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REPAIR AND MAINTENANCE TRAINING AND DEMONSTRATION UNIT

DP/JAM/71/514

JAMAICA

TERMINAL REPORT

Prepared for the Government of Jamaica by the
United Nations Industrial Development Organization,
executing agency for the
United Nations Development Programme

 United Nations Industrial Development Organization

United Nations Development Programme

REPAIR AND MAINTENANCE TRAINING AND DEMONSTRATION UNIT

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Project findings and recommendations

Prepared for the Government of Jamaica
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of M. Sahni, Project Manager

United Nations Industrial Development Organization
Vienna, 1975

Explanatory notes

A comma (,) is used to distinguish thousands and millions.

References to dollars (\$US) are to United States dollars.

The monetary unit of Jamaica is the Jamaican dollar (\$J).

During most of the period of the project, the value of the Jamaican dollar in relation to the United States dollar was \$J 1 = \$US 1.10.

The following abbreviations are used in this report:

CARICOM	Caribbean Community
ILO	International Labour Organisation
JIDC	Jamaica Industrial Development Corporation

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SUMMARY

The project "Repair and Maintenance Training and Demonstration Unit" (DP/JAM/71/514) was approved by the Governing Council of the United Nations Development Programme (UNDP) at its twelfth session in June 1971. The project document was signed in November 1972. The United Nations Industrial Development Organization (UNIDO) was designated as the executing agency, in association with the International Labour Organisation (ILO). Pre-operational activities began in January 1972; field work began in June of the same year and was terminated at the end of September. The counterpart agency was the Jamaican Industrial Development Corporation (JIDC). The project was financed by UNDP contributions totalling \$US 501,300 and a total government contribution of \$J 497,800.

The primary objective of the project was to assist the Jamaican Government in maximizing the industrial resources of the country by establishing a training and demonstration programme in the repair and maintenance of plant and machinery. The work began with industrial surveys to determine the areas in which effort was most needed and could be most effectively supplied. Based on the findings of these surveys, field work was performed in such areas as the development of maintenance and repair facilities and the training of their personnel, the introduction or upgrading of inventory control, the rationalization of the procurement of spare parts and study of the feasibility of the production of at least some of them, the rehabilitation of potentially useful machinery and the replacement of that which had become obsolete.

Jamaica has decided to make the introduction of the multiple-shift system in industry a national priority. This policy depends upon the reliability of industrial plant and machinery. In terms of establishing preventive maintenance, conserving foreign exchange by reducing dependence upon external sources of spare parts and the development of manpower resources, the project has already made an important contribution. These services should be continued and intensified, since they contribute directly to the achievement of national priorities for the industrialization of Jamaica.

INTRODUCTION

Project background

The industrial sector of the Jamaican economy has expanded considerably in recent years. In addition to the processing of agricultural products and the production of certain consumer goods, new industries in textiles, clothing, foot-wear, cement, paints and industrial chemicals are now producing for both the local market and for export. This rapid growth, combined with tariff protection, has given rise to a certain non-utilization of full production capacity, among other problems, owing to inadequate maintenance of machinery and equipment. This situation was noted in a report by a UNIDO consultant and has been confirmed subsequently by a UNDP/UNIDO technical assistance expert, who has initiated activities in this field.

The Caribbean Free Trade Association (CARIFTA) agreement has opened significant export possibilities for manufactured goods within the area but will also foster competition with other industrial producers in it. Jamaican industry must thus become more efficient if it is to become more competitive. It was expected that the present project would contribute to the achievement of this objective by establishing appropriate repair facilities as well as upgrading maintenance techniques and instituting programmes for the industrial sector and training personnel to deal effectively with repair and maintenance problems.

The Government of Jamaica, in an effort to maximize the industrial resources of the country, has sought to develop a training and demonstration programme to implement a long-term programme for effective maintenance and repair operations in industrial establishments. The main features of this assistance are the provision of technical and management training and consulting services, as well as training courses and seminars.

Official arrangements

The project was approved by the Governing Council of UNDP at its twelfth session in June 1971. The project document was signed in November 1972. Pre-operational activities had begun in January 1972, the actual field work began in June of the same year, and the project was terminated at the end of

September 1975. UNIDO was designated as the executing agency in association with the International Labour Organisation (ILO). The counterpart agency was the Jamaica Industrial Development Corporation (JIDC). The international and senior counterpart staff are listed in annex I. Two fellowships for study abroad were awarded, as shown in annex II. The major non-expendable items of equipment contributed by UNDP are listed in annex III. The documents prepared during the project are listed in annex IV. The project was financed by the following contributions:

Total UNDP contributions	\$US 501,300
Government contributions in kind:	
Building and workshop	\$J 293,800
Other	<u>204,000</u>
Total Government contribution	<u>\$J 497,800</u>

Objectives of the project

The main objective of the project was to assist the Jamaican Government in maximizing the country's industrial resources by developing a training and demonstration programme in repair and maintenance. In this connexion, the project was expected to establish a long-term policy for maintenance and repair operations in selected industries. More specifically, the Repair and Maintenance Training and Demonstration Unit was to achieve the following objectives:

Set up maintenance programmes, schedules and systems, including preventive maintenance in selected industrial establishments

Demonstrate modern maintenance and repair techniques

Organize and upgrade repair facilities and operations

Advise on the selection of plant machinery, its proper layout and correct installation

Advise on standardization of plant equipment, machinery, tools and other supplies

Analyze the cost effectiveness of recommendations developed under the preceding items

Study and advise on the possible production of components and spare parts, and prepare financial plans for the recommended production facilities

Conduct specialized training courses, both in-plant and for counterpart personnel

FINDINGS

Project operations

To accomplish the tasks of the project, an objective examination of variable factors (manufacturing processes, machines, rates of production and availability of trained and skilled personnel) as applicable to individual organization was considered as essential. It was therefore decided that preliminary surveys of individual organizations should be planned to ascertain the requirements and scope of the work programme.

Areas of work

To ensure that the programme would be effective and systematic, the planned work was categorized as follows:

Industrial surveys

Development of maintenance organizations and repair facilities

Maintenance programming and scheduling

Demonstration of modern repair and maintenance techniques

Selection and layout of plant and equipment

Standardization of plant and equipment

Analysis of cost effectiveness of systems

Inventory control

Assistance from project workshop

Training of personnel:

Seminars

In-plant training

Demonstrations

Specialized training

Training of maintenance technicians

To make maintenance planning less dependent on imported replacement parts, a preliminary study on spare parts production and development was also carried out with the view that the manufacture of spare parts might be developed progressively at a later stage.

A sample survey to collect data on idle and underutilized and repairable machinery on the island has been carried out with a view to identifying areas where assistance should be rendered to ensure optimum utilization of available machines.

The work done in the listed areas is discussed in detail in the ensuing paragraphs. However, during the period of the project, 148 industrial services were provided and 998 participants were trained in 41 different training activities.

Industrial surveys

In order to establish detailed work programmes within each factory, industrial surveys of repair and maintenance facilities were carried out to determine:

- Extent and intensiveness of work to be done in each specified area
- Special needs for skills and training in relation to existing equipment and standards of skills
- Special organizational needs, such as composition of staff and grouping of work activities and procedures
- Maintenance systems, depending upon types and condition of equipment
- Allocation of priorities by management.

Industrial surveys of 30 firms were carried out. These surveys had a positive effect in diagnosing industrial maintenance and management problems, thus enabling the management to analyze areas in their respective organizations for the identification and allocation of priorities within the following areas:

Organization

- Establishment and development of maintenance departments in factories
- Grouping and regrouping of engineering tasks
- Co-ordination and supervision of work
- Work procedures

Technology

- Introduction of preventive, planned and corrective maintenance
- Improving techniques of inspection and routine checking
- Improving technical services and machine shop facilities

Development of better repair techniques
Development of tool room facilities
Improving workshop practices and technology

Equipment

Standardization
Equipment analysis
Innovation analysis

Stores

Techniques of storekeeping and management
Introduction of inventory-control measures
Reclamation and retrieval of used and worn-out parts
Stores layout

Systems

Maintenance appraisals
Maintenance budgets
Preparation of maintenance schedules and weekly programmes
Record keeping
Maintenance of technical publications and analogous data

Training on equipment

Special training was given on the following equipment: pumps, diesel equipment (testing, calibration and phasing), boilers (package, water-tube and fire-tube), hospital equipment, electric motors, air compressors, control instruments and air conditioners.

Staff training

Special training was also given to improve the qualifications of staff to cope with industrial change, as follows:

Seminars and courses to improve maintenance discipline, attitudes, incentives, policies and procedures

Short courses on maintenance organization and control
Implementation of planned and preventive maintenance
Updating of skills pertaining to specific equipment
Courses on techniques such as technical inspection, in repair operations and maintenance programmes and schedules
Specialized skill training in techniques pertaining to welding, instrument maintenance, office equipment, and sewing machines etc.
Seminars on inventory control, with particular reference to spare parts, stores standardization etc.

At the time the surveys were conducted, meetings with managements of the surveyed factories were held regularly to discuss the proposed plan of work and priorities. The response was very encouraging; the survey reports were extremely helpful in drawing up specific work programmes and schedules.

Maintenance programming and scheduling

Maintenance programming and scheduling were introduced in 31 firms. To ensure full implementation, considering the acute shortage of suitably trained personnel, simple types of programming and scheduling techniques were adopted. At times, depending on the situation in a particular organization, programme phasing was resorted to. The basic principles of the system included:

A simple listing of equipment, as the adoption of a financial plant register was not considered advisable at the present stage. The physical inventory of the equipment was to provide the additional advantage of serving as induction training for new workers

Collection of data regarding various repetitive routines such as inspections, lubrications and adjustments

The frequency and timing of maintenance tasks

Preventive maintenance schemes

Since the processes, working conditions and availability of personnel differ from industry to industry, these schemes were tailor-made to the requirements of the individual cases. Various systems of record keeping were also suggested, depending upon the size of the organization and magnitude of the task involved. For larger factories, a visual record system was found suitable, while for some others a system using normal card-filing index cabinets was considered adequate. For still smaller factories, the simple system of entries in desk diaries was found best.

This activity has been extremely helpful in changing the concept of maintenance from breakdown maintenance to preventive maintenance. The result has been that, gradually, fewer production man-hours are being lost because of breakdowns. The programming and implementation of preventive maintenance systems must be done in stages, so the programme was scheduled over a period of time. Marked improvement was noted in the maintenance functioning of 31 firms in which maintenance programming had been introduced.

Development of maintenance organization and repair facilities

The maintenance organizations of 21 factories were studied, based on the following considerations: the existing organizational structure, duties and responsibilities; and the proposed organizational structure, depending on factors such as the type of operations, availability of personnel, size of organization and maintenance department, location of plant, the number of shifts and the work-load of maintenance.

The basic factors considered in development of an organizational chart were the preparation of organizational charts and the control of paper work, as discussed below.

Preparation of organizational charts

One of the main considerations kept in view while preparing the charts was to correct problems arising from the absence of any clear division of responsibility among the various functional groups, such as production, maintenance and other industrial services in the plant. A wide margin of flexibility was also included to accommodate any future modifications as a compromise between the present system, which results from a lack of available trained personnel, and the one that will prevail when development has been achieved.

Control of paper work

As most of the organizations are either small or of medium size, it was considered advisable to keep paper work to a minimum. Consequently, in most cases, no separate section to plan, schedule and record activities was found necessary. It was felt that, in medium-sized organizations, a technical clerk attached to the maintenance department should be able to relieve the supervisory personnel of routine paper work. In smaller organizations, particularly where

the store is centrally located, the storeroom clerk would have an assistant; the work-load would be light, and the storeroom clerk well acquainted with the production equipment and spare parts. It was observed that the paper work for maintenance can be taken care of by the storeroom clerk.

On examination, no justification could be found for recommending separate maintenance organizations for some of the smaller plants. In such cases, it was considered more economic to employ one millwright and a helper to undertake simple preventive maintenance checks such as lubrication, replacement of fuses, re-lamping and inspection; the use of maintenance contractors to undertake all types of repair activities was recommended.

As regards larger plants, where maintenance departments were found to have sizable maintenance workloads, in order to limit the maintenance work force and to make better productive use of the personnel, such maintenance services as basic lighting, air conditioning and plumbing were recommended to be contracted out. This system was considered advantageous because it enables the plant maintenance personnel to concentrate their activities on the maintenance of production equipment and machinery so as to reduce down-time and thus increase productivity.

In order to have repair and maintenance for individual factories permanently available, it was considered essential to have repair organizations within them. For this reason, analytical examinations of existing facilities were made and, wherever possible, they were used as nuclei for the development of the organizations. Although staffing and reorganizing repair and maintenance facilities took much time and involved additional funds, improved maintenance efficiency was achieved by implementing the proposed organizations.

The responsibilities of production staff vis-à-vis maintenance staff were clearly indicated in the proposals; the scope for future expansion and diversification of products was taken into full account in deciding the size and components of these organizations. It was emphasized that the general lack of trained personnel and high rate of turnover of maintenance personnel in particular are adversely affecting the growth of strong and effective repair organizations.

Demonstration of modern repair and maintenance techniques

The problems of maintenance varied for different industries; it was necessary to take them on completely individual bases. The maintenance problems, as brought out by the various industries, were studied in depth and assistance to 30 firms was given to correct their difficulties. Some examples follow.

The package boiler in Fashion Guild could not be operated properly for want of proper maintenance awareness. The proper system of maintenance and check points was demonstrated.

The Public Works Department was facing difficulties in carburizing and hardening gears. The correct procedures were demonstrated.

The Long Life Mufflers plant was having difficulties with the proper maintenance of its power hacksaw and guillotine machines. A system of maintenance was devised and demonstrated.

At Yallah's Farm there were frequent breakdowns of agricultural machines owing to insufficient knowledge of maintenance practices. The machines were examined, and a proper system of repair and maintenance was established and demonstrated.

Routine repair and maintenance techniques for printing machinery were suggested to stationery manufacturers.

In Western Fabrication, repairs to a tool-holder for their nailmaking machine were indicated.

In Hanover Spices Limited, difficulties were being experienced in proper feeding of turmeric to the hammer mill and with the system of polishing this spice. A feed chute and stand for the hammer mill were designed and built with which the turmeric could be fed in small quantities. Experiments were also conducted on the polishing of turmeric, and a suitable drum polisher was designed and fabricated.

At Arawak Woodworking Establishment Ltd and Paper Processors Limited, new layouts for compressed air systems were suggested. Compressed air with high moisture content was being used, with consequent major breakdowns and deterioration of pneumatically operated equipment. The wet compressed air also impaired paint spraying in the woodworking plant. A distribution (ring mains) systems,

with re-sized piping and using different types of fittings and couplings was suggested. Air traps were positioned at certain point in the system, and an air receiver was also located in the system to be used as a cooler and as a trap for water and oil.

The scope of this activity was very wide, starting with a simple engineering problem and working up to very complex electronic equipment. Therefore, selected demonstrations of techniques of maximum benefit were organized. This assistance has had a profound impact on the operation of each organization by improving not only the maintenance activities but also over-all productive efficiency.

Selection and layout of plant and machinery

In Jamaica, since plant and machinery are imported from all parts of the world, the criteria for selection of proper equipment are of particular importance for industry. It was emphasized that the selection of any plant not only requires that it be simple to operate and maintain, but that the availability of spare parts throughout the working life of its machinery should be ensured. It was therefore suggested that great care be taken during the stages of drawing specifications, tendering and selection.

Machinery layout and correct installation

In order to obtain the optimum efficiency of equipment, the importance of proper layout and correct installation of machinery must be recognized. Guidelines for the development of layouts in various industries have been formulated. In some industries that were developing new workshops, assistance in the selection of proper machinery and complete layouts were provided. In industries with installed equipment, new layouts were recommended to improve working efficiency and achieve higher productivity.

Modernization and improvement of plant

It was noted that it could be possible to improve the effectiveness of some equipment by making modifications such as providing mechanical seals instead of packings, using silicon-controlled rectifiers in place of motor generators, or automatic and centralized lubrication in place of point-by-point lubrication. Modifications were suggested to modernize and improve the plant wherever feasible.

The maximum benefit of this activity can be obtained at the time of implementation of new or expansion plans. As the project was primarily concerned with plants already in operation, the project team had to work within many limitations. However, by suggesting and drafting new layouts of machinery in a number of firms, production bottlenecks were eliminated and the operation of the plants was improved.

Standardization of plant and equipment

The plant and equipment in Jamaica are acquired from many sources by direct purchase or by bilateral aid, assistance, gift etc. Consequently, there is a wide variety of equipment of the same general types, so standardization has proved to be very difficult. Under the circumstances, it was felt to be premature and impracticable to consider setting up any national standards, and therefore advisable to approach the problem on an individual industry basis. Industry was advised on the merits and demerits of standardization and the basic factors that should be considered in decisions relating to it. It was also made very clear that the best way to achieve tangible results was to begin standardization at the planning stage.

Most Jamaican industries have not yet adopted the metric system and still continue with the British units (see annex III and annex V). As industry in the country is still developing, it might well be much easier to adopt metric standards at this stage than later, so the needs and advantages of the suggested changes were emphasized. The major impact of this activity has been to develop an awareness of the need for standardization in industry. Although, in general, assistance was provided to a larger number of industries, specific assistance was provided to only 11 of them.

Analysis of the cost effectiveness of systems

The economics of the recommendations were worked out at the time of the submission of proposals, but to achieve the expected results, it is not only necessary that the proposals be implemented in full but also that they be operated long enough to permit the procedure to become stabilized and to yield the required results. Since little time (only a year or so) has elapsed since most of the

suggestions were implemented, and as in a number of cases full implementation of suggestions is still not complete for want of staff or high staff-turnover rate at operative levels, the real impact of all these recommendations cannot yet be fully assessed. However, to enable the industry to appreciate the necessity of establishing cost centres based on maintenance job orders, the importance of cost sheets etc. was emphasized. To illustrate the mechanism of operation for different types of industries, cost-effectiveness systems were implemented.

Although no conclusive analysis of the impact of this suggestion based on the periodic feedback of information from industry can be worked out at this stage, it could be observed that an appreciable saving has been achieved in fully implemented stages of the work.

Inventory control

It was noticed that, owing to the rapid development of the economy of Jamaica and the non-availability of personnel trained in the appropriate techniques, the control of inventories, and particularly of spare parts, was not given proper emphasis. The results were that not only was the capital tied up in inventories excessive, but also, owing to improper control, stocks of some parts were inadequate, while those of others were excessive. To ensure proper maintenance planning, it is essential that the right spare parts be available in the right quantities at the right times.

A survey was made in a number of industries, and inventory control assistance was provided to 12 industries. In the case of Jamaica Citrus Growers Limited, the studies on inventory control were coupled with in-plant training, and the progressive implementation of suggestions in stores-keeping and accounting were followed up.

The recommendations on inventory control studies were based on the following factors:

- Stores reorganization, including the preparation of job descriptions
- Assessing and recommending the manning strength of stores
- Stock codification
- Review of stores procedures regarding replenishment, receipts and issues

- Stock control and recording procedures
- Alphabetical classification of stores items
- Systems of physical verification of stocks
- Reports for managerial controls
- Standardization and reduction of variety of stores items
- Budgets and budgetary control procedures
- Systems of stores accounting
- Materials handling systems for storage
- Methods of forecasting usage
- Tools control
- Systems of stores control for maintenance planning and control

The services on inventory control have resulted in establishing proper stock-control systems. It is expected that, in time, production lost while waiting for spare parts will be reduced appreciably in the organizations where studies were undertaken.

The effective implementation of a preventive maintenance system needs a strong backing of inventory control measures, particularly concerning the provision of spare parts. The studies have been effective in emphasizing the needs for inventory and systems controls and their applicability for all types of organizations.

Spare parts production

Objectives of the spare parts development study

The objectives of the study were to identify spare parts that are consumed in sizable volume in Jamaica but that are presently imported, to select the high usage-value items for development and to study the possibilities of manufacturing them locally, and to investigate facilities on the island that could possibly be of value in the development and manufacture of spare parts.

Data collection

The process of collecting data proved to be very tedious and time consuming, since the various industries had not kept proper records of the annual consumption and value of spare parts and because of the reluctance of the personnel

concerned to assist in this task beyond their normal routines. In order to save time, a simple questionnaire was prepared and sent to about 300 industries, representing the principal industrial sectors of the country. Unfortunately, the response was not only disappointing but incomplete and had to be backed up by personal visits.

Survey of available facilities

During the study it became evident that, in order economically to manufacture certain spare parts locally, better use should be made, wherever possible, of facilities already installed rather than using capital to import further machinery. With this aim, a preliminary survey of the facilities available on the island was performed at the same time (annex V). It was found that, although there were good foundries for cast iron and non-ferrous metals, machine shops, fabrication shops and motor rewinding facilities in the country, steel foundries and facilities for forging and special rubber moulding were non-existent.

Development of spare-parts manufacturing

The process of development of spare parts production was divided into four stages:

Selection of a spare part, based on its annual rate of consumption and simplicity of manufacture, and collection of data on its usage and value

Study of the selected part with regard to such considerations as engineering and manufacturing processes, availability of raw materials, cost of manufacture and type of development assistance needed

Study of the manufacturing skills locally available to participate in the development of the selected part

Seeking assistance from manufacturers away from the island regarding the development of manufacturing processes, equipment, raw material quotations etc.

Forty-seven items were found to be suitable for local manufacture and have been classified accordingly. Thirty other items were found unsuitable because of the non-availability of raw materials and manufacturing facilities, as discussed below and shown in annex VI.

Spare parts presently feasible for local manufacture

There were found to be 12 items for which there was adequate local raw material, equipment and demand. Four of these are already being produced.

Some items can be produced locally, but their unit manufacturing cost would be uneconomically high owing to their low volume of consumption. There are 35 of these, of specialized nature and used by only three enterprises. It might become economic to manufacture some or all of them if the output of these enterprises were greatly increased or if similar units come into production.

Spare parts not presently feasible for local manufacture

Six items were found for which demand and raw materials were inadequate. It might be uneconomic to import the needed raw materials solely for these items, and the unit cost of manufacture would be high, owing to low demand. Twenty-four items were found to be unsuitable for local manufacture because of the non-availability of production facilities, technical skills or raw materials as well as low consumption. These items would require steel-casting, forging or rubber-moulding facilities, none of which now exist on the island. It would be uneconomic to install them for just a few small-demand items, but this question could be reviewed when and if such facilities become available.

In the course of investigating possibilities for the development of spare parts production, contact was made with 65 Jamaican enterprises. In order to obtain manufacturing process details and the prices of raw materials, information was requested and received from 63 manufacturers in other countries. The Industrial Inquiry Service of UNIDO rendered great assistance to the project in obtaining technical know-how and manufacturing processes for some of the spare parts under investigation.

Training

Since the main objectives of the project were to provide assistance in developing a training and demonstration programme in repair and maintenance techniques and to set up repair operations and organizations, a major activity was personnel training. As the project was to cater for the industrial sector as a whole, the training offered had to be very broadly based so as to encompass the requirements of different industries and a wide range of technical skills. Brief descriptions of the various principal training activities are given below.

Seminars

The seminars that were conducted covered a wide and varied range of subjects and activities. They were subdivided as follows:

Maintenance management

- Maintenance techniques for boilers
- Repair and maintenance of instruments
- Systems and methods of lubrication
- Maintenance of power transmissions
- Systems of preventive maintenance
- Trouble-shooting of motor vehicles

Materials management and control

- Stores management
- Inventory control
- Materials management

Equipment maintenance courses

- Office machines
- Pumps
- Electric motors
- Internal combustion engines
- Sewing machines
- Motor vehicles

Development of maintenance personnel

Work study
Maintenance for middle management
Maintenance management
First-line supervision development

Training aids

In order to provide practical orientation to the seminars, the theoretical lectures were backed up by the following techniques to serve as training aids: case studies, film showings, management games, demonstrations and visits to industrial plants.

In-plant training

In factories where sufficient participants were available, in-plant training, tailor-made to suit their individual needs, was programmed and organized. In some cases, these programmes were of up to three months' duration.

Demonstration of techniques

Particular pains were taken by the project to demonstrate various maintenance techniques so as to update the skills of local personnel. Some of the techniques demonstrated were: welding, pump maintenance, boiler maintenance, repair of electric motors, lubrication, instrumentation, maintenance of internal combustion engines, maintenance and operation of sewing machines, maintenance of steam systems, preventive maintenance, transmissions, maintenance of farm equipment, maintenance of air compressors, and maintenance and operation of workshop equipment.

Specialized training

From time to time, training within an industry was organized to cater for the special problems and requirements of the industrial sector. This training was normally coupled with progressive implementation of suggestions.

Training, as a major activity of the project, had the maximum impact on the development of industrial sector as a whole. It was aimed at the development of managerial techniques, human skills, maintenance technologies, engineering

processes, workshop practices, operation techniques etc. and thus had to be designed to cover a very wide spectrum. Although the project was very thinly equipped with personnel and facilities to undertake such a varied task, it was accomplished successfully.

It can be said that the activities of the project have produced perceptible improvements in the skills and techniques of supervisory and managerial personnel and in the technologies of specialized processes. The training courses, whether in-plant, seminars, demonstrations or specialized training, were all very much appreciated, with the result that the project carried out 41 training activities, with 998 participants.

The project has also launched a very ambitious programme of training maintenance technicians, who are in very short supply in Jamaica. The first group of ten persons started their one year's training on December 1974 and were to complete it at the end of November 1975. Although it is too early to predict the impact of this training on the industrial sector, the numerous inquiries received by the project regarding the recruitment of a second group indicate that the progress of the maintenance technicians is being observed with keen interest by the industrial sector.

Workshop

The workshop, although started later than planned owing to delays in the arrival of equipment and the construction of the building, is now fairly well equipped with the facilities listed below.

Manufacturing facilities: metal cutting and machining, welding, general fitting and repair, auto repairs and forging.

Testing facilities: diesel pump injector tests and repairs, electrical repair and tests, and refrigeration and air conditioning tests.

The workshop has been backing up training activities appreciably to provide practical orientation to theoretical discussions. The success of the training of the maintenance technicians is mainly due to the practical work done by the trainees in the workshop.

Furthermore, the workshop has played a useful role in supporting the industrial sector by undertaking jobs for which technical know-how is lacking

in the country. Whenever such jobs are undertaken, the opportunity is taken to demonstrate the techniques so as to develop local skills. The workshop plays an important role by fabricating spare parts to remove bottlenecks in production processes in various organizations, so as to raise their productive efficiency.

The role played by the workshop has been appreciated by the industrial sector and, in years to come, the workshop may form the nucleus for the development and training of maintenance activities in different industries in the country. However, the non-availability of the mobile workshop has limited the possibilities for conduct training and demonstrations for agricultural and industrial enterprises located away from Kingston.

Rehabilitation of machinery

Significant amounts of machinery in both the agricultural and industrial sectors were found to be unserviceable and thus unproductive. A survey to diagnose the causes of this situation and to provide technical assistance and guidance for rehabilitation was programmed. A sample survey of 24 industrial firms was undertaken. The findings were as shown below:

In eight cases, the machinery required rehabilitation

In nine cases, improvement in maintenance skills and techniques was required if the machinery was to be properly maintained

In six cases, rehabilitation of machinery was unfeasible because of a lack of spare parts

In but nine cases in the sample of 24 was no assistance for the rehabilitation of machinery required

It can be seen that some of these firms fell into more than one category. The survey revealed that potential exists for substantial assistance to both agriculture and industry by the project. This activity was to be investigated in much greater depth during the second phase of the project, in which greater numbers of agricultural and industrial firms were to be covered and technical assistance was to be provided to each individual enterprise according to its requirements.

Contributions of the project and national priorities

To assess objectively the contributions made by any single project towards national development is both difficult and complex, since such assessment must take into account the over-all effects of all national and international resources in that particular area of development. However, the contributions made by the present project towards the achievement of the national objectives can be said to be important and lasting, as discussed below. In general, the project has made a positive impact in technical and manpower development and skill training to lay the foundation for the rapid and full industrialization of Jamaica.

Productivity

High productivity is a national objective and, to achieve it, optimum utilization of machines and plants involved in production and services is essential. In terms of establishing preventive maintenance, assisting in repair and maintenance of machines and improving repair techniques, the project activities have made significant contributions.

Minimization of production costs

A major task facing the industrial sector is to produce goods at low cost so that Jamaica will be able to compete in the world and CARICOM markets. In order to reduce production costs, operation and maintenance costs of machines must be kept to the barest minima. Project activities such as incorporating improved maintenance, inventory control measures and establishing effective repair facilities within the factories have made contributions towards achieving this important but difficult task.

Multiple shifts

To increase production, the strategy of adopting multiple shifts in factories has been adopted as a national priority. High reliability and availability of machines for second and third shifts on a permanent basis is a prerequisite for this strategy. Project activities such as conducting industrial surveys to evaluate the condition of machines and the availability of repair and maintenance facilities, with implementation plans for improving weak areas are also important in the implementation of this strategy.

Balance of payments

To protect Jamaica's balance of payments situation, strict import restrictions have been imposed. Consequently, the rehabilitation of repairable but presently unserviceable machines, production studies on substitutes for spare parts and keeping machines operational for longer periods are recognized measures. The project activities, as a whole, have contributed directly towards these tasks.

Manpower development

Skill and specialized training have been given highest priority in manpower development. A major task accomplished by the project was to conduct large-scale training programmes in managerial techniques, human skills, maintenance technologies, engineering processes, workshop practices and operational techniques.

II. RECOMMENDATIONS

Preliminary study of spare parts production and development has identified an industrial activity that can be built up to further the industrialization of Jamaica by reducing its dependence on imported spare parts. To follow through on this good beginning, not only must these surveys be continued, but plans to manufacture specific spare parts must be drawn up and the interest of local entrepreneurs in producing them must be stimulated. Technical guidance and follow-up must be provided until spare parts production has been fully developed.

The sample survey of rehabilitation of machinery has indicated a need for a full-scale study to identify the machines and equipment in the following categories:

Possible to repair

Unrepairable - to be scrapped

In working order but no longer required by industry

In working order but underutilized

Assistance should be provided by the project to put repairable machinery back into working order. The data for the last two categories can be compiled and passed on to Government so that, instead of issuing further licences to any industry to import similar equipment, the industry could be direct to buy the idle equipment or make use of the underutilized capacity. Visits to industries have shown that there are good possibilities in this field and that substantial foreign exchange could be saved if efforts were directed to build up this activity.

The maintenance technicians' course, which was begun in December 1974, is the first of its type in the island. It is proving highly successful and should form a regular activity of the project, since there is a shortage of trained personnel of this kind.

The workshop is now fairly well equipped with general equipment to cater for normal industrial maintenance needs. It would be advisable to expand its activities so that it can become a valuable support to industry and develop to the stage of a commercially viable proposition. This would help to improve acceptance of project activities by industry and provide better scope for practical training.

The project has been trying, successfully, to develop modern maintenance and repair techniques that would be applicable to the wide industrial sector in the country. At this stage of development, it may be advisable to lay more emphasis on studying, guiding and assisting in maintenance problems and techniques on an industrial branch basis.

The industrial sector has greatly benefited from the project and has expressed appreciation for the assistance rendered in terms of training, industrial services, special studies and surveys on repair and maintenance requirements and the establishment of effective facilities. These services should be continued and intensified, since they contribute directly to the achievement of the national priorities for industrial development in Jamaica.

Annex I

INTERNATIONAL AND SENIOR COUNTERPART STAFF

<u>Post</u>	<u>Name</u>	<u>Dates</u>
<u>International staff</u>		
Project manager	Madan M. S. Sahni	October 1972 to September 1975
Maintenance management expert	Fouad I. Habib	June 1973 to October 1974
Repair and workshop organization expert	Gote Fredriksson	September 1973 to September 1975
Inventory control expert	M. N. Gupta	July 1974 to September 1975
Vocational training expert	Gordon Atkinson	June 1973 to June 1974
<u>Senior counterpart staff</u>		
Counterpart to project manager	Trevor C. Dunn	August 1974 to present
Maintenance management engineer	Richard Clarke	September 1975
Repair workshop organization engineer	Keith A. Sunarth	September 1973 to present
Inventory control	Pascal Gordon	October 1974 to present
Vocational training engineer	Don Grant	September 1975
Maintenance management engineer	C. A. Lee	June 1973 to August 1974

Annex II

FELLOWSHIPS AWARDED

Fellow	Trevor C. Dunn
Duration of fellowship	Six months (August 1974 to January 1975)
Subjects of study	Maintenance management and programming, inventory control etc.
Places of study	Swedish Industrial Development Authority (SIDA) Training Programme, Stockholm; Columbia University, New York; Pan American University, Edinburg, Texas
Fellow	Keith Sunarth
Subjects of study	Maintenance management and programming, workshop organization etc.
Places of study	Georgia Institute of Technology, Atlanta; International Centre for Advanced Technical and Vocational Training, Turin, Italy

Annex III

MAJOR ITEMS OF NON-EXPENDABLE EQUIPMENT CONTRIBUTED BY UNDP

<u>Item</u>	<u>Quantity</u>
Drilling machine, model MF4/RC floor model	1
Grinder, model M 'Bison'; double-ended pedestal	1
Rockwell Delta 20-inch wood/nonferrous metal cutting band saw	1
American Air Compressor, model No. B331-BO Kellogg	1
6-inch Belt sander, model No. 33 Powermatic	1
Surface grinding machine, model Elliott 921	1
Angle cutter, punching and shearing Machine, model FC-1	1
Hydraulic floor jack, Model J-134 (capacity 4 tons)	1
Coil-winding machine, model A1/X	1
Standard horizontal shaping machine, 18-inch	1
Vehicle tools	1
Battery tester	1
Growler	1
Blacksmith's tools	1 set
Avometer, Model 8x, AC/DC	1
Clipper volt meter/ammeter, Model S248	2
Vehicle: Ford, model Cortina 1600 XL Estate	1
Vehicle: Ford, model Cortina 1600 XL Saloon	1
16-inch Circular saw bench, type Shoda HS 121	1
Transformer welder, Hobart Type T-295	1
Torch welding-cutting kit	2
Workshop tools	1 set

<u>Item</u>	<u>Quantity</u>
Drawing equipment	1 set
Power hack saw, Model Keller No.1, 5 inches x 5 inches	1
Portable projection screen, Eike model KDX-18	1
Drafting equipment beam compass S6R80 and accessories	1 set
Multi-range insulation tester	1
9952N15 "Real Handy" charging station with 6711A21 basic starter kit	1
Mobile floor hoisting crane, Star model	1
Projector, movie sound (Catalogue No. 83025A), with accessories	1
Film strip and slide projector (7450X)	1
Mascot 1600 Eighty-Gap Standard 220/3/50 lathe with spares and accessories	1
Overhead projector (Catalogue No. 301AX-DV), with accessories	1
No. 8504Y14 tachometer	1
Vertical grinder, model 8300A56A	1
Episcope Vz 3	1
Air-operated drill W/3/8-inch chuck	1
Tool storage cabinet	1
Hardware cabinet	1
3M "209" automatic copier	1
VL 1550 surface plate, semi steel, Grade 1	1
Legs for surface plate, 32 inches high	1 set
ESB-70 Disk sander, 115-Volt, 50 Hz	1
KRA-300 d Bench (6989180)	1

<u>Item</u>	<u>Quantity</u>
5093-AGSB Tool set (6952220)	1
VG-124DB Valve-seat grinder set	1
Secondary current injection test set	1
Counter unit for above	1
Type 460 dead-weight pressure-gauge tester	1
Workshop tools	2 sets
Lathe, Blomquist type	1
Drawing instrument S6560 and table	1 set
Spray painting equipment	1 set
Type writer, Facit B 730, manual:	1
Semi-automatic welding transformer	1(on order)

Annex IV

DOCUMENTS PREPARED DURING THE PROJECT

Progress reports

Progress reports on the project and its activities were submitted on the following dates:

No. 1	February 1972
No. 2	September 1972
No. 3	May 1973
No. 4	January 1974
No. 5	April 1974
No. 6	October 1974

Technical reports

Survey reports

Survey reports concerning 30 firms were prepared.

Training reports

Training reports on completion of the following training events were issued:

1. Pump seminar
2. Maintenance management seminar
3. Package boilers seminar
4. Electric motors and generators seminar
5. Stores management seminar
6. Lubrication seminar
7. Instrumentation seminar
8. Internal combustion engines
9. First-line supervision
10. Power transmission
11. Sewing machines
12. Welding techniques
13. Motor vehicle repair supervisors' course
14. Motor vehicle repair techniques
15. Properties and uses of steam

Special studies

Special studies in the following areas were conducted and reports were prepared:

- Training requirements and existing facilities in Jamaica
- Assistance to small-scale industries
- Preliminary paper on spare parts production
- Survey report on maintenance in the food processing industry.

Annex V

CLASSIFICATION OF MANUFACTURING FACILITIES

<u>Type of facility</u>	<u>Organization</u>	<u>Remarks</u>
Foundries (ferrous and non-ferrous)	Precision Castings Ltd	Use green sand and shell moulding process. Can cast up to 2 tons/day.
	Caribbean Castings and Engineering Co. Ltd	Have cupolas, rotary furnace and crucibles. Can cast up to 10 tons/day. Specializes in sugar-mill manufacturing.
	Caribbean Steel Co. Ltd	Can produce alloy steel up to 50 tons/day in an arc furnace; presently producing only reinforcement bars.
	Mahabir and Co. Ltd	Crucible furnace only. Can produce approximately 200 lb/day of aluminium casting only. <u>a/</u>
Machining (lathes, milling, shaping, planing, drilling, pipe threading)	Caribbean Castings and Engineering Co. Ltd	Facilities to handle big jobs up to 5 ft in diameter and 28 ft long. <u>b/</u>
	Masterton Limited	Can handle jobs up to 2 ft diameter 16 ft long.
	Randial's Engineering Works	Can handle jobs up to 29 in. diameter, 18 ft long. <u>c/</u> Specialities are cylinder reboring and crank-shaft grinding.

a/ The pound (lb) is 0.453 kilograms.

b/ The foot (ft) is 30.480 centimetres.

c/ The inch (in.) is 2.540 centimetres.

<u>Type of facility</u>	<u>Organization</u>	<u>Remarks</u>
	Sang's Engineering Works Limited	Facilities available to handle jobs up to 16 in. diameter and 10 ft long. specialities are manufacturing high-tensile bolts, pipe-threading and hand-forging.
	Pahk Limited	Can machine jobs up to 30 in. diameter 20 ft long.
	Gas Cylinders and Metal Products Ltd	Jobs 27 in. diameter and 18 ft long can be machined.
	Allied Engineering Works Ltd	Can undertake jobs up to 20 in. diameter and 16 ft long. Speciality: metal spraying.
Sheet metal fabrication (mild and soft steels, brass, copper, lead) and spray painting	Masterton Limited	Speciality: tank cleaning by steam. Can fabricate from plates up to 1 in. thick.
	K.I.C. Limited	Can fabricate from up to 2-in. thick plates. Speciality: tank fabrication and spray painting.
	Randial's Engineering Works	Fabrication of mild and soft steels.
	Pahk Limited	Fabricate from plates up to $\frac{1}{2}$ in. thick. Speciality: lead lining.
	Tank-Weld Limited	Can fabricate from up to $\frac{1}{4}$ in. thick plates.
	Tropical Metal Products	Can fabricate from plates up to $\frac{1}{2}$ in. thick. Specialities: metal door-frames and aluminium windows.
	Todd's Engineering Works Ltd	Can fabricate from plates up to $\frac{1}{2}$ in. thick. Speciality: spray painting.

<u>Type of facility</u>	<u>Organization</u>	<u>Remarks</u>
	Structural Engineers Ltd	Can fabricate from plates up to $\frac{1}{2}$ in. thick. Specialities: spray painting and brazing.
	Gas Cylinders and Metal Products Limited	Can fabricate from plates up to 1 in. thick. Specialities: spray painting and heat treatment.
	Allied Engineering	Can fabricate from plates up to $\frac{1}{2}$ in. thick.
	Clark and Clark Limited	Can fabricate from plates up to $\frac{1}{2}$ in. thick. Speciality: manufacture of exhaust systems.
Electric motor and transformer rewinding	R. A. Silvera Ltd	Can rewind motors up to 300 hp.
	Teletronics Ltd	Can rewind motors up to 300 hp and transformers up to 500 kVa.
	Dynamo Motors Ltd	Can rewind motors up to 100 hp.
	Universal Distribution and Electricity Ltd	Motor rewinders.
Anodizing and aluminium extrusion	Alcan Products of Jamaica Limited	Speciality: extrusion of various aluminium sections.
Electrical control equipment	Electrical Manufacturers Jamaica Ltd	Manufacture of power and distribution boards, motor control centres and electrical control equipment.
Gear hobbing and cutting	Caribbean Casting and Engineering Co. Ltd	Can manufacture spur, helical, worm and bevel gears etc.
	Pahk Limited	Can cut spur and helical gears on milling machine.
Electroplating	Jamaica Electro plating Limited	Specialities: chromium and silver plating.

Annex VI

SPARE PARTS STATUS

Spare parts that can be manufactured

Spare parts economic to manufacture locally

<u>Organization</u>	<u>Name of part</u>	<u>Remarks</u>
Esso West Indies (Refinery)	Tower tray clamp Manway lock clamp	Tools designed at the unit. Quotations obtained from Toolmakers Institute and Sang's Engineering Works shows total savings of \$1,310.50 against initial investment of \$2,975.00 if manufactured locally.
Jamaica Oxygen and Acetylene Industrial Gases Limited; Tropical Gas Co. Inc.; Shell Co. West Indies Ltd Webster Gas Limited	Handwheel for regulating valve	Aluminium casting developed and manufactured by Mahabir and Co. These five firms have shown interest in the use of locally manufactured spare.
All industries	Nuts, bolts and screws	A study of quotations for machines from foreign firms shows that it is feasible and economic to set up a plant for manufacturing nuts and bolts. A detailed study is under way.
Renton Limited	Gloves	Local manufacture is in progress.
Caribbean Casting Ltd	Gears	The gear-hobbing machine at this enterprise could be used to manufacture gears on a jobbing basis locally.
Caribbean Cement Co. Ltd	Shear bolt No. 17545 Shear bolt No. 15216 Shear pin No. 38915	After development and study, this enterprise is making its own spare parts.

<u>Organization</u>	<u>Name of part</u>	<u>Remarks</u>
West Indies Glass Co. Ltd	Beaters	This enterprise makes its own spare parts, using case-hardened mild steel, resulting in short working life. EN9 steel was recommended to increase their working life.
Caribbean Cement Co. Ltd	Sido Foolax cooler frame	Study shows that this part could be manufactured in the company's workshop, using EN8 steel.
	Foolax cooler sub-frame	

Spare parts that could be manufactured but that would be uneconomic owing to low usage

Ariguanabo Co. of Jamaica Ltd	Filling motion stand	Quotations for casting and machining obtained from Caribbean Casting Ltd proved to be too high in comparison to the stock prices of these items.
	Filling feeler guide	
	Right-hand cloth roll rack	
	Left-hand cloth roll rack	
	Crank arm shim	
	Knock-off bunter	
	Right-hand protector rod bearing	
	Left-hand protector rod bearing	
	Right-hand back box plate	
	Left-hand front box plate	
	Right-hand front box plate	
	Left-hand protector rod bearing cap	
	Right-hand protector rod bearing cap	
	Bobbin support	
Latch depressor		

<u>Organization</u>	<u>Name of part</u>	<u>Remarks</u>
	Shuttle feeler Adjuster	
Caribbean Cement Co. Ltd	Aluminium lever Elevator link	
Ariguanabo Co. of Jamaica Ltd	Cradle and pin Crank arm end Detector wire link Fork holder	These are small items of low usage value at present, and their production process is geared for mass production, that is, by pressings. Present consumption could not justify the cost of manufacturing the needed tools. Present consumption could not justify the cost of setting up moulds for aluminium castings.
Caribbean Cement Co. Ltd	Coupling arm 66026 Valve seat Grid screen bearing Gear wheel pin Chain link pin Coupling arm 66023 Coupling arm 66024 Chain pin	Quotations from Sang's Engineering Works for manufacturing these items, which are all done on the lathe, proved to be too expensive to manufacture owing to high machining cost and low present-day usage. Also, quotations on batches of 100 range from 50% to 500% more expensive than the unit stock price.
West Indies Glass Co. Ltd	Spring pins Locks Valve operating stud	Small items manufactured on a lathe. Not economic to manufacture outside owing to low usage. Recommend manufacturing in own workshop.
All industries	Washers	Information obtained from overseas and domestic firms shows that there are many varieties of washers in use. If there is to be local manufacture of washers more information is required as to the types most commonly used locally. It would be uneconomic to manufacture for the entire range.

<u>Organization</u>	<u>Name of part</u>	<u>Remarks</u>
<u>Spare parts that cannot be manufactured at present</u>		
<u>Non-availability of raw materials and low usage</u>		
Ariguanabo Co. of Jamaica Ltd	Filling bolster	Bronze piping not available locally and would be uneconomic to import owing to low usage.
	Bolster warp	
	Shaft for cradle	High-temperature alloy steel not available.
Caribbean Cement Co. Ltd	Foolax cooler frame	High-temperature alloy steel not available.
	Bronze bush No. 22422	Bronze piping not available locally.
	Bronze bush No. 18126	Bronze piping not available locally.
<u>Non-availability of manufacturing facilities, technical skill, raw materials and low usage</u>		
Ariguanabo Co. of Jamaica Ltd	Finger trip	Forging facilities not available.
	Fork grate	
	Thread cutter, pipe	Rubber-moulding facilities not available.
	Apron warp	
	Parallel shoe	
Caribbean Cement Co. Ltd	Bush	Forging facilities not available.
	Follower bush	
	Roller	
	Pump bushing	
	Follower plate	
	Chain wear plate	
	Pump-end cover	
Filler piece		
All industries	Industrial belts and hoses	Received estimates of machinery costs from overseas firms but, in order to study their feasibility, the following are required: (1) Drawings and quantities of moulded parts

<u>Organization</u>	<u>Name of part</u>	<u>Remarks</u>
		(2) Characteristics and quantities of tubes
		(3) Specifications and quantities of belts. This would require a survey of between 5,000 and 10,000 man/hours.
Jamaican Oxygen and Acetylene Industrial Gases Ltd	High-pressure cylinder regulating valves	The manufacture of valves to regulate H ₂ O ₂ , etc. is a specialized process for which no facilities are available. The manufacturing processes have not yet been obtained from overseas manufacturers even after prolonged correspondence.
	Cartridge fuses	The manufacturing process, as requested from various overseas firms, is still awaited, but several overseas dealers have suggested that it is not advisable to start manufacturing this item owing to a world-wide decline in demand, since cartridge fuses are being replaced by circuit breakers.
	'O' rings	This is a low-demand item, cheap and with numerous varieties. There are no manufacturing facilities available for them on the island, and details of the manufacturing processes are still awaited from overseas firms. Setting up a separate industry for 'O'-ring manufacture cannot be justified.
	Coil springs	This is a low-demand item, cheap and with numerous varieties. There are no manufacturing facilities available on the island, but data for study have been obtained from overseas firms.
Caribbean Cement Co. Ltd	Grinding balls	Low demand does not justify the forging method. Information about the casting process has been requested from a company in the United States of America, which refused to supply any data. This information is being sought from enterprises in India.

Organization

Bauxite, sugar and
other industries

Name of part

Valves: gate, globe, relief,
ball, butterfly, check
diaphragm

Remarks

Consumption data collected
show that various types
and sizes of these items
are in use, and that
manufacturing such a wide
range would be uneconomic.

Plugs

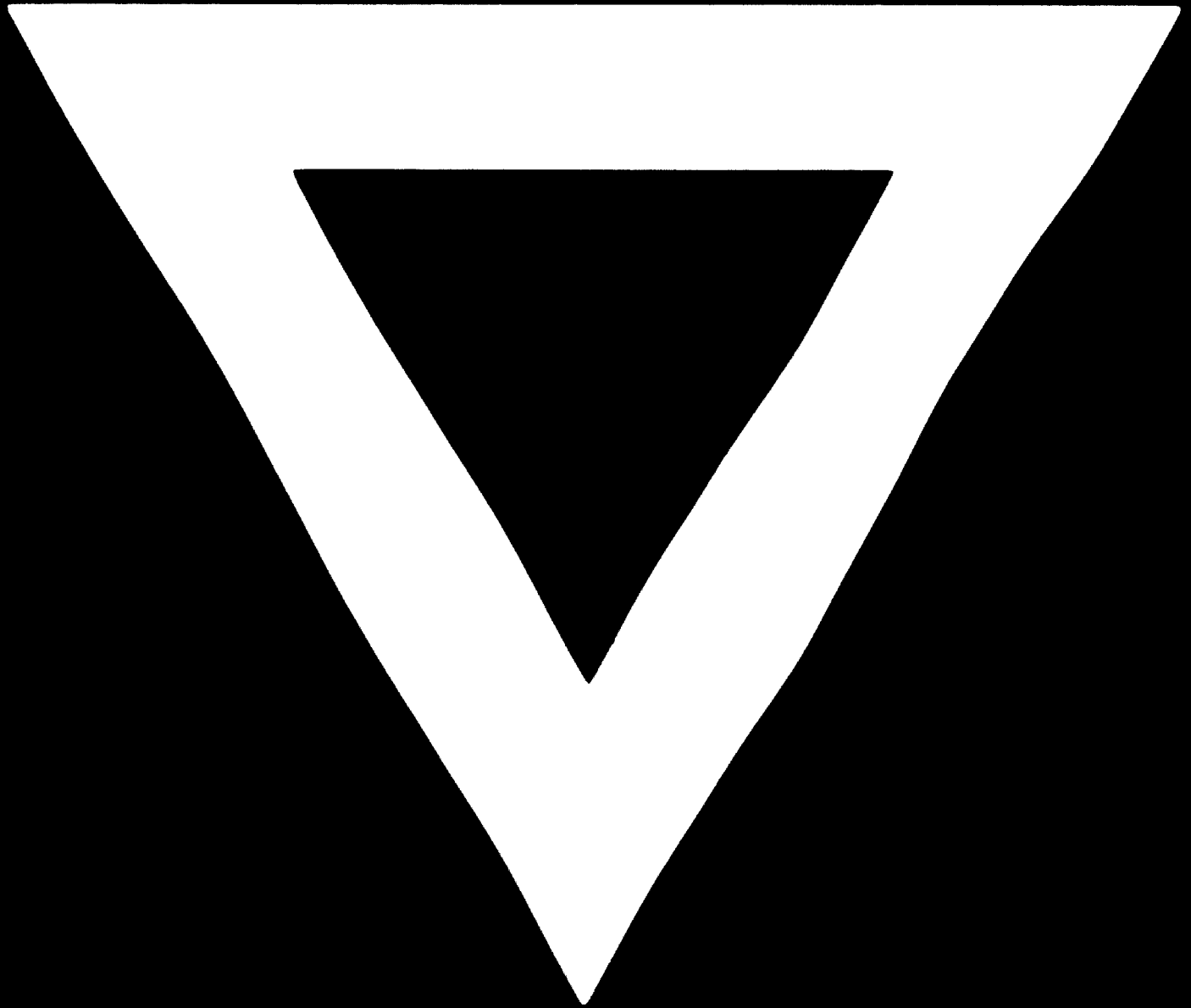
Flanges: slip-on,
welded, blind

Couplings

Filter elements



C-272



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