively on the equipment manufacturers' manuals and catalogues, where they can be obtained.

Most of the maintenance and repair operations performed depend for their quality on the skill and experience of the individual mechanic, foreman or engineer in charge of the work.

The systems and methods used in each specific case depend on the skill and experience of the available personnel, the tools and equipment at hand, etc.

Supervision is the responsibility of the personnel who do the job and depends on their skill, since, apart from the points covered in the manuals supplied with the equipment, there are no written checklists.

Each piece of machinery or equipment is dismantled and reassembled with reliance on the skill and experience of the work crews, and also on the available tools and instruments.

A range of manual, semi-automatic and automatic lubrication systems are in use.

Greasing is performed using both oils and greases. Shell's grease No. 7222 is used, with excellent results, for the greasing of the cane crushers.

The sugar industry is co-operating with the petroleum industry for the purpose of reducing the number of oils and greases in use.

Unfortunately, the training and information of the personnel engaged in lubrication work has not been given the necessary attention.

Rust- and corrosion-control systems do exist, albeit on a limited scale.

How best to prepare surfaces before painting has not been well explained, and this is an area where there is a need for improvement through more appropriate training and information.

No energy-saving systems have been developed.

No system of non-destructive testing has been developed.

Some compensation instruments are available.

Non-destructive testing equipment is not often leased from private firms.

For the time being, sugar industry officials believe it is more economical to have the machinery inspected.

6. Workshops

The type of workshop available depends on how many years ago the mill was built and when its principal tools were purchased and installed.

The management is of the opinion that the model on which the workshops are patterned is a good one. As they put it: "What we lack is experience and skill on the part of the workers, foremen and engineers operating the tools and equipment already available in the shops".

Most of the mills have separate shops for mechanical, electrical and instrument work. If the qualified personnel were available, the workshops could handle an estimated 80 per cent of the necessary repairs on their own.

Thanks to the new petroleum industry, modern new private workshops have sprung up for repair and manufacturing orders. As a result, the management believes that 75 per cent of all repair work can be performed on the island.

Structural steel elements, tanks, pipes and cast parts are being or can be produced locally.

The reconditioning of parts and components is not very highly developed. Welding is used. The management would like to see more progress in this area.


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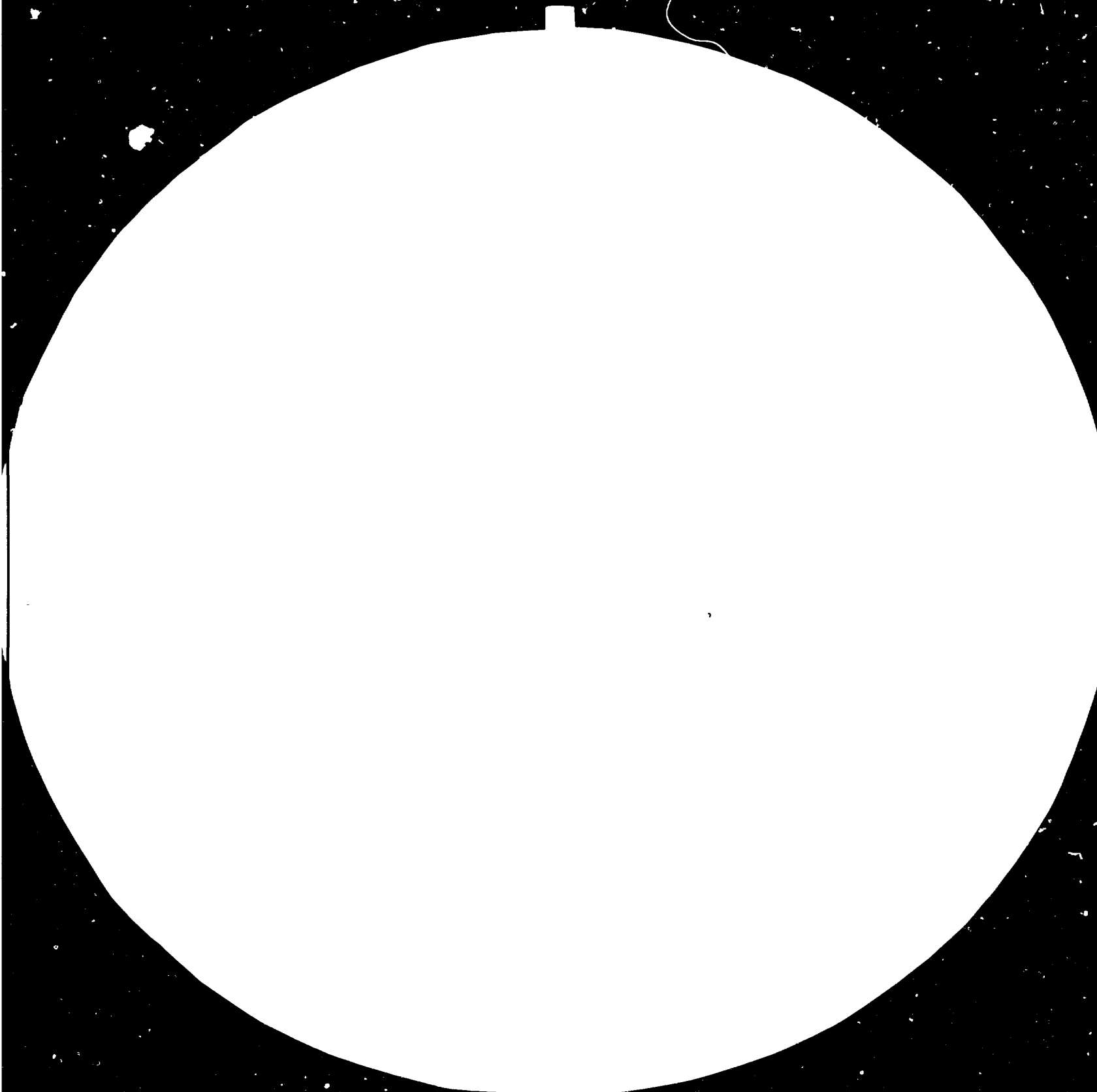
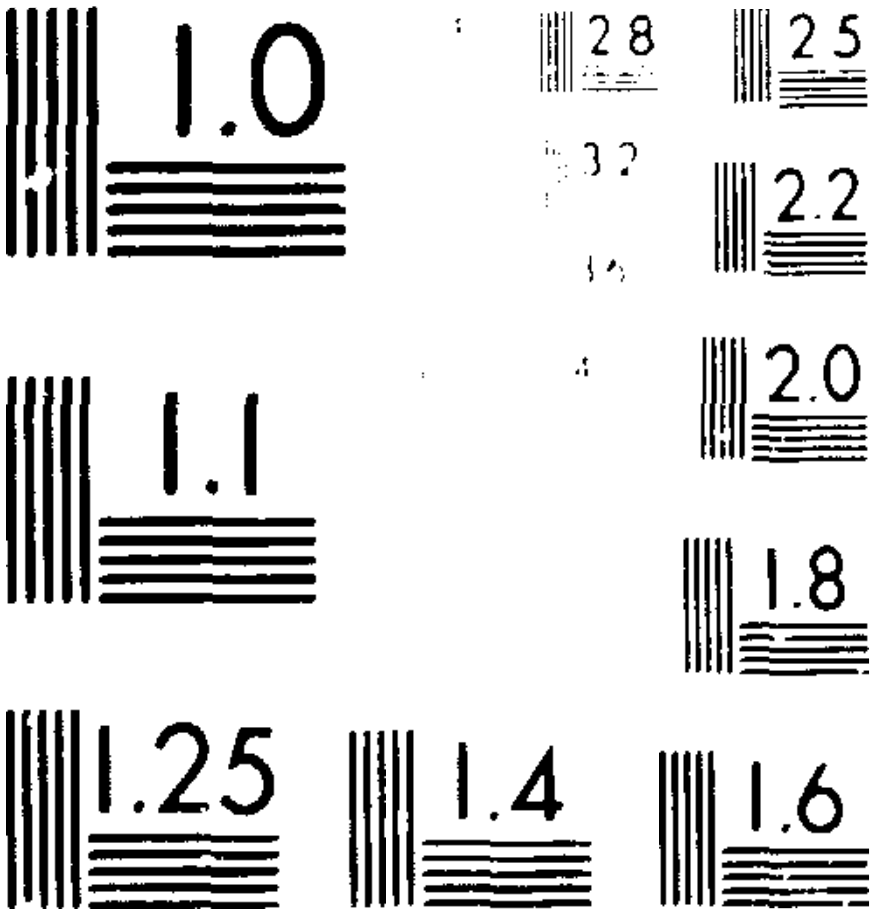




All tools and machinery have to be imported, and the same is normally true of any kind of raw material.

Almost every year, technicians and mechanics are sent abroad for training on machinery and instruments purchased from various companies.

7. Outlook

In the maintenance and repair area the sugar industry suffers greatly from a shortage of trained personnel with the ability to carry out all the repair and maintenance work the industry requires.

There is also a substantial shortage of managerial personnel at all levels.

Sugar industry spokesmen expressed great interest in any kind of initiative that would result in an improvement of their situation with respect to repair and maintenance. They are also interested in any kind of national or multinational enterprise to manufacture equipment, components, and spare parts that could be of benefit to both the industry and the country. Finally, these spokesmen indicated keen interest in participating in a regional programme of maintenance, research, training and implementation.

8. Conclusions

Trinidad appears to be facing certain problems which differ slightly from those of the other Caribbean countries.

Since it is an oil-rich country, it is better off than the remaining countries of the area where there is a lack of foreign exchange.

Unfortunately, from the managerial level down to the level of the skilled worker, the sugar industry has lost a large portion of its qualified personnel to the petroleum sector, where salaries and wages are higher. This is the root cause of the deterioration suffered by the sugar industry in Trinidad.

Students from Trinidad can and do attend the University of the West Indies, where they can enroll in courses especially designed for the sugar industry and obtain post-graduate degrees.

There are colleges of arts and sciences, along with workshops offering technical training in machinery and instrumentation. Mechanical engineers from Jamaica and elsewhere are also being trained, the purpose being to graduate more qualified personnel for maintenance positions in the sugar

industry. Most of the courses and schools admit students from the other English-speaking countries of the Caribbean region. However, these institutions have too limited a capacity to satisfy the urgent need for qualified personnel for the sugar industry.

Trinidad appears to be the country with the most advanced computer systems in the area. This is a field in which Trinidad could become a centre for the teaching and training of skilled personnel from among the English-speaking countries of the region, until such time as these other countries develop their own ability to train the personnel they need for the operation of their own computers.

PROJECT: DESIGN OF MODERN MAINTENANCE SYSTEMS AND TECHNIQUES FOR SUGAR MILLS

National Report

# OUTLINE NATIONAL REPORT

A. General information

Country .....

Responding institution .....

Address of the institution .....

.....

Name of the person preparing the report .....

His position in the institution ..... Date .....

B. Production

1. Number of mills:_____. Enclose list of mills, indicating their names and addresses.

2. Total area in the country under cultivation:_____ hectares.

3. Total area under sugar cane:_____ hectares.

4. National installed milling capacity per annum:_____ tonnes.

5. Percentage of installed capacity utilized per annum:_____ per cent.

6. National milling average per day:_____ tonnes.

7. Annual installed production capacity for raw sugar:_____ tonnes; for types of sugar:_____.

8. Real national production of raw sugar and individual types of sugar over the last five years, in thousands of tonnes:_____.

| Year | Raw sugar | Types of sugar | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 1977 | | | | | | | | |
| 1978 | | | | | | | | |
| 1979 | | | | | | | | |
| 1980 | | | | | | | | |
| 1981 | | | | | | | | |

9. Actual number of production days a year (average for last five years):_____ days.

C and D. Maintenance and organization of maintenance

The replies to these sections of the form will depend on whether the sugar industry is private, State-owned or a mixed sector. If ownership is private or mixed, the replies will summarize the information contained in the individual mill reports. If the entire sugar industry is State-controlled in terms of the origin and uniformity of its technical and administrative regulations, the replies to these sections will reflect the industry's current status and prospects for the future with regard to maintenance and repair, with these data to be supplemented of course by any information received from the mills.

In summary, sections C and D of the national report will contain comments on the current situation and outlook in the area of maintenance and repair, with particular attention to the following points:

Systems, methods and effectiveness of maintenance and repair;

Non-destructive testing of equipment, components and parts;

Anti-corrosion techniques;

Lubrication;

Fuel- and energy-saving techniques;

Manufacture of equipment, components and parts;

Organization and management of the maintenance system;

Maintenance control;

Workshops, etc.

E. General policies

Whatever the form of ownership of the industry, this section should discuss where the country stands with regard to the following points:

1. Has the national sugar industry participated, is it participating, or does it wish to participate in some kind of multinational co-operation project for the development of the sugar sector?

2. What possibilities and/or obstacles might arise with regard to the establishment in the country of national maintenance and repair centres? If such centres are already in operation, discuss their organization and services.

3. Would the national sugar industry be willing to participate actively in the setting up of multinational stations to provide technical and scientific assistance in the detection of faults and defects in equipment, components and parts, and in research (into materials, lubrication and lubricants, tools, etc.) for improving the productivity of the mills?

4. A decisive factor in the efficiency and productivity of equipment and mills is the active participation of the human agent in the work of conservation, maintenance and repair. Accordingly, the training of maintenance personnel is an indispensable and urgent requirement. This kind of training might be imparted through courses of short duration (at most eight weeks) on such subjects as: the organization of maintenance services; the application of new maintenance methods and systems; the use of new high-efficiency materials and tools; methods for extending the service life of equipment, components and parts; workshop organization; the maintenance of "key" equipment and parts; recommendations on anti-corrosion and lubrication techniques, etc. - all designed to improve the performance of the sugar industries of the region. Would your country's sugar industry send maintenance personnel to courses of this kind and would it defray the participants' expenses? It is understood that the country hosting these courses would undertake to hold to a minimum the expenses connected with the participants' stay there.

5. Is there any national interest in participating in multinational enterprises engaged in the engineering, design and manufacture of equipment, components and parts for the sugar industry and for sugar industry products at the regional level?

6. Are there any national technical standards governing sugar industry equipment, processes, materials, maintenance, etc.? Would the country be willing to play an active role in the development of standards (of the COPANT type) for the sugar sector?

7. Is there any interest in participating in seminars (with a maximum duration of five days) on the dissemination and transfer of maintenance and repair technology among the GEPLACEA countries?

8. Is there any interest in the organization of maintenance and repair courses and seminars (points 4 and 7) at the national level?

9. What other national and regional co-operation activities which have not been mentioned in this outline and which could promote improved efficiency in the sugar industry through the introduction of modern maintenance techniques might be organized?

10. In the event the national sugar industry were to participate in one or more of the regional co-operation activities described in this outline, which of the following forms of participation would be best suited to it:

| | |
|---|---|
| A cash contribution | ( ) |
| Provision of a pilot mill | ( ) |
| Provision of a research laboratory | ( ) |
| Provision of infrastructure facilities (premises, transport, simultaneous interpretation facilities, support personnel, etc.) | ( ) |
| Provision of maintenance workshops (for mechanical or electrical work, casting, etc.) | ( ) |
| Provision of high-level technical personnel | ( ) |
| Provision of equipment and instruments | ( ) |
| Others (please specify) | ( ) |

If any of these forms of participation is selected, please describe it in as much detail as possible.

## INSTRUCTIONS FOR FILLING OUT THE REPORT

Only those points which require explanation will be discussed.

A. General information. Self-explanatory.

B. Production

The figures called for in points 1 to 9 are to be understood as referring to annual averages.

If reports are available from all the mills, the figures given in points 4 to 9 will represent the arithmetic mean of the figures given in those reports.

Section B can also be completed using data supplied by the responding institution itself, the national bureaux of statistics and census, the national planning department, etc.

C and D. Maintenance and the organization of maintenance

It will be virtually impossible to prepare these sections, as indeed any part of the national report, unless information is available on what is taking place at the individual mills. It is possible that in some countries the work of scheduling, organizing and planning the maintenance and repair activities at the mills may be centralized, but for the majority of the questions asked in sections C and D of the outline, replies will require the contributions of the persons responsible for carrying out and monitoring the maintenance; hence the importance of the mill reports. This situation will be much more difficult in countries where the sugar industry is in private or mixed ownership, because in such cases there is almost certainly no one agency or person in a position to provide information on the situation at each of the country's sugar mills. As a consequence, the co-operation of the mills themselves is crucial.

In any case, whatever the information available, the data reported in sections C and D must refer to the points raised under these sections in the mill report outline. In the case of many points, the information may be general (referring to all the mills), while in others - particularly the final paragraphs (summaries) of sections C and D of the national report outline - a more detailed analysis and evaluation will be required.

E. General policy

This section of the report will require a statement of the authorized and representative views of the national sugar industry. It is recommended that for every question of this section the reply be as precise and concise as possible.

Finally, it would be of valuable assistance in preparing the regional report and the GEPLACEA maintenance project draft if copies were attached of any type of standards, guidelines, reports, tables, checksheets and maintenance systems and methods, whether in use at the mill or at the national level.

PROJECT: DESIGN OF MODERN MAINTENANCE SYSTEMS AND TECHNIQUES FOR SUGAR MILLS

Mill report

PROJECT: DESIGN OF MODERN MAINTENANCE SYSTEMS AND TECHNIQUES FOR SUGAR MILLS

## Introduction

As part of the joint implementation by UNDP/UNIDO and GEPLACEA of development programmes to improve the efficiency of the regional sugar industry, this project envisages the promotion and strengthening of technical co-operation systems among developing countries through the carrying out by the industries of the area (Latin America and the Caribbean) of joint activities of technical support.

The activities considered here are designed to provide studies and analyses of the problems of maintenance and repair at the sugar mills of the region. This project will produce as its basic output a general (regional) report, along with another report by countries, the evaluation of which will lead to the preparation of the draft of a new large-scale regional project, for the development and implementation of which UNDP/UNIDO will provide valuable assistance.

In summary then, this project represents the first stage of a large-scale regional technical co-operation project among the GEPLACEA countries, aimed at developing the sugar industry of the area.

Essentially, the purpose of this first stage is to identify and co-ordinate the possibilities, requirements and capabilities of the participating GEPLACEA member countries with a view to the implementation of a regional maintenance and repair programme. To this end, it will be necessary to prepare national reports on the current situation and prospects with regard to maintenance and repair practices, operations, methods and systems. These reports must be as realistic and truthful as possible so that, by analysing and evaluating them, the most accurate and pragmatic recommendations, conclusions and suggestions possible can be formulated for national and regional application.

## Outline for the preparation of the national reports

### Coverage

The intention is that, in addition to the objectives indicated in the introduction to the present document, the result of the comparative analysis of the national reports should be of benefit to the participating Governments and all the other GEPLACEA member countries with regard to

maintenance and repair activities, and that it should be possible in this way to start a programme aimed principally at increasing the efficiency of the sugar industry at all levels. To this end, it is recommended that the information be as complete and explicit as possible. The outline presented here is by no means to be regarded as inflexible, the fact being that the persons appointed to prepare the national reports may include any additional information they think may be useful and contribute to the objectives of the report.

It is very important that the reports contain any up-dated sugar industry handbooks, since this will provide a valuable opportunity to prepare such handbooks for those countries that do not yet have them. In this connection, any country wishing such assistance can already obtain it through GEPLACEA.

As there are several mills in each of the GEPLACEA member countries and as it is vital that the information gathered be as complete as possible, it will be necessary to prepare two outlines - one for the mills and the other for the country. Each of these will provide valuable information for GEPLACEA and for all of the participating member countries. In the case of the countries, the data collected will provide the organizations involved in co-ordination research, programming, planning, etc., which participate in the preparation of the national report, with invaluable material on which to base additional studies of their national sugar industries.

## OUTLINE OF THE MILL REPORT

### A. General information

Name of the mill:_____

Address of the mill: Street and No.:_____

State, department or province:_____ Country:_____

Telephone:_____ Telex:_____

Name of the respondent:_____

His position:_____ Date of the report:_____

B. Production

1. Area under cultivation:_____ hectares.

2. Yield of cane per hectare:_____ tonnes.

3. Tonnes of cane per tonne of sugar (average):_____ tonnes.

4. Installed annual grinding capacity:_____ tonnes.

5. Average percentage of capacity utilized/year:_____ per cent.

6. Average volume (in tonnes) ground per day:_____ tonnes.

7. Installed annual production capacity for raw sugar: _____ tonnes; for types of sugar:_____

8. Real annual production of raw sugar and types of sugar: _____ tonnes; _____ tonnes; _____ tonnes; _____ tonnes.

9. Actual annual number of production days (average for last five years): _____ days.

C. Maintenance

1. Do you have separate mechanical and electrical maintenance or a a system of general maintenance? _____

2. Do you do your own maintenance or contract it out? _____

3. Once the production period has ended, on the average how many days a year are actually devoted to general maintenance? _____

4. What is the mill's average idle time (in hours) for unscheduled maintenance during the production period? _____. Include statistics for the last five years: 1977 _____; 1978 _____; 1979 _____; 1980 _____; 1981 _____.

What are the principal causes of unscheduled shutdowns? _____

_____.

What equipment or section of the mill causes the greatest number of unscheduled shutdowns, and approximately what percentage of the total number of unscheduled shutdowns does this represent? _____

_____.

5. Number of years the basic equipment (by section) has been in operation? _____

_____

_____.

6. Indicate the sections where there is more than one piece of equipment to perform a single function. For example: tandem mill, sugar pans, evaporation system, etc., and place an (x) following the sections in which these equipment units are of different makes. _____

_____

_____.

Are the parts, components and spare parts of this equipment interchangeable? Yes ___ No ___ Partially ___. Have you done anything to standardize the equipment? Yes ___ No ___. If the answer is No, what are the main repair and maintenance difficulties as a result of this? _____

_____.

If you have any study on this subject, please attach it to the report.

7. What are the principal kinds of repair carried out in the mill's own workshops and in outside workshops?

| Mill's own workshops: | Outside workshops: |
|---|---|
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |

8. Do you have your own workshop for mechanical work? Yes ( ) No ( ); for electrical work? Yes ( ) No ( ); combined electrical and mechanical workshop? Yes ( ) No ( ); carpentry shop? Yes ( ) No ( ); model-building shop? Yes ( ) No ( ); casting shop? Yes ( ) No ( ); instrumentation shop? Yes ( ) No ( ); workshops of other kinds?

Do you have, in addition, any auxiliary workshops or shops attached to any particular section of the mill? Yes ( ) No ( ). Describe them. _____.

9. What parts, spare parts, components and equipment do you manufacture? All ( ) Some ( ). Do you sell any of these items to other mills? Yes ( ) No ( ). _____

Please fill in annex 1.

10. Do you have any difficulties in obtaining suitable materials for the manufacture of parts and components and the performance of repairs? _____

_____.

If you have resorted to substitutes for any of the materials, indicate the material used, the equipment unit, part or component, and the results. _____

_____.

11. Do you cannibalize equipment? Yes ( ) No ( ). If so, what do you do with the incomplete equipment? _____

_____.

What are the main reasons for resorting to this practice? _____

_____

12. What is the average time for the delivery of parts and components manufactured outside the mill? _____. And when manufactured at the mill itself? _____. What are the main reasons for delays? _____

_____.

13. Are you a member of any central organization or maintenance co-operative that services other mills? Yes ( ) No ( ). If you are, indicate the main advantages and disadvantages, and the type of agreement or contract. _____

_____.

Please attach any information you may have on this subject.

14. What is the system of measurement most commonly used, the decimal system or the English system? _____. If the answer is the English system, is there any trend towards changing it? Yes ( ) No ( ). Does the system in use cause difficulties in obtaining parts, spare parts and components? Yes ( ) No ( ). What importance attaches to the system in use with respect to inventories of parts, spare parts and components? _____

_____.

15. Do you employ non-destructive testing or any technical or scientific system for the detection of faults and defects in equipment units, parts and components? Yes ( ) No ( ). If you do, indicate whether the instruments used are your own or acquired from outside sources.

_____.

Mark with an (x) the equipment or instrument used:

Detection system:

| | | | |
|---|---|---|---|
| Ultrasonic | ( ) | Noise level meter | ( ) |
| X-ray | ( ) | Portable mechanical levelling equipment | ( ) |
| Magnetic | ( ) | Vibrometer | ( ) |
| Liquid-penetration type | ( ) | Optical levelling equipment | ( ) |
| Parasitic-current type | ( ) | Roughness meter | ( ) |
| Others | ( ) | Hardness meter | ( ) |
| Ultrasonic leak detector | ( ) | Metallographic microscope | ( ) |
| Ultrasonic digital thickness gauge | ( ) | Universal traction machine | ( ) |
| Digital contact thermometer | ( ) | | |

Indicate whether you have used other equipment and for what purposes. _____

_____.

16. Do you use any kind of anti-corrosion system: sand-blasting, painting, other coatings, etc. Yes ( ) No ( ). If so, indicate briefly the results. _____

_____.

17. Have you carried out any studies of methods of lubrication (for reducer housings, axle bearings, gear boxes, etc.). Yes ( ) No ( ). Indicate the results. _____

_____ _____.

_____. Attach any suc .

18. Are there any problems with domestic lubricants? _____

_____.

If you use imported lubricants, indicate the percentage they represent: _____.

19. Mention any measures you may have introduced to reduce fuel consumption. _____

_____.

20. Use this space to comment on any maintenance-related aspects that may not have been covered in the preceding questions. _____

_____.

D. Organization of maintenance

It is possible that at most mills the information for this section of the report may already be available as part of their maintenance system. It is recommended that any written material on this subject be attached, with additions to update it where appropriate.

1. Personnel

1.1 Total number of mill personnel: _____.

1.2 Total personnel employed in maintenance tasks:

| Classification | Permanent personnel during production period | Maintenance shutdown period |
|---|---|---|
| Engineers | | |
| Technicians | | |
| Skilled workers | | |
| Unskilled workers | | |
| Administrative staff (secretaries, etc.) | | |
| Total | | |

1.3 Do you have highly trained maintenance personnel? _____

_____.

1.4 Do you send personnel to training centres for further training in maintenance? Yes ( ) No ( ). If so, how many a year?

_____.

1.5 Are any training courses organized at the mill itself? Yes ( ) No ( ). If so, indicate the frequency of such courses and the subjects they cover. _____

_____.

1.6 If available, attach any flowcharts or instructions regarding the duties and responsibilities of the maintenance staff.

2. Costs

2.1 Indicate the average total annual cost of maintenance in United States dollars or as a percentage of total production cost, for the following headings:

| | | | |
|---|---|---|---|
| Labour ..... | $US | _____ | % _____ |
| Materials ..... ..... | $US | _____ | % _____ |
| Parts, spare parts and components from outside sources ..... | $US | _____ | % _____ |
| Lubricants ..... | $US | _____ | % _____ |
| Miscellaneous (fuel, energy, transport, etc.) ..... | $US | _____ | % _____ |
| Other items ..... | $US | _____ | % _____ |
| Total ..... | $US | _____ | % _____ |

2.2 Total annual maintenance labour cost as a percentage of the total annual cost of the labour employed at the mill: _____%.

2.3 Total hourly cost of maintenance labour in $US: _____.

3. Maintenance systems and methods

Please attach any material you have on the following:

3.1 Mill maintenance planning and scheduling systems;

3.2 Preventive, operational and emergency maintenance scheduling (activities and times) by section and equipment units;

3.3 Maintenance standards and manuals;

3.4 Materials standards and manuals for parts and components;

3.5 Work orders and the personnel responsible for handling them;

3.6 Standards and systems for the control of part, spare part and component inventories;

3.7 Computerized control of general maintenance operations, inventories, costs, etc.; steps currently being taken to introduce computerization, or reasons why this is not possible at present;

3.8 Systems and standards for the organization of workshops for design, casting, model-making, mechanical work, electrical work, etc.;

3.9 Current situation at the mill with respect to acquisition maintenance;

3.10 Inventory systems covering all the items by mill sections or equipment groups which receive maintenance servicing;

3.11 General organizational diagram of the maintenance service;

3.12 Other organizational considerations.

4. Maintence control

Please include under this section all material regarding the following aspects:

4.1 Standards and recommendations for maintenance control, especially with regard to the use of daily incident report forms and weekly and monthly summaries; permanently updated graphs; report forms for each service, indicating: type of maintenance, section or equipment serviced, causes of the fault, materials used, workshop man-hours expended, costs, etc.;

4.2 Current lists of equipment units along with their performance and servicing records, indicating the required daily, weekly, monthly and annual maintenance operations and checks which must be performed for each unit and, above all, comments of interest for each piece of equipment;

4.3 Statistics on time lost;

4.4 Cleaning schedules;

4.5 The accounting of work pending;

4.6 Possible programmes of pre-scheduled repair and maintenance shutdowns;

4.7 Possible schedules of shutdowns for lack of cane or other non-production-related reasons, affording an opportunity for the performance of some maintenance operations;

4.8 Planning, scheduling and standards for equipment dismantling and repair; control and verification systems; testing and calibration, etc.;

4.9 Other maintenance control considerations.

5. Workshops

5.1 Workshop systems of operational planning and scheduling; workshop organization;

5.2 List of equipment units and machine-tools available; equipment to be acquired and the reasons why;

5.3 List and organization of operations and of equipment, parts and components repaired; determination of priorities;

5.4 Methodological guidelines and standards for the re-conditioning of equipment, parts and components; equipment and instruments used for this purpose;

5.5 Quality control systems used with parts and components manufactured and/or repaired;

5.6 Steps taken to improve the productivity of the equipment and workshops in general; improvements still required to that end.

5.7 Does the lack of uniformity in mill production equipment create problems for you in repairing the equipment and in manufacturing parts and components in series? What recommendations can you offer?

5.8 Are there any problems with respect to the maintenance of the workshops' own equipment and machine-tools (parts, spare parts, lubricants, etc.)?

## INSTRUCTIONS FOR FILLING OUT THE REPORT

Only those points which require explanation will be discussed.

A. General information. Self-explanatory.

B. Production

It is understood that the figures for points 1 through 9 refer to the annual average. Point 6 refers to a 24-hour day. If, in addition to the average, data are available for the last five years (point 9), the days should be indicated for each of these years.

C. Maintenance

2. The question refers to whether the maintenance servicing is performed by the mill's own personnel or by some outside firm hired for this purpose.

4. The reference is to scheduled shutdowns and shutdowns due to production equipment malfunctions. Shutdowns due to the lack of cane are not included. Shutdowns due to electric power and steam outages are included only if these outages originated at the mill.

5. The reference is to large equipment units only, the respondent being asked to indicate how many years these units have been in service.

6. This information will indicate whether there are problems because of the lack of uniformity among the equipment units, parts, components, etc.

7. Outside workshops may be either in the country or abroad.

8. Some mills, in addition to the general workshops, also have, for example, a workshop for emergency work in the grinding section.

13. If some kind of agreement is about to be concluded, please indicate this fact.

D. Organization of maintenance

1.1 Includes administrative, production and maintenance personnel.

1.2 An indication should be made in the second column of the table of the total number of permanent personnel employed in maintenance plus those who may be assigned to maintenance during the shutdown period after the harvest.

2.1 The costs indicated for the items listed under "Miscellaneous" do not refer to overall mill costs, but only to that part of these costs which was expended in connection with maintenance.

2.2 Example: If the mill's total labour costs amounted to $US 3 million and if during that same year labour costs for general maintenance amounted to $US 750,000, the figure 25 per cent should be indicated.

3. Maintenance systems and methods

The information covering most of these points may already be available in the form of manuals, guidelines, standards, graphs, individual sheets, etc., either for the country as a whole or for individual mills. If this is the case, all that need be done is to attach a copy of this material.

If such material is not available, please indicate very briefly after each of the 12 points what you have or what you routinely do, or else simply write No if that is the appropriate answer.

4 and 5. Maintenance control and workshops

Proceed in the same way as indicated for section 3.

Annex 1

Assume that the grinding rollers were produced at the mill's own casting shop and that approximately 10 per cent of them are sold to other mills. The table in this case would be filled out as follows:

| Description | ORIGIN | | |
|---|---|---|---|
| | In-house manufacture | Domestic manufacture | Imported |
| Grinding rollers * (10%) | x | | |

ANNEX 1

LIST OF EQUIPMENT, PARTS, COMPONENTS, SPARE PARTS, MATERIALS, ETC. MANUFACTURED BY THE MILL ITSELF OR BY DOMESTIC WORKSHOPS, OR IMPORTED.

| DESCRIPTION | ORIGIN | | |
|---|---|---|---|
| | In-house manufacture | Domestic manufacture | Imported |
| | | | |

/2.

2.

Notes: (a) Place an "x" in the column indicating the origin.

(b) If there are sales to other mills, place an asterisk (*) after the description of the item, followed immediately, in parentheses ( ), by the percentage of annual production sold.

UNITED NATIONS DEVELOPMENT PROGRAMME

Project of the Group of Latin American and Caribbean Sugar-Exporting Countries (GEPLACEA):

(names of the countries participating in the project)

PROJECT DOCUMENT

| | |
|---|---|
| Title: | Development and application of a regional maintenance system for the sugar industry |
| Number: | Duration: |
| Primary function: | Direct assistance |
| Secondary function: | Service |
| Sector: | Industry (UNDP class. and code): 35 |
| Sub-sector: | Sugar industry (UNDP class. and code): Industrial services and institutions, 35-30 |
| Regional implementing agency: | Group of Latin American and Caribbean Sugar-Exporting Countries (GEPLACEA) |
| Executing agency: | United Nations Industrial Development Organization (UNIDO) |
| Estimated starting date: | July 1983 |
| GEPLACEA inputs: | 7,940,400 (in kind) UNDP inputs: $US 5,635,000 |

Signed: _____ Date: _____

on behalf of GEPLACEA

_____ Date: _____

on behalf of the executing agency

_____ Date: _____

on behalf of UNDP

## IMPORTANT NOTE

It should be made clear that this project document is the draft of a regional project designed and budgeted to cover a programme of activities for a maximum of eight countries over a period of three years. The participation of a larger number of countries would mean fewer activities or less far-reaching results. If the number of countries is increased, the original scope of the project can be retained only by increasing its budget.

Some degree of flexibility has been built into the design of the project; in other words, just as the budgetary allocations may be lowered if activities are curtailed or the number of countries is reduced, so too they have only to be increased to allow for a greater number of participating countries or an extension of the planned activities.

The mission believes that, as a basic document for the formulation of a final project, this draft contains all the required elements of information, since it is thought that the final objectives and activities of the regional project will be jointly developed at a meeting organized exclusively for that purpose both by the countries with a genuine interest in participating in the project, the GEPLACEA Permanent Secretariat, the Cuban Government and UNIDO.

I. Background and justification

The sugar industry of the region is characterized by technologies and equipment which have remained unchanged for considerably more than half a century. Despite this, this industry accounts for more than 32 per cent of world sugar production and more than 52 per cent of the volume of world sugar exports. To produce these amounts, there are approximately 700 mills in the region, valued at about $US 20 billion. To this should be added that every year some $US 1 billion are invested in these mills for maintenance or spent because of unscheduled shutdowns.

These are eloquent figures and justify the priority attention that has been given to this project of scientific and technical maintenance, the principal purposes of which are the following: (a) to lower processing costs and increase the productivity of the equipment and the mills; (b) to achieve a balanced, rational and optimum consumption of energy; (c) to analyse the domestic and regional preservation, reconditioning and manufacture of equipment, parts and components; (d) to develop maintenance planning and scheduling; (e) to study and analyse the quality and use of materials, tools, machine-tools and workshops; (f) to introduce standards for equipment, parts, components and methods; (g) to conduct research into problems of corrosion, lubrication and abrasion; (h) to disseminate detailed information on the current status and technological advances in the various production and maintenance areas of the sugar industry, and to promote the required training of personnel at all levels.

At the present time, at almost all the mills of the region maintenance is performed in the traditional way, i.e., by taking advantage of the periods when the mills are idle. There are two basic reasons for these shutdowns: (a) the cyclic nature of sugar production, which is basically due to climatic factors and results in idle periods of nearly half a year (attention should be given in this connection to the few countries in the region which, apart from any climatic factors, schedule shutdowns of 20 to 60 days a year exclusively for mill maintenance); and (b) shutdowns which occur during operating periods due to equipment malfunctions and reasons not related to maintenance.

In the first of these cases, the mill's equipment and machinery is totally dismantled, a system which in addition to being extremely expensive is not required for all the equipment. In the second case, the equipment

is inspected, after which it is superficially serviced. In both cases, the inspection is visual, and since there is a lack of the proper instruments and techniques, repair and maintenance requirements difficult to diagnose simply by sight may go unobserved, the result very often being breakage and shutdowns often lasting for several days and entailing repercussions in terms of disrupted production, higher fuel consumption and increased operating and maintenance costs.

In addition, sugar industries are found mainly in developing countries, and even though sugar is a fully processed product, as regards pricing and marketing, producers face the same obstacles as the suppliers of raw materials, and sometimes even worse ones. In many of these countries, sugar is the only source of foreign exchange revenue and the principal source of employment, so that any fluctuations in the international sugar market have a direct effect on the economic well-being of these countries. Not only have the efforts undertaken throughout this century to secure sugar prices that are in reasonable ratio to those of other products and that develop in parallel with worldwide economic developments and trends not succeeded, but it has not even been possible to achieve stability in sugar prices. This situation is further aggravated by the constantly rising prices for the equipment, parts, spare parts and materials used in the various stages of the sugar agro-industry.

All these factors are a source of major concern to those who are responsible for the management of this agro-industrial sector and who are aware that, in many cases, their earnings are insufficient to ensure even the barest margin of survival. It may be that this is due solely to the fact that sugar, for all its being a fully processed product, originates in underdeveloped or developing countries. Paradoxically, sugar is the equivalently lowest-priced universal energy ingredient of the human diet, something that is altogether inequitable.

Any effort or initiative to improve the dire situation confronting the majority of the sugar-producing countries and, above all, to assist in the development and upgrading of this agro-industry sector, will be welcomed not only by the producing countries themselves, but also by those agencies whose mission it is to contribute to and promote the well-being of humanity.

On the basis of these brief facts, the conclusion may be drawn that international development and promotion organizations have the responsibility of contributing actively to the plans and programmes of agencies

which, like the Group of Latin American and Caribbean Sugar-Exporting Countries (GEPLACEA), are working to launch projects aimed at improving the technical and economic situation of the sugar industry.

Finally, on the basis of the large number of countries involved in this sector, the size of the workforce employed in the growing and processing of sugar, the quality and quantity of the final product, and all the other factors discussed above, there is a clear need for the implementation, with as little delay as possible, of a regional project to make available to the Latin American and Caribbean cane-sugar producing countries the most advanced methods, systems and techniques with which to approach the demanding tasks associated with the maintenance and repair of sugar industry equipment.

## II. Special considerations

This project is conceived as a regional effort to develop the Latin American and Caribbean sugar industry sector by providing it with modern maintenance systems and techniques.

In addition to the objectives and purposes discussed throughout this document, the project is in response to two of the global goals established as priority targets by the Governments and by UNDP and GEPLACEA, namely:

The conservation and saving of energy through the reduction of energy consumption in the industry and through the optimum and efficient use of the sources of energy produced by the industry itself;

The promotion, among the developing countries, of technical co-operation methods and systems through mutual support in the form of technology transfers between the sugar mills of the region.

## III. Objectives

The idea of this project springs from the urgent need to put an end to the technical, economic and scientific situation with which the sugar industry has had to contend for almost a century and which has today been further aggravated by the world crisis. Basically, apart from immediate and substantial improvements in sugar marketing, the development of this sector depends, above all else, on a significant increase in the productivity of plant and equipment and, as a result, on a parallel reduction in production costs. These objectives can be achieved through

the use by the regional sugar industry of modern maintenance techniques and systems which will enable the sugar producers of the Latin American and Caribbean area to operate with greater efficiency.

A. Development objectives

The development objectives of this project on behalf of the regional sugar industry sector are the following:

1. To improve the efficiency of the Latin American and Caribbean sugar industry by reducing the following:

   Lost time due to breakdowns and/or unscheduled interruptions of operation;

   Problems caused by the obsolescence of equipment and methods;

   Maintenance and repair costs;

   Consumption of fuel and lubricants;

   Consumption of materials, parts and components;

   Operating costs;

   Inventories of parts, spare parts and components;

   Problems caused by corrosion, abrasion and internal defects in equipment units, parts and components;

   Problems connected with the organization, management, administration and technology of maintenance and repair systems;

   Problems connected with the establishment of technical standards, and the like.

2. To train maintenance and repair personnel;

3. To increase the productivity of the workshops involved in the maintenance and repair effort;

4. To achieve greater and better use of the installed industrial capacity;

5. To establish systems for co-operation and transfer of technology among the sugar producers of the region and between these and producers on other continents;

6. To promote the manufacture, in the individual countries and/or in the region, of capital goods for the sugar industry.

B. Immediate objectives

On the basis of the national reports of the countries selected in the feasibility study prepared for this project, and the comments and recommendations contained in the regional report prepared by the experts on the current status and outlook in the area of sugar mill maintenance and repair in the countries visited, the project's immediate objectives are the following:

1. To disseminate among the mills of the Latin American and Caribbean countries information on the advances achieved through the maintenance system which is being introduced in Cuba, as an incentive for improving the maintenance services at these mills;

2. To develop an awareness of the importance of maintenance, within the production system, as an indispensable factor in improving product quality, boosting plant productivity and lowering production costs; and, since maintenance thus contributes to the efficiency of the mill, to emphasize the position of the maintenance service within the mill's organizational structure, keeping in mind its technical support function;

3. To develop technical standardization for equipment, parts and components as an essential factor in modern maintenance systems;

4. To promote the use of new and appropriate materials, high-efficiency techniques and tools, and methods and tools for extending the service life of equipment, parts and components and for reconditioning them;

5. To introduce modern and effective techniques for the detection of faults and defects in equipment and components, and to publicize the importance of so-called "acquisition maintenance";

6. To promote the planning, organization and scheduling of maintenance along with the establishment of maintenance control systems and methods;

7. To promote the use of modern lubrication systems, the reduction of fuel consumption and the optimum and rational use of the sources of energy generated in the industry;

8. To introduce practices and methods for combating corrosion and abrasion;

9. To encourage the exchange of technical information on maintenance among the region's sugar producers, and their co-operation and participation in multilateral programmes for the development of the regional sugar industry;

10. To improve the productivity, organization and services of the workshops (mechanical and metalworking, electrical, instrumentation, casting, etc.) operating in support of the maintenance system;

11. To train maintenance and repair personnel at all levels in new techniques, methods and systems and in the use of up-to-date equipment;

12. To disseminate information on "who's who" in the manufacture, sales, distribution and procurement of capital goods (equipment, parts and components) for the sugar industry, and to promote the establishment of engineering and design enterprises and of national and multinational companies to manufacture these capital goods.

C. Summary of objectives

1. Maintenance standards

(a) Administration;

(b) Organization of workshops and warehouses;

(c) Preventive maintenance;

(d) Repair techniques;

(e) Standardization, etc.

2. Non-destructive testing

(a) Ultrasonic fault-detection;

(b) Vibration balancing and control;

(c) Ultrasonic leak-detection;

(d) Hardness testing;

(e) Noise-level determinations;

(f) X-ray inspection;

(g) Optical alignment control, etc.

3. Anti-corrosion methods

(a) Corrosion research and testing;

(b) Surface treatment;

(c) Application of paint;

(d) Equipment and instruments;

(e) Safety measures.

4. Reconditioning of parts and components

(a) By arc welding;

(b) By gas welding;

(c) By special welding;

(d) By high- and low-temperature powder metallurgy techniques;

(e) By the deposition of materials with better characteristics than the original;

(f) By larger to smaller elements.

5. Lubrication, hydraulic systems, metallurgy

(a) Friction;

(b) Lubricants;

(c) Lubrication systems;

(d) Hydraulic systems;

(e) Oil recovery;

(f) Bearings;

(g) Casting;

(h) Metallurgy, etc.

6. Energy (temperature control) and energy savings

(a) Electricity;

(b) Steam;

(c) Fuel;

(d) Turbines, electric motors, internal combustion engines;

(e) Boilers, etc.

7. Computerized maintenance

   (a) Information and administrative control;

   (b) Control through preventive maintenance;

   (c) Warehouse control;

   (d) Workshop control;

   (e) Cost control;

   (f) Production control.

8. Instrumentation

   (a) Formation of working groups and teams;

   (b) Tools and equipment;

   (c) Maintenance and repair, etc.

9. Information and technology centre

   (a) Selection of catalogues, manuals, textbooks, information, etc.;

   (b) Translation, printing, reproduction, etc.;

   (c) Library support;

   (d) Registration;

   (e) Information distribution, etc.

10. Other subjects, within the scope of our project, related to maintenance and to maintenance research, training and practices in the sugar industry

As a general rule, for each of the subjects covered a programme of research, training and practical implementation will be carried out under the project, involving all the participants from among the member countries in accordance with the official programme of the project.

IV. Outputs

The outputs expected from this project are the following:

1. A maintenance manual that may be applied at any sugar mill in the region and that basically covers the organization, planning and scheduling of a modern technico-scientific system of maintenance, with particular attention to the following points:

   The development of a maintenance service organizational diagram and a description of the functions of each of the system's departments,

with practical examples illustrating how the system can be applied at any mill regardless of its size and the size of the maintenance staff,

The main technical standards for maintenance and repair operations, along with a discussion of the materials to be used in various equipment units, parts and components depending on their composition, structure, existing plant characteristics and the cyclical nature of sugar production in the region,

Recommendations on the most suitable equipment for use, plus guidelines and standards for the organization and effective operation of the maintenance support workshops,

Applicability and use of technical and scientific testing techniques for the inspection of equipment, parts and components, along with information on the methods and instruments used to detect faults and defects, and on high-efficiency tools to facilitate maintenance,

Descriptions of maintenance centres and of how they operate;

Recommendations and guidelines on the protection and the reconditioning of parts and components, as well as the equipment units and instruments used in the maintenance system,

Guidelines and recommendations on the planning of scheduled, preventive and operational maintenance and on the frequency at which typical repairs are performed,

Recommendations on systems to combat corrosion and abrasion;

Model forms for: the inventory control of all elements subject to maintenance, technical instructions, cost control, time-keeping, etc.,

Guidelines and recommendations on the dismantling of equipment and systems,

Recommendations on professional personnel, technicians and skilled workers and on their functions;

2. Regional personnel training courses in sugar-mill maintenance and repair techniques, methods and systems;

3. Establishment of a system of training involving personnel exchanges among the mills of the region;

4. The organization of regional seminars on specific maintenance-related subjects and on questions of the transfer of technology among regional specialists and between these specialists and those of other parts of the world, with particular attention to the problems of: maintainability; after-sale service; the possibilities for the design and manufacture within the region of equipment, parts and components; the conditions and prospects with regard to maintenance at the national level, etc.;

5. The preparation of directories listing the producers, distributors and users of capital goods for the sugar industry;

6. Recommendations on the design and manufacture of equipment, parts and components for the sugar industry;

7. The formulation of effective guidelines and methods for the maintenance and repair of specific equipment types, namely: heat and electricity generators and heat-exchange units, speed reducers, transmission systems, etc.

8. The development of a computerized system for the rationalization of maintenance scheduling, inventory control (parts, spare parts and components), etc.;

9. The establishment of a regional maintenance information exchange system.

V. Activities

In accordance with the preliminary report of the joint UNIDO/GEPLACEA mission and the evaluation of the interests of the various countries participating in this project and their individual catalogue of requirements, and considering the roles of the various project counterparts, once the joint areas of development have been identified and the corresponding responsibilities defined, the following will be the priority activities of the project:

1. Joint meeting of the countries participating in the regional project, for the purpose of:

   Agreeing on procedures for the implementation of the project (definition of subject areas and work plans and assignment of countries to their implementation, analysis of the allocations to each subject area and of the appropriate counterpart, etc.); and

   Designing the machinery for the exchange of experience and dissemination of information on achievements among the remaining GEPLACEA countries.

2. Preparation of the general maintenance manual for sugar mills.

3. Regional training courses.

4. International seminars on the transfer of maintenance technology.

5. Preparation of directories containing listings of manufacturers, distributors and users of capital goods for the sugar industry.

6. Promotion of, and collaboration in, the establishment - at the mill, national and multinational levels - of design and engineering departments, with this activity to be initially aimed at the solution of local problems through the adaptation of design to the industrial requirements of the region, and at the identification and elemination of specific equipment malfunctions.

   At a later stage, depending on the possibilities and continuity of the project, this activity is to include the engineering of plants and equipment, parts and components, with a view to their series manufacture.

7. Joint mission for the analysis of tenders and the purchase of equipment and materials.

8. Practical development of maintenance and repair operations, fault detection in parts and materials, high-efficiency tools, methods for the protection and reconditioning of parts, the use of new materials (alloys and non-metallic materials), techniques for combating corrosion and abrasion, etc.

9. Description and erection of laboratories and instrumentation areas for physical and non-destructive testing.

10. Meeting of the participating countries to evaluate the project and ensure its continuity.

11. Tasks connected with the establishment of a maintenance information exchange system.

VI. Project inputs

Comment. It should be noted that in some of the countries visited, despite the genuinely critical situation through which the sugar industry of the region is currently passing, major efforts are being made to introduce modern systems of maintenance. This work is being performed by high-level scientific and technical professionals. We would suggest therefore that consideration be given to these people when the time comes to recruit experts both for this project and for others having to do with the sugar-cane industry.

The inputs described below are estimates only; the final figures will represent the sum of the commitments by the participating countries.

1. Description of GEPLACEA inputs

For the execution of this project, GEPLACEA will furnish all the technical staff and auxiliary personnel, and such infrastructural and supporting facilities as may be required. These project inputs will be provided both at the headquarters of the GEPLACEA Permanent Secretariat and in the host country and participating countries of the project in the quality and quantity and at the times indicated below:

| Personnel | Duration |
|---|---|
| Co-Director, professional with a university degree and more than ten years of experience in the sugar industry | From the beginning of the project |
| Twelve university-level technicians with organizational and practical experience in maintenance at sugar mills, the metal-working and engineering industry, casting operations and machine-tools | From the beginning of the work |

| | |
|---|---|
| Thirty-six middle-level technicians with practical experience in maintenance at sugar mills, the metalworking and engineering industry, casting operations and machine-tools | From the beginning of the work |
| Eighteen auxiliary maintenance workers | From the beginning of the work |
| Four secretaries, six office workers and drivers | From the beginning of the work |
| One designer and two draftsmen | From the beginning of the work |
| Technicians and assembly and construction workers | From the beginning |
| <u>Offices, facilities, transport and support</u> | |
| Premises for courses, seminars and training; offices and laboratories for project activities | From the beginning of the work |
| Pilot mill and supporting workshops | From the beginning of the work |
| Facilities and expenses in respect of transport for personnel in the host country and participating countries | From the arrival of the experts |
| Technical and bibliographical information and other national resources required for the operation of the project | For the duration of the project |
| Organizational support for meetings, courses, seminars, training, etc. | For the duration of the project, according to programme requirements |

1.2 <u>Description of UNDP/UNIDO inputs</u>

| Personnel | Duration |
|---|---|
| (a) Co-Director, professional with a university degree, expert in the area of maintenance | 36 months |
| (b) Promotor, professional with a university degree | 36 months |

| | | |
|---|---|---|
| (c) | Expert in support workshops, machine-tools, and the reconditioning of parts<br>Expert in problems of corrosion, abrasion and lubrication<br>Expert in the installation and repair of instrumentation<br>Expert in data processing and systems computerization<br>Expert in the design, engineering and manufacturing of equipment, parts and components<br>Experts on short-term contracts | 108 months |

Equipment, personnel training, meetings and other facilities

| Description | Amount and time |
|---|---|
| Missions: analysis of systems and organizations, tenders and purchase of equipment | Six missions of approximately five days' duration each |
| Personnel training fellowships in: maintenance engineering, maintenance and repair techniques, lubrication and anti-corrosion techniques, protection and reconditioning of parts and components, workshop organization and management, thermo-electric and pumping systems, etc. | Total of 108 man-months outside the region and 216 man-months at mills in the region |
| Regional and intercontinental seminars on specific subjects | Four, with not less than 30 participants per seminar |
| Personnel training courses in carefully selected subjects | Four, with not less than 30 participants per course |
| Consultants' meetings and conference; project evaluation and monitoring | Three, with the participation of two representatives from each participating country |
| Light transport facilities and mobile laboratories | - |

| | |
|---|---|
| Equipment | Instruments and equipment for measuring, inspection, application and mechanical testing of materials; tools and materials |
| Miscellaneous | Facilities for the experts, designers and technicians |

VIII. Evaluation of the project

In view of the length of this project, there will be a need for one or two reviews a year. The progress of the project will be evaluated in accordance with the policies and procedures established by UNDP for this purpose. The organization, terms of reference and timing of these evaluation reviews will be decided by consultation between GEPLACEA, UNDP and UNIDO. The progress reports and the terminal report will be jointly prepared by the project's two co-directors, using the forms prepared for this purpose by UNDP.

IX. Possibility of the continuation of the project

Before the end of the project, and on the basis of the results which it is hoped will be achieved through it, GEPLACEA and UNDP/UNIDO will discuss the possibility of continuing the project and/or starting a new supplementary one.

Final note

All the figures discussed in this project document are tentative. The final figures will be determined by the number of countries participating in the project and by the contributions of the United Nations and other organizations.

## Timetable of Activities

| Work plan | First year | Second year | Third year |
|---|---|---|---|
| 1. Analysis of areas to be considered | | | |
| 1.1 Visits to mills and workshops | | | |
| 1.2 Contacts with technicians and specialists | | | |
| 1.3 Joint meeting of participating countries | | | |
| 2. Formulation of conclusions on areas analysed | | | |
| 3. Study missions, analysis of tenders and purchase of equipment, tools and materials | | | |
| 4. Practical work | | | |
| 5. Preparation of the general maintenance manual for sugar mills | | | |
| 6. Promotion of activities and system for the exchange of experience | | | |
| 7. Transfer of technology and personnel training | | | |
| 7.1 Training (fellowships) | | | |
| 7.2 Training courses | | | |
| 7.3 Seminars | | | |
| 7.4 Evaluation meetings | | | |
| 8. Directory of manufacturers, distributors and users of capital goods | | | |
| 9. Promotion and establishment of engineering and design enterprises | | | |
| 10. Terminal report | | | |

VII. Budget

Annual budget breakdown

1. GEPLACEA counterpart: host country, participating countries and executive secretariat

| Description | Total m/m | Total $US | First Year m/m | First Year $US | Second Year m/m | Second Year $US | Third Year m/m | Third Year $US |
|---|---|---|---|---|---|---|---|---|
| (a) Project personnel | | | | | | | | |
| Project Co-Director | 36 | 108,000 | 12 | 36,000 | 12 | 36,000 | 12 | 36,000 |
| University-level technicians | 432 | 864,000 | 144 | 288,000 | 12 | 288,000 | 12 | 288,000 |
| Middle-level technicians | 1,296 | 1,036,800 | 432 | 345,600 | 432 | 345,600 | 432 | 345,600 |
| Operational assistants | 684 | 342,000 | 228 | 114,000 | 228 | 114,000 | 228 | 114,000 |
| Secretaries | 144 | 72,000 | 48 | 24,000 | 48 | 24,000 | 48 | 24,000 |
| Designer | 36 | 54,000 | 12 | 18,000 | 12 | 18,000 | 12 | 18,000 |
| Draftsmen | 72 | 57,600 | 24 | 19,200 | 24 | 19,200 | 24 | 19,200 |
| Translator | 36 | 72,000 | 12 | 24,000 | 12 | 24,000 | 12 | 24,000 |
| Office workers and drivers | 180 | 54,000 | 60 | 18,000 | 60 | 18,000 | 60 | 18,000 |
| Sub-total | 2,916 | 2,660,400 | 972 | 886,800 | 972 | 886,800 | 972 | 886,800 |
| (b) Offices, facilities, transport of personnel and administrative support | | | | | | | | |
| Personnel training: courses, seminars, meetings, premises, materials, administrative support | | 300,000 | | 100,000 | | 100,000 | | 100,000 |
| Equipment: | | | | | | | | |
| Expendable equipment | | 240,000 | | 80,000 | | 80,000 | | 80,000 |
| Non-expendable equipment (mill) | | 3,000,000 | | 1,000,000 | | 1,000,000 | | 1,000,000 |
| Premises | | 1,500,000 | | 500,000 | | 500,000 | | 500,000 |
| Miscellaneous costs: | | | | | | | | |
| Use and maintenance of equipment | | 150,000 | | 50,000 | | 50,000 | | 50,000 |
| Miscellaneous | | 90,000 | | 30,000 | | 30,000 | | 30,000 |
| Sub-total | | 5,280,000 | | 1,760,000 | | 1,760,000 | | 1,760,000 |
| Total GEPLACEA contribution | | 7,940,400 | | 2,646,800 | | 2,646,800 | | 2,646,800 |

## Budget Summary

| Description | Total $US | First Year $US | Second Year $US | Third Year $US |
|---|---|---|---|---|
| **UNDP/UNIDO inputs** | | | | |
| Experts | 180 m/m 1,260,000 | 54 m/m 378,000 | 78 m/m 546,000 | 48 m/m 336,000 |
| Equipment | 3,340,000 | 2,000,000 | 1,400,000 | 340,000 |
| Training, courses, seminars | 670,000 | 180,000 | 310,000 | 180,000 |
| Missions | 150,000 | 50,000 | 50,000 | 50,000 |
| Light transport and miscellaneous | 190,000 | 73,000 | 59,000 | 58,000 |
| Meetings | 25,000 | 10,000 | 5,000 | 10,000 |
| Total UNDP contribution | 5,635,000 | 2,691,000 | 1,970,000 | 974,000 |
| **GEPLACEA counterpart** | | | | |
| Personnel | 2,916 m/m 2,660,400 | 972 m/m 886,800 | 972 m/m 886,800 | 972 m/m 886,800 |
| Training, courses, seminars, meetings | 300,000 | 100,000 | 100,000 | 100,000 |
| Equipment | 3,240,000 | 1,080,000 | 1,080,000 | 1,080,000 |
| Premises | 1,500,000 | 500,000 | 500,000 | 500,000 |
| Miscellaneous | 240,000 | 80,000 | 80,000 | 80,000 |
| Total GEPLACEA input | 7,940,000 | 2,646,800 | 2,646,800 | 2,646,800 |
| **Grand total for the project** | 13,575,400 | 5,337,800 | 4,574,800 | 3,662,800 |

## 4. Practical activities

**Description of activities**

4.1 **Techniques for the detection of faults and defects and mechanical testing of parts and materials**

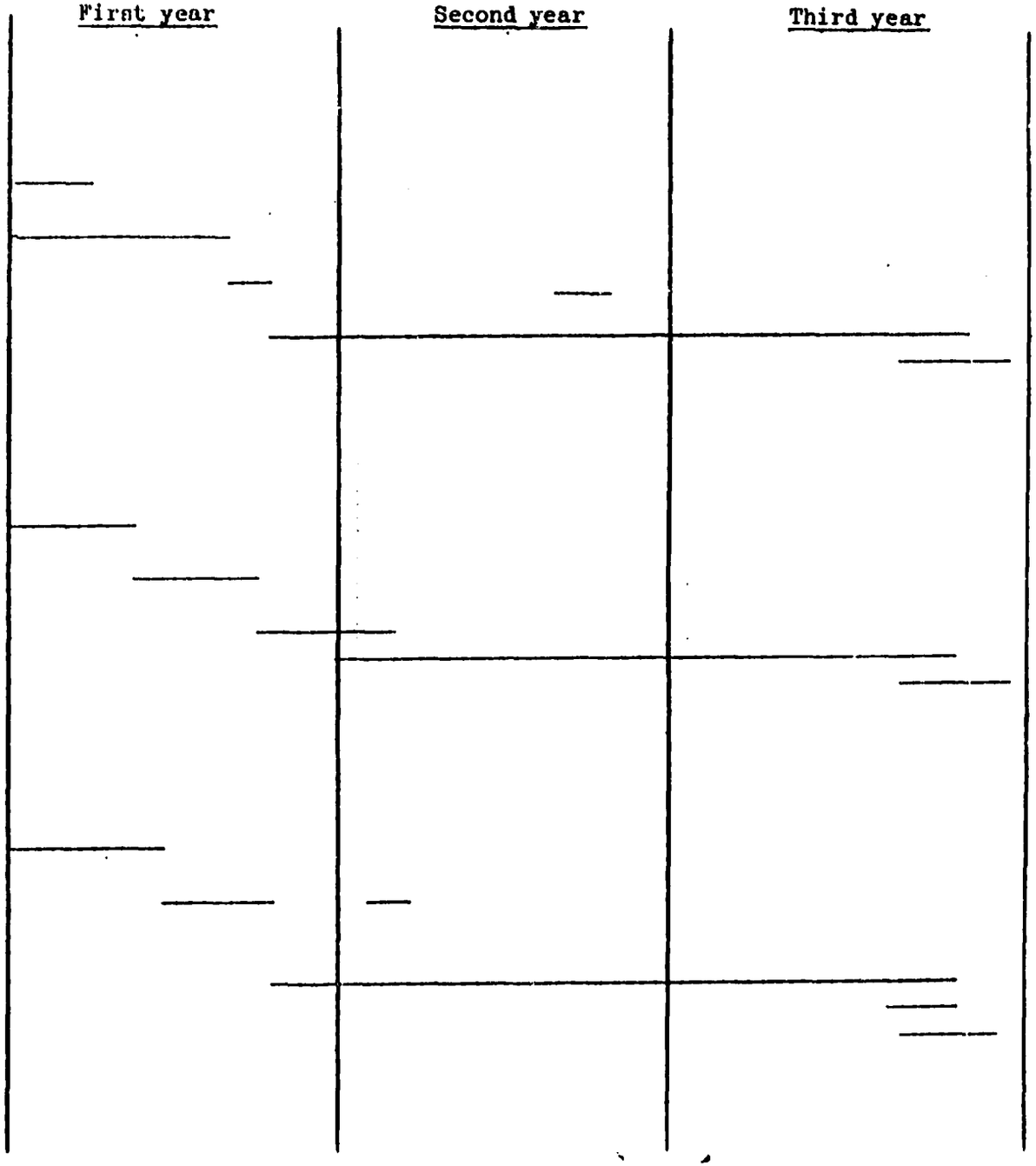
- (a) Analysis of techniques to be used
- (b) Analysis of the characteristics of the equipment to be used
- (c) Mission to analyse tenders and purchase equipment
- (d) Development of industrial techniques and experience
- (e) Report and recommendations

4.2 **Systems and methods for maintenance and repair control**

- (a) Analysis of control methods and systems
- (b) Missions to evaluate systems in other industries
- (c) Adaptation and innovation of systems and methods
- (d) Industrial application
- (e) Report and recommendations

4.3 **Methods for the reconditioning of parts, and introduction of new materials**

- (a) Analysis of the methods to be used
- (b) Feasibility studies, study of tenders and purchase of materials and equipment
- (c) Development of application techniques and sites
- (d) Industrial testing
- (e) Report and recommendations



First year

4.4 Systems and methods for the operation of supporting workshops and the use of high-efficiency tools and machine-tools

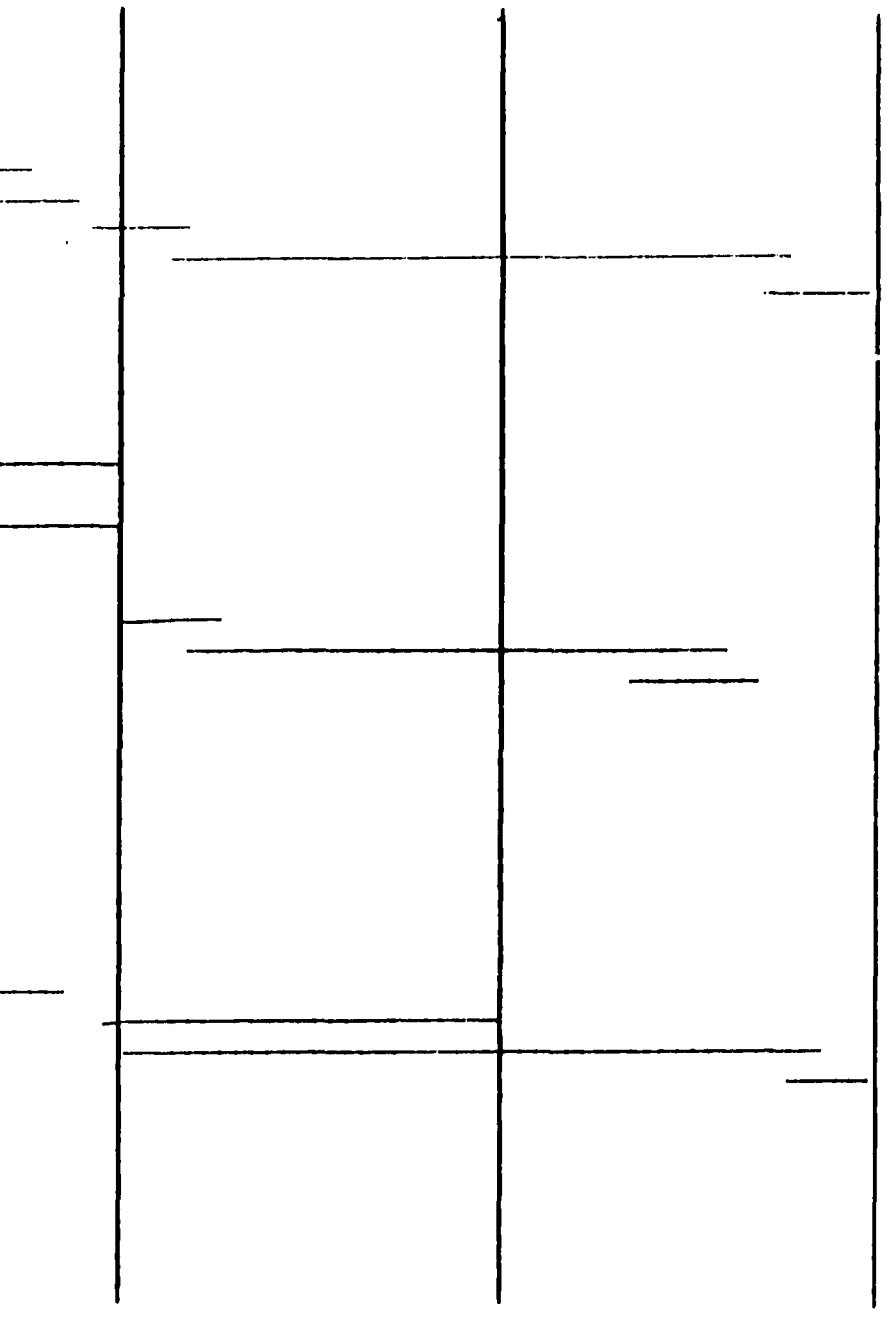
(a) Analysis of the general situation
(b) Analysis of tools and equipment
(c) Development of appropriate methods
(d) Industrial testing
(e) Report and recommendations

4.5 Systems and methods of lubrication and control; protection against corrosion

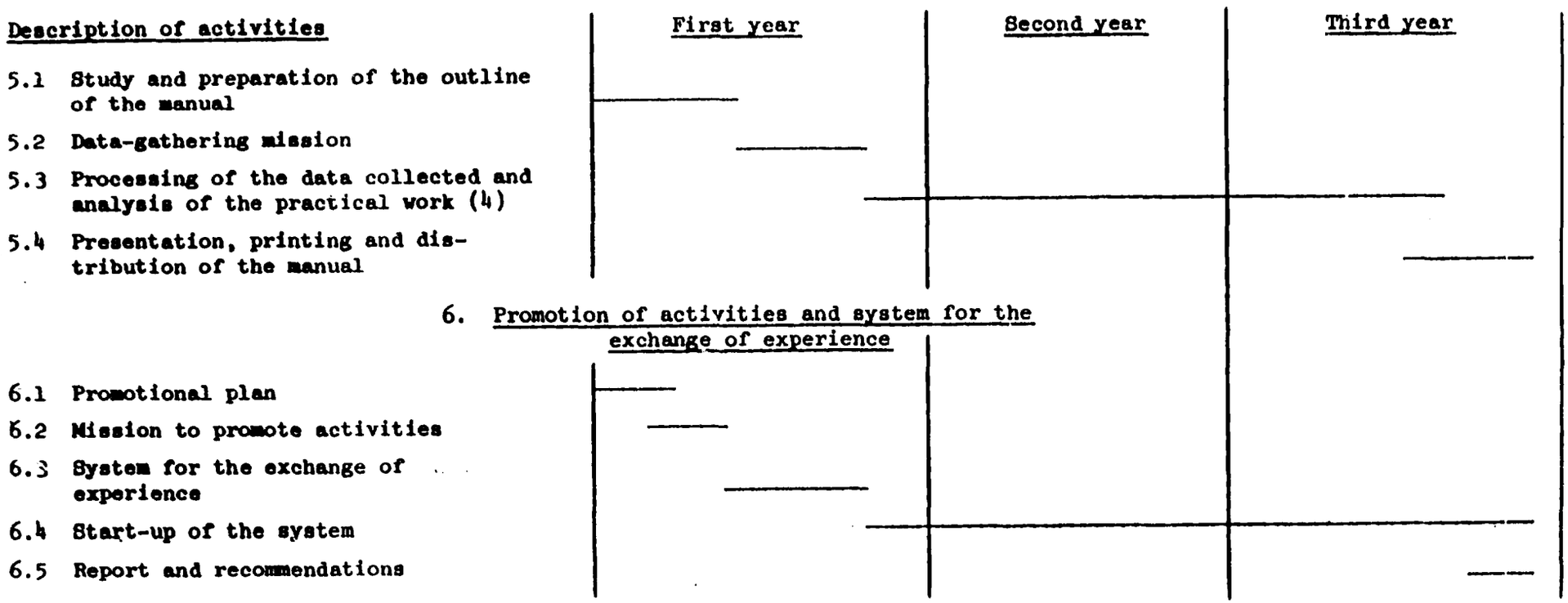
(a) Analysis of methods and systems
(b) Determination of materials and equipment to be used
(c) Feasibility study, analysis of tenders and purchase of materials and equipment
(d) Industrial testing
(e) Report and recommendations

4.6 Casting processes, materials and parts

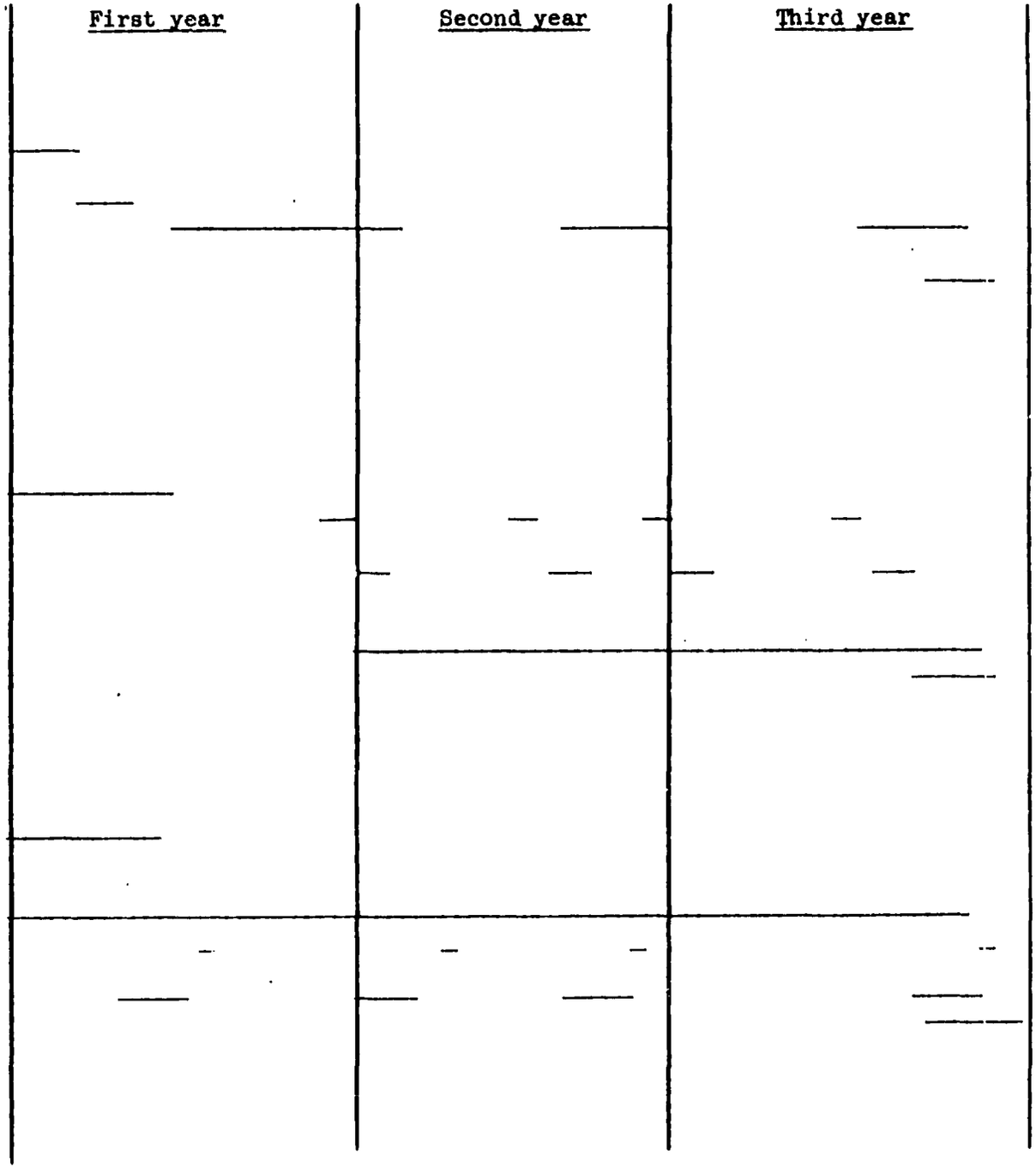
(a) Analysis of casting systems and processes in the sugar industry
(b) Determination of the characteristics of the alloys produced
(c) Mission to study methods in other industries and tenders, and to purchase equipment
(d) Casting of parts
(e) Industrial testing
(f) Report and recommendations


Second year
Third year

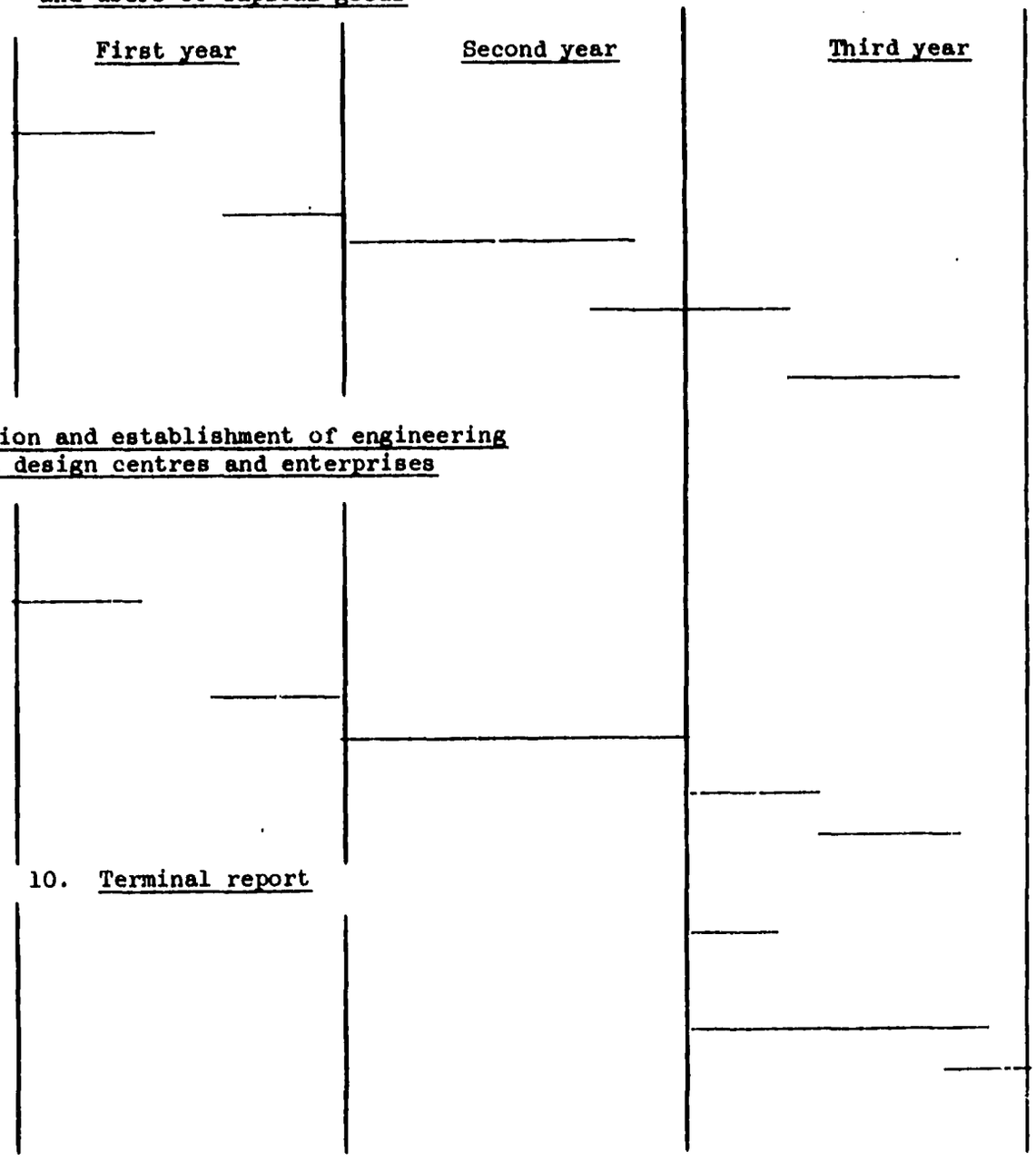
5. General maintenance manual



## 7. Transfer of technology and training of personnel



8. Directory of manufacturers, distributors and users of capital goods




8.1 Outline of the survey; preparation and distribution of forms

8.2 Promotion and consultation mission to GEPLACEA member countries

8.3 Collection of information

8.4 Processing of information and preparation of the directory

8.5 Printing and distribution of the directory

9. Promotion and establishment of engineering and design centres and enterprises

9.1 Preparation of a promotional document; definition of the area of activities to be covered by these centres and enterprises

9.2 Advisory assistance for the establishment and development of the centres and enterprises

9.3 Industrial applications

9.4 Evaluation of results

9.5 Report and recommendations

10. Terminal report

10.1 Outline of the report

10.2 Compilation of reports and recommendations on the various activities

10.3 Evaluation of reports

10.4 Terminal report

UNIDO

# PROJECT BUDGET/REVISION

| 3. COUNTRY | 4. PROJECT NUMBER AND AMEND. | 5. SPECIFIC ACTIVITY |
|---|---|---|
| | | |

10. PROJECT TITLE: UNDP/UNIDO input ($US)

| 15. 10. PROJECT PERSONNEL 11 EXPERTS / Post title | 16. TOTAL m/m | 16. TOTAL $ | 17. m/m | 17. $ | 18. m/m | 18. $ | 19. m/m | 19. $ | 20. m/m | 20. $ |
|---|---|---|---|---|---|---|---|---|---|---|
| 11-01 | | | | | | | | | | |
| 02 Co-Director | 36 | | 12 | | 12 | | 12 | | | |
| 03 Experts | 144 | | 42 | | 66 | | 36 | | | |
| 04 | | | | | | | | | | |
| 05 | | | | | | | | | | |
| 06 | | | | | | | | | | |
| 07 | | | | | | | | | | |
| 08 | | | | | | | | | | |
| 09 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 11 | | | | | | | | | | |
| 12 | | | | | | | | | | |
| 13 | | | | | | | | | | |
| 14 | | | | | | | | | | |
| 11-99 SUBTOTAL: | 180 | 1,260,000 | 54 | 378,000 | 78 | 546,000 | 48 | 336 | | |

21. REMARKS

UNIDO

## PROJECT BUDGET/REVISION

2. PAD NUMBER

| 4. PROJECT NUMBER | | 18. TOTAL | | 17. | | 18. | | 19. | | 20. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | m/m | $ | m/m | $ | m/m | $ | m/m | $ | m/m | $ |
| 12.01 | OPAS Experts | | | | | | | | | | |
| 13.00 | Support Personnel | | | | | | | | | | |
| 14.00 | Volunteers | | | | | | | | | | |
| 15.00 | Experts Travel /missions | | 150,000 | | 50,000 | | 50,000 | | 50,000 | | |
| 16.00 | Other Personnel Costs | | | | | | | | | | |
| 17.01 | Locally hired Experts | | | | | | | | | | |
| 17.02 | Locally hired Experts | | | | | | | | | | |
| 19.00 | Total Personnel Component | | 150,000 | | 50,000 | | 50,000 | | 50,000 | | |
| 20. | SUBCONTRACTS | | | | | | | | | | |
| 29.00 | Total Subcontracts Component | | | | | | | | | | |
| 30. | TRAINING | | | | | | | | | | |
| 31.00 | Fellowships training and /courses | | 400,000 | | 100,000 | | 200,000 | | 100,000 | | |
| 32.00 | Study Tours, UNDP G. Training/Meetings | | 100,000 | | 25,000 | | 50,000 | | 25,000 | | |
| 33.00 | In-service Training | | 20,000 | | 5,000 | | 10,000 | | 5,000 | | |
| 34.00 | Group Training (non-UNDP) | | 150,000 | | 50,000 | | 50,000 | | 50,000 | | |
| 36.00 | Meetings/Consultations (non-UNDP) | | 25,000 | | 10,000 | | 5,000 | | 10,000 | | |
| 39.00 | Total Training Component | | 695,000 | | 190,000 | | 315,000 | | 190,000 | | |
| 40. | EQUIPMENT | | | | | | | | | | |
| 49.00 | Total Equipment Component | | 3,340,000 | | 2,000,000 | | 1,000,000 | | 340,000 | | |
| 50. | MISCELLANEOUS | | | | | | | | | | |
| 51.00 | Operations — Maintenance/ Mobile laboratory and vehicles | | 100,000 | | 50,000 | | 25,000 | | 25,000 | | |
| 52.00 | Reports | | 10,000 | | | | | | 10,000 | | |
| 53.00 | Sundries | | 70,000 | | 20,000 | | 30,000 | | 20,000 | | |
| 55.00 | Hospitality (non-UNDP) | | 10,000 | | 3,000 | | 4,000 | | 3,000 | | |
| 59.00 | Total Miscellaneous Component | | 190,000 | | 73,000 | | 59,000 | | 58,000 | | |
| 99. | GRAND TOTAL: | | 5,635,000 | | 2,691,000 | | 1,970,000 | | 974,000 | | |