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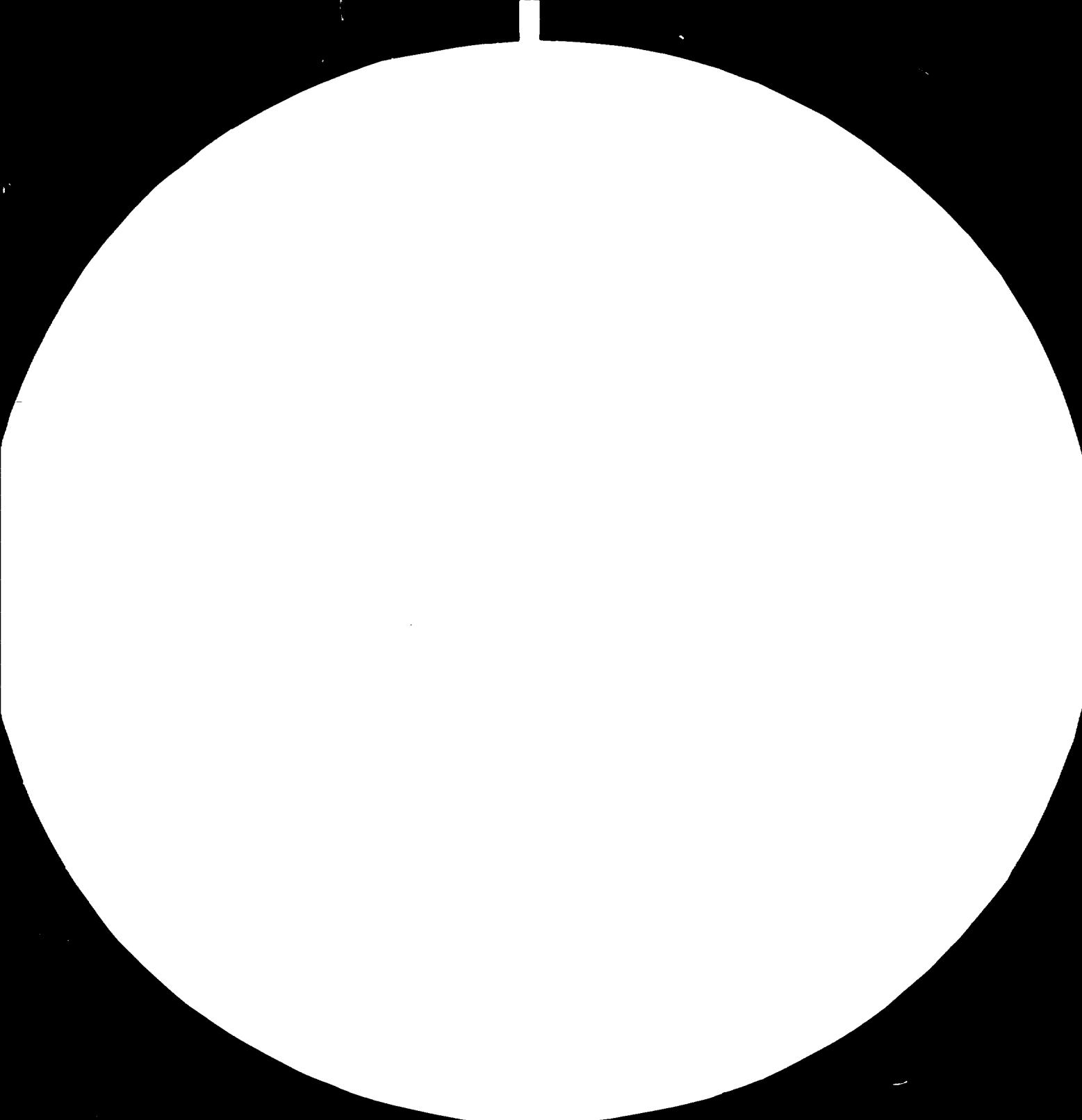

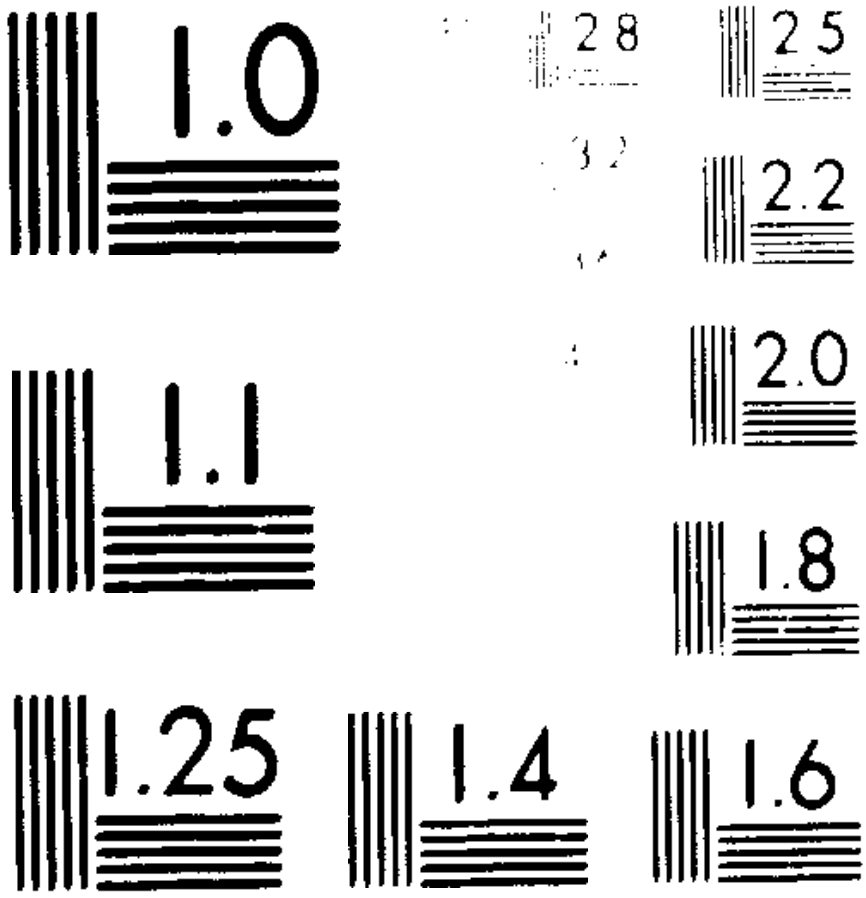
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ASSISTANCE TO

THE

TANZANIA INDUSTRIAL RESEARCH AND DEVELOPMENT ORGANIZATION

(TIRDO)

Tanzania. REPORT ON

DEVELOPMENT OF TIRDO ACTIVITY

IN ENGINEERING SERVICES.

(DP/URT/78/019/11.03)

Prepared for

the Government of the United Republic of Tanzania

by the

United Nations Industrial Development Organization

Executing Agency

for the

United Nations Development Programme

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UNIDO - Expert in Engineering

MARCH 15, 1982

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This report has not been cleared with the United Nations Industrial Development Organization which does not, therefore, necessarily share the views presented.

SUMMARY

The observations on which the findings and recommendations of this report are based were obtained in 30 visits to factories, institutions, parastatal organisations and by wide ranging conversations and discussions with individuals, managers, administrators, educationists, etc.

There are very extensive areas of very basic engineering technology unavailable to Tanzanian industry. This has the effect of slowing down industrial development and retarding the performance of industrial companies. For example:

1) There is no qualified metallurgist practicing in Tanzania.

2) There is no polymer chemist available to industry generally with a knowledge of the primary plastics materials.

3) There is no qualified welding engineer with a knowledge in international specifications and welding procedures for class A welding.

4) There is no fully equipped facility for carrying out non-destructive testing outside Dar es Salaam University.

5) There is no facility for the design of products, special purpose equipment or process installations.

6) There is no organisation available to carry out the routine inspection testing and adjustment of industrial heating equipment (process heat).

7) There is no technical advisory service to assist industry to solve its day to day problems or to devise means to improve their processes or their efficiency.

There is a shortage of experienced, qualified mechanical and production engineers in the country; a number of people interviewed observed that the greater proportion of graduates leaving the Faculty of Engineering at Dar es Salaam University find their way into management positions where they no longer practice engineering. The quickest and most efficient method of remedying this is to assemble at TIRDO a pool of specialists, technologists and engineers whose services will be available to industry 'on call' to deal with technological problems as they arise.

High priority should be given to staff recruitment and training to augment the existing cadre of two mechanical engineers, one civil engineer and two chemical engineers. Expatriate experts should be employed to head the Engineering Department and its Divisions until Tanzanian engineers are ready to assume these responsibilities. The recommended plan for added staff is summarized as follows:

BUDGET YEAR	ENGINEERING OFFICERS	TECHNICIANS & FITTERS
1982/83	4	3
1983/84	5	5
1984/85	2	10
1985/86	1	5
1986/87	2	2

Funds are needed as soon as possible to equip the laboratories and workshops. Lists of essential machines, equipment, tools and supplies have been prepared in two priorities. Estimated equipment costs with seaworthy packing, FOB the country of origin are:

Priority	Cost (U.S. Dollars)
First	358,860
Second	239,401
Total	598,261

Considering the current industrial problems and the Government's desire to expand the industrial base, the provision of a technical infrastructure dedicated to the support of industry, helping it to grow and develop, is seen as most important to the national economy and to Tanzanian aspirations. The existence of a competent industrial service organization will enable continuing solutions to basic problems and allow structual changes within industry rather than continuing the pattern of the singular treatment of the symptoms not the maladies.

ACKNOWLEDGEMENTS

The author wishes to acknowledge with gratitude the patience and tolerance of all of those in State and Parastatal bodies and those executives in industry who gave their valuable time during the interviews, some of them long.

He also wishes to thank the staff of TIRDO especially the Director General, Mr. C. L. Tarimu, for their assistance in the writing and compiling of this report.

Finally, grateful acknowledgement must be rendered to the UNIDO staff at TIRDO for their help and their kindness during the mission and especially to Mr. C.A. Stone, Chief Technical Adviser, whose knowledge of Tanzania proved invaluable in the interpretation of many of the details elicited during the interviews.

CONTENTS

1.0. INTRODUCTION

1.1. This report gives the findings of the Survey of the Tanzanian Engineering Industry commissioned by the United Nations Industrial Development Organisation, Project No. DP/URT/78/019/1103/A and makes recommendations to the Government of the Republic of Tanzania on the role and development of the Engineering Department of the Tanzanian Industrial Research and Development Organisation (TIRDO).

1.2. The work of this mission was carried out in two periods between November 16, 1981 and March 8, 1982: the total usable time was 50 days, of which 30 were spent on field work.

1.3. Since the mechanical engineering/metal working sector has a major input to and influence on virtually all manufacturing, processing and service industries the survey extended to these sectors as well to determine the total requirements of TIRDO in the field of engineering.

1.4. Two distinct sets of problems were identified and are dealt with separately in this report.

1.5. One set is dominated by current national economic factors but never-the-less some contribution to resolving these can be made by the present TIRDO staff with a little additional field training and experience and equipment.

1.6. The second set arises from the almost complete absence of technical support for the engineering industries outside of the major educational institutions. This lack of a technical infra-structure to support industry will seriously impede the development of the manufacturing processing and service sectors and frustrate the National Industrial Development Plan.

1.7. The immediate problems are dealt with in detail in section 7.0 and the longer term problems in Section 8.0. A summary of the staffing of the TIRDO Engineering Department for the technical support of industry is given in Section 9.0. A proposed staff re-cruitment calendar is set out in Section 9.0. This has been related

1.7. Contd...../.....

to the priorities of the proposed work programme and has been integrated with the proposed schedule for the acquisition of workshop and laboratory equipment.

1.8. Detailed specifications of equipment and metal working machinery have been drawn up: these are summarised in this report and shown in Appendix 1; the costs shown have been converted to dollars and a priority order for purchase is indicated. In determining this priority precedence was given to the basic laboratory test equipment and measuring instruments on which all functions of the Engineering Department rely to enable them to carry out their work. They should be regarded as the capital investment in the technical infrastructure.

2.0. METHODOLOGY

2.1. The observations on which the findings and recommendations are based were obtained in 30 visits to factories, institutions, parastatal organisations and by wide ranging conversations and discussions with individuals, managers, administrators, educationionists etc.

2.2. In order to ensure free and frank discussion strict confidentiality in regard to anything seen or heard was stressed. Consequently the findings are given in summary form only.

2.3. Details of discussions, visits etc. were recorded and are held in the confidential files of the UNIDO Chief Technical Adviser at TIRDO.

2.4. Acquaintance was made with previous work and documentation; UNIDO reports; the UNIDO Project Document: The Proposal by TIRDO to the European Economic Community; the National 20 Year Plan; and the objectives and priorities for industrial expansion outlined by the Minister for Industries in his budget speech to Parliament in December, 1981.

2.5. In all 28 visits to industrial premises were made: these were chosen from the companies listed in the index published by MEIDA a privately organised group of 80 companies in the manufacturing field and from the Directory published by TISCO, a parastatal organisation which carries out industrial studies and undertakes consulting work for industry. Both indexes show company names, location, products, number of personnel and in the case of MEIDA, installed capacity.

2.6. The sample was chosen to be as representative as possible of manufacturing, processing and service industries within the limitations of time and transportation. Twelve companies directly involved in metal working, nine companies from the processing sector and three from the service sector and four involved in processing rubber or plastics materials were seen.

2.7. Visits were also paid to parastatal organisation with contiguous interests to TIRDO.

2.8. The survey covered industries in Dar es Salaam and Arusha. In choosing the sample both large scale operations and small were chosen as well as those with a good reputation and others whose record was not so good.

2.9. The advice of the Chief Technical Adviser, the TIRDO technical liason service and the existing Tanzanian staff engineers was sought and readily given in compiling the sample list.

2.10. Finally when the survey was completed and tentative views were formed these were outlined to Professor S. Lwakabamba Head of the Mechanical Engineering Department of the University of Dar es Salaam for his comments and elaboration.

2.11. They were also discussed with Mr. J.W. Chohan, Honorary Secretary of the Institution of Engineers Tanzania: Mr. Chohan is a practicing engineer of high repute and of long standing.

The lists of workshop equipment were derived in the main from those companies who responded to enquiries made at the European Machinery Manufacturers Trade Fair held in Hanover in October, 1981.

3.0. CONCLUSIONS

3.1. There are extensive areas of very basic engineering technology unavailable to Tanzanian industry.

3.2. This has the effect of slowing down industrial Development and retarding the performance of industrial companies.

3.3. The quickest and most efficient method of remedying this is to assemble a pool of specialist technologists and engineers whose services will be available to industry 'on call' to deal with technological problems as they arise.

3.4. The numbers of these specialists considered to be necessary may pose problems in recruitment but every effort must be made to overcome this since the problems created by their absence is very much greater.

3.5. International agencies have been set up to assist in the training of technologists for lesser developed countries e.g. those set up by the United Nations and the European Economic Community under the Lome, Maghareb and Mashreq Agreements: these should be availed of.

It is recommended strongly that the 'pool' of specialists proposed should be located at TIRDO to be made available to Tanzanian industry when required.

4.0. SUMMARY OF THE MAJOR FINDINGS

4.1. The Tanzanian manufacturing and processing industries make a wide range of industrial products. There is ample scope for this to be increased with technical, managerial and financial assistance.

4.2. Certain basic elements of the metals/engineering sector are considered to be totally inadequate to serve industries which are planned for rapid growth under the National Twenty Year Plan - for example:

1) There is no qualified metallurgist practicing in Tanzania.

2) There is no polymer chemist available to industry generally with a knowledge of the primary plastics materials.

3) There is no qualified welding engineer with a knowledge in international specifications and procedures for class A welding.

4) There is no fully equipped facility for carrying out non destructive testing outside Dar es Salaam University.

5) There is no design facility for the design of products, special purpose equipment or process installations.

6) There is no organisation available to carry out the routine inspection testing and adjustment of industrial heating equipment. (Process heat)

7) There is no technical advisory service to assist industry to solve its day to day problems or to devise means to improve their processes or their efficiency.

4.3. At this point it is worth quoting from the report of the Economic Commission for Europe ECE/ENGIN/12 VOL CHAPTER 1 - concluding remarks -, (UN Publication E.81. II. E.6, 1980) ....." the significance of the metal and engineering products taken as a whole bears out the fact that in any developed or developing system, the engineering industries occupy a leading place. They act as an accelerator for technical progress, both contributing to and consuming it."

4.4. Two categories of serious, major problems were identified which are retarding progress in the industrial sector: firstly, there is an acute shortage of raw materials and feed stock and a similar shortage of spare parts for production, processing machinery and transportation. These arise from national economic considerations and hopefully, will be short lived.

4.5. The second category is long term only in the sense that the effect if not corrected will have long term consequences and also the corrective measures needed will take time to achieve without active assistance from agencies outside Tanzania.

They arise from the absence of a technical infrastructure which is dedicated to supporting the industrial sectors by providing a service to help solve day to day technical problems and to assist them to develop products, processes, manufacturing systems etc.

4.6. Productivity in many factories is exceptionally low; 25% of installed capacity in some cases. This, at the moment, results from the shortages mentioned and cannot easily be corrected in Tanzania until normal working conditions are restored.

4.7. The concepts of product inspection quality control procedures, quality assurance etc. is almost totally absent within manufacturing and service industries. This is not surprising at the moment, nor can it be remedied quickly since with the present shortages virtually any quality of product has a market.

4.8. There is a shortage of experienced, qualified mechanical and production engineers in the country : a number of people interviewed observed that the greater proportion of graduates leaving the Engineering School at Dar es Salaam University find their way into management positions where they no longer practice engineering.

4.9. There is a shortage of skilled operatives: fitters, turners, millers, toolmakers etc. Some measures are being taken to remedy this through Government training programmes, and by special arrangements with bi-lateral aid support. Expatriate engineers and managers generally spoke highly of the craft skills of the operatives but were critical of their ability to adapt quickly to new methods or routines and considered them some-what lacking in innovative skills: more specifically this was related to the lower levels of management, i.e. supervisors and foremen.

5.0. RECOMMENDATIONS

5.1. The engineering functions of TIRDO should be rapidly expanded and developed as a centre of excellence for engineering technology in Tanzania.

5.2. It is recommended that within the Engineering Department four divisions or sections should be set up namely:-

1) MATERIALS TECHNOLOGY
2) MANUFACTURING TECHNOLOGY
3) DESIGN AND DEVELOPMENT
4) ENERGY CONSERVATION

5.3. Considering the current industrial problems and the Governments desire to expand the industrial base, the provision of a technical infrastructure dedicated to the support of industry, helping it to resolve its day-to-day problems and assisting it to grow and develop is seen as most important to the national economy and Tanzanian aspirations. The existence of a competent industrial service organization will enable continuing solutions to basic problems and allow structural changes within industry rather than continuing the pattern of the singular treatment of the symptoms not the maladies.

5.4. The next ten years should be regarded as a "period of formation" for TIRDO during which the organisation would operate for the benefit of Tanzanian industry whilst at the same time it built up its resource of manpower and equipment to enable it to undertake necessary, specific and relevant short term and small scale investigations at the request of industry or the Government for the purpose of overcoming particular difficulties or, for example, to make use of indigeneous materials.

5.5. Measures to alleviate some of the current, acute, problems facing industry should be put in hand immediately. Use can be made of the existing engineering graduates for this purpose but these will require short periods (3 to 6 months) of 'field' training in the methods and techniques of the activities specified in section 7.0 in an institution outside Tanzania. This will enable TIRDO to make a contribution to the resolution of some of the current problems in the industrial sector.

5.6. Since it will be very difficult to find Tanzanian educated, trained and experienced in some of the disciplines required, a start should be made now in selecting second and third level students for placement in educational establishments, institutions and industries outside Tanzania where they can acquire the relevant education training and work experience which will be required. Grants are available through various agencies for this purpose.

5.7. Appointments should be made in 1982 for the Heads of Divisions for the functions outlined in 5.2 above so that these men can assume a leadership role in developing quickly these activities. It is recognised that in all probability some of these may, by force of circumstances, have to be expatriates recruited on contracts (3 to 5 years) with counterpart appointments being nominated now and assuming office as Assistant Heads following their overseas further training.

5.8. Funds should be made available to purchase the equipment required to tackle the current problems as outlined in section 7.0. The engineer's function has no equipment of any kind at the moment. £ 30,000 would satisfy immediate requirements for small tools, and basic measuring instruments, thermometers, pressure gauges, flow meters, etc.

5.9. Further funds should be sought so that a start can be made in equipping the laboratories and workshops as soon as possible.

5.10. The Government should use the staff of TIRDO to represent Tanzania at international conferences, seminars etc. to assist the technical civil service in matters pertaining to engineering technology.

6.0. PROBLEMS IDENTIFIED AND COMMENTARY

6.1. The technical problems observed to be facing Manufacturing and Processing Industries in Tanzania can be divided into two categories.

6.2. Category one are the problems which demand an urgent solution in order to alleviate the most pressing needs of the industries and to which attention by TIRDO can be given with a minimum of additional resources and staff training.

6.3. They arise mainly from national and international factors which gave rise to shortages of spare parts, replacement components and in some case supplies of raw material or feed stock.

6.4. The second category of technical problems which are dependent on the engineering and metal working sectors for solutions arise from the inadequacy of technical support services in Tanzania which are specifically dedicated to the manufacturing and processing sectors.

6.5. The absence of an adequate technical infrastructure will have an influence on the immediate problems but the main impact will be in hindering or slowing down the development of the industrial sector as enunciated in the National Twenty Year Plan. It would also discourage overseas companies from participating with Tanzanian industry or granting manufacturing licences to local companies. In visits to manufacturing and processing plants it was observed that in some, valiant efforts were being made to overcome shortages : but where components failed there was no means of investigating why, or of ensuring that the replacement being made would perform better or as well.

6.6. Where replacement parts were being cast (mainly from scrap metal the engineers in charge had no means of knowing the composition, structure or physical properties of the new part.

6.7. As far as engineering design is concerned only a few 'in house' facilities were observed and these appeared to be available only to the company's own products.

6.8. Knowledge of welding procedures specification, testing and certification was scant.

6.9. Apart from within the University there was no means of checking materials or weldments by non-destructive methods (on the occasion of the visit, the University's own industrial X ray equipment was unserviceable)

6.10. No experimental stress analysis equipment was encountered.

6.11. In a large number of factories complaints about 'burnt out' electric motors were common : no explanation for this high incidence of failure was forthcoming; apparently no investigation has been carried out.

6.12. Some support services are available at the moment from the Faculty of Engineering at Dar es Salaam University but it has to be constantly borne in mind that the University's primary function is to educate the young engineers for the future of Tanzanian industry. Auxiliary functions attached to the University, for instance, the Institute for Production Innovation are regarded as an extension of the educational process.

6.13. It is unrealistic to expect the University to provide the full range of services, advisory, technical consultancy, testing, design, etc. at an adequate level for industries which have been planned for rapid growth and which are dispersed widely throughout Tanzania. It is understood that the University Faculty of Engineering is understaffed.

6.14. Support on certain aspects of engineering technology principally industrial engineering is available from the National Institute of Productivity and the functions of a national calibration service, standardisation and product certification will be provided by the National Bureau of Standards.

6.15. The establishment of a National Design Centre, TEMDO, for the tool making industry has just been initiated; it will be located at Arusha in Northern Tanzania.

6.16. TIRDO, and TEMDO should be viewed as complimentary organisations with TIRDO supplying technical service to TEMDO; close liason should be established between them at an early stage to avoid unnecessary duplication of staff and equipment. It seems highly probable that TIRDO would have to establish branch offices elsewhere in Tanzania at some future stage of its development in order to improve the response time to requests for assistance and to cut down travelling time and expenses; the TEMDO site at Arusha could be one location for a branch office.

6.17. TIRDO's technical support services will be required also by other parastatal organisations such as SIDO, The Small Industries Development Organisation; TISCO, The Tanzanian Industrial Studies & Consultancy Organisation; NSC, The National Steel Corporation; NECO, The National Engineering Co. Ltd., and TBS, The Tanzania Bureau of Standards.

6.18. Some overlapping or duplication of facilities and services will no doubt occur and be unavoidable but when the magnitude of the asks are considered along with the geographical distances involved, this is not seen as unnecessarily wasteful or detrimental.

7.0. SOLUTIONS FOR IMMEDIATE PROBLEMS (SHORT TERM STRATEGY)

7.0.1. It is not suggested that TIRDO can solve all of these problems at once but it can make a useful contribution almost immediately to prevent machinery breaking down, to reduce the foreign exchange now being spent on the purchase of spare parts and replacement components, to optimise the utilisation of fuels now being imported for the use of industry and to some extent improving the efficiency of use of raw materials which have to be imported. Suggested areas of immediate activity for TIRDO Engineering Department are:-

Planned and Preventive Maintenance
Energy Management
Process Improvement
Materials Conservation

7.1. Planned and Preventive Maintenance

7.1.2. It was observed in a number of plants visited and it was stressed by almost all of those interviewed that machinery were lying idle or working at reduced or impaired capacity through defective components or shortage of spare parts.

7.1.3. The implementation of simple routine procedures could extend the life cycle of existing machinery and prevent costly secondary damage to major components by anticipating or preventing minor failures.

7.1.4. Inspection procedures and work schedules are already well documented in relevant texts. Computer software packages, some for use with micro computers are available which will print the documentation cards required in the factories thus reducing the time and manual effort required.

7.1.5. These techniques can be learnt and adapted to local industry in a very short time. The acquisition of simple "condition monitoring" equipment would enhance the work. The outlay for a seismic vibration meter, a revolution counter, an infra-red heat detector and an insulation resistance meter would be of the order of 1000 US Dollars.

7.1.6. Some efforts towards implementing such systems are being made by one group of manufacturing companies but it should be available as a service to all manufacturing and processing-plants throughout Tanzania.

7.2. Energy Management

7.2.1. Importation of fuels for industry is a further drain on foreign exchange: the efficient use of all forms of energy contributes significantly to the overall efficiency of manufacturing and processing companies by reducing the unit cost of production.

7.2.2. Energy conservation should be an ongoing and integral part of factory management: TIRDO can provide stimulus and leadership in this field, indirectly through education and technical information, by publications, seminars etc. and directly by providing technical expertise to assist companies or public bodies in their own efforts towards conservation.

7.2.3. Areas of activity suggested are:-

Efficient use of process water and steam
Efficiency of steam raising plant
Efficient use of compressed air
Operation of plant and machinery
Load and power factor correction
Air conditioning systems - air changes
Building insulation
Efficient use of transportation

7.2.4. In some European countries services such as these are provided free of charge to industry by the state in order to ensure the conservation of energy. They can be provided by TIRDO making use of technicians under the guidance and management of research officers.

7.3. Process Improvement

7.3.1. In virtually all the manufacturing plants opportunities for process improvements were observed.

7.3.2. Examples of these are:- A continuous belt drying tunnel which functioned incorrectly when purchased resulting in defective product had been discarded and had not been in use for some considerable time. The manufacturer was anxious to increase production and wanted it brought back into use: the cost of a new tunnel was of the order of 500,000 Tanzanian shillings. An investigation of some possible alterations to the drive mechanism and electrical installations should be carried out to ascertain if it is possible to improve the performance: with adequate facilities TIRDO could carry out the modifications necessary: these are not available at the moment.

7.3.3. In a factory producing consumer goods it was seen that the introduction of simple conveyors and manipulators would improve the flow of material through the plant and increase output. This company was already on a four shift system. In addition the volume of scrap plastic material suggested that a process investigation was called for. There was no system for recording down time and no breakdown analysis was carried out.

7.3.4. Generally the layout of machinery was considered to be poor and there appeared to be too much 'work-in-hand' between work stations suggesting that production studies were required.

7.3.5. This last observation was made in other plants visited as well and in one such, the problem had been recognised and the assistance of TIRDO was requested to devise corrective measures.

7.4. Material Conservation

7.4.1. Material costs represent 60 to 80% of the cost of manufacturing products. Most engineering materials require energy to produce them or to form or shape them: for example it takes one ton of oil to make one ton of steel.

7.4.2. Any improvement therefore which can be effected in use of materials for manufacture or processing contributes not only to lower unit costs of production but will also help to reduce the annual costs of Tanzanian imports.

7.4.3. Simple value analysis techniques can be applied to existing or new products to find out if useful improvements in the utilisation of materials can be made: the existing TIRDO engineering staff are familiar with the methods to be used.

7.4.4. Areas of activity for them in Materials Conservation would be:-

Design	Can less material be used. Is the product 'over designed'
Type of Material	Is there an alternative cheaper or indigenous material which can be used.
Specification	Is the material specification the most suitable; would a higher or lower grade being improvements in utilisation.
Manufacturing Processes	Are the optimum manufacturing processes specified e.g. would casting be better than fabrication.
Protection	Does the product have an adequate life cycle; would corrosion protection extend it.
Ordering	Is the correct size sheet or bar being ordered to minimise waste of material and manpower.
Quality Control	Are the inspection facilities well organised and equipped to ensure that the minimum scrap product is produced.

7.4.5. It must be emphasized that all of these activities are within the competence and capabilities of the present Engineering Officers at TIRDO. Short periods of training in some of the techniques and instruments are recommended and a period of 'on-the-job' training in an institution or establishment performing a similar role is desirable in order to impart confidence to the staff.

7.4.6. The 'short term' strategy is stressed as being urgent because of the immediate difficulties confronting industry in Tanzania: it is never-the-less based on sound engineering principles and disciplines. The disciplines adopted now deriving from economic adversity will stand industry in good stead in the future: they are disciplines more frequently neglected than practiced in many more prosperous and developed economies.

7.5. Staffing for 'Short Term' Strategy

7.5.1. The staff of the engineering department consists at the moment of two Mechanical/Production Engineers, one Civil Engineer and two Chemical Engineers. None of these engineers has any (extensive) experience of working in industry.

7.5.2. It is intended to use the Civil Engineer as 'Site and Services' manager for the TIRDO complex when it is completed: in the meantime he will have to extend his present knowledge of relevant aspects of mechanical and electrical engineering by work experience in a similar environment and by limited study. When this is completed and until such time as his full time services are required on the TIRDO site he should be made available to industry to assist in the organisation of their maintenance activities.

7.5.3. The two mechanical engineers are graduates of the University of Dar es Salaam and are sufficiently well educated to undertake some project work for industry: they may require the supervision of a more experienced engineer for a short period until they gain

in confidence. At the moment they have no tools or equipment of any kind to enable them to undertake work. They may also require brief periods of specialised instruction in specific topics not covered in depth in their university course.

7.5.4. It is proposed that one of these should concentrate on the improvement and development of engineering processes for industry: opportunities for this were observed in nearly all of the industrial premises visited.

7.5.5. The second mechanical engineer should be employed on aspects of 'Value Analysis' to assist industry in the conservation of raw materials of manufacture and in the improvement in production methods for example design of production aids, assembly, tooling, quality improvement to reduce scrap etc.

7.5.6. One of the chemical engineers should be employed in organising industry to improve the utilisation of all sources of in energy. Again it was observed during the survey of industry that with one exception no attention was paid to conservation and it appeared that for instance, industrial heating oil was being squandered.

7.5.7. Again a short period of training in a similar institute carrying out this work regularly will be required to familiarise him with the routines, specific instrumentation etc. Four to six months should be sufficient.

7.5.8. Much of the routine work in energy can be carried out by suitably qualified technicians trained and organised by the engineering officer.

7.5.9. It is forseen that this engineer would be potential Head of the Energy Conservation Division discussed in the long term strategy where he would concentrate on the wider aspects of energy conservation involving a deeper knowledge of heat transfer, process heating and control etc.

7.5.10. No additional staff is suggested for the short term strategy for the time being: as the service develops any additional staff required would be at technician level.

7.5.11. The functions of plant maintenance and production and process improvement would be grouped in the Manufacturing Technology function of the longer term strategy and the present staff are seen as potential leaders for this Division.

8.0. SOLUTIONS TO THE LONGER TERM PROBLEMS (3 TO 5 YEAR STRATEGY)

8.1. The technical support services to be established by TIRDO both to serve industry and provide a sound base for its own projected activities can be grouped into four major functions.

8.2. Each of these functions would embrace a number of separate activities which in themselves would require a number of senior specialists and support staff.

8.3. In order to satisfy the industrial engineering requirements of Tanzania TIRDO should become the 'centre of excellence' for these activities. The main functions proposed are:

ENGINEERING MATERIALS TECHNOLOGY
MANUFACTURING TECHNOLOGY
DESIGN AND DEVELOPMENT
ENERGY CONSERVATION

8.4. Engineering Materials Technology

8.4.0. Materials Laboratories

It is proposed that in the medium term non-metallic materials such as plastics, ceramics, timber etc. should be associated with the metallurgical facility but as TIRDO develops, separate facilities for these will be required, sharing at the beginning some equipment. The metallurgical facility consists of the metallurgical laboratory, the physical testing laboratory, the field testing section and the technical services provided by the professional metallurgists.

8.4.1. In the short and medium term period 3 to 5 years the materials laboratories should be equipped progressively to cater for industrial problems such as material identification, checking materials to specification, failure analysis, corrosion investigation, etc.

8.4.2. The required laboratory equipment listed in Appendix 1. The principal items will be tensile, compression and hardness testers, specimen preparation apparatus, non-destructive testing equipment, heat-treatment facilities etc.

8.4.3. It is proposed to include surface coating apparatus for the electroplating of small components and to enable proposed plating procedures to be checked. As an aid to assisting in the resolution of current problems in industry the equipment chosen should be capable of depositing 'hard' chrome on bearings and small shafts to rehabilitate them or to extend their serviceable lives. (Metal spraying equipment should also be purchased for this purpose but should be located outside the preparation or test areas.)

8.4.4. 'Fixed' plant is proposed for the detection of cracks in castings, forgings and parts machined from alloy steels which have a propensity to crack on machining or after heat treatment; this should be developed as a subcontract service to industry.

8.4.5. Mobile non-destructive-test equipment (NDT) is recommended and is strongly emphasized. It will include dye penetrant, magnetic, eddycurrent, ultrasonic and industrial X-Ray equipment. It is essential that this equipment should be acquired soon so that the safety and continous operation of existing petrochemical and processing plant can be assured. It is condisered important to move quickly on this as, at the moment, there are no recognised welding standards for quality or procedures in the country. It would also encourage the placing of contracts with local engineering companies for repair work or work normally brought in from abroad e.g. pressure vessels, process vessels, pipe work and load bearing structures.

8.4.6. Plastics materials have become an important part of engineering design and manufacture; there are more generic types of plastics materials than there are metals and within each type many compounds or 'alloys'. Plastics materials are therefore seen as a priority functions in materials technology and should be developed within a

a short period - 3 years. Special purpose equipment is required for testing plastics and is included in Appendix 1. Provision is also made for a small ceramics laboratory and a specialist in this field.

8.4.7. It is proposed that a senior materials scientist should be recruited as soon as possible to undertake responsibility for the rapid development of this facility. His primary qualification should have a knowledge and experience of plastics or hold a second qualification in polymer science.

8.4.8. A proposed staffing plan and management structure is shown in Figure 1. It proposes specialists (R.O) in plastics, ferrous and non ferrous metals, metallurgical process, (casting, forging, forming etc.) surface coatings and corrosion, and testing including non destructive testing.

8.4.9. A senior laboratory technician is proposed to organise the work of the laboratory technicians of which 8 are proposed initially: one technician specialising in plastics testing is suggested and one for ceramics. Preparation of tensile and weld test specimens has been assigned to the general engineering workshop where one or two turner/millers would be specially trained for this work.

8.5. MATERIAL TECHNOLOGY ACTIVITIES

8.5.1. The specialists will be field oriented as well as providing technical supervision to the laboratory technicians. They will be the direct link with industry. Each will have a speciality in metullurgy, polymer science or ceramics and, in so far as is possible, deal only with topics within their own speciality. Since the University of Dar es Salaam does not specialise in metallurgy or polymer science these technologists will have to be educated and trained abroad.

8.5.2. Materials Specification

To provide advice to Tanzanian industry and TIRDO designers on the interpretation of or choice of materials from national or international standards; to advise on the characteristics of materials e.g. hardenability, machinability, formability, weldability.

PROPOSED STAFFING AND ORGANISATION OF MATERIALS LABORATORY

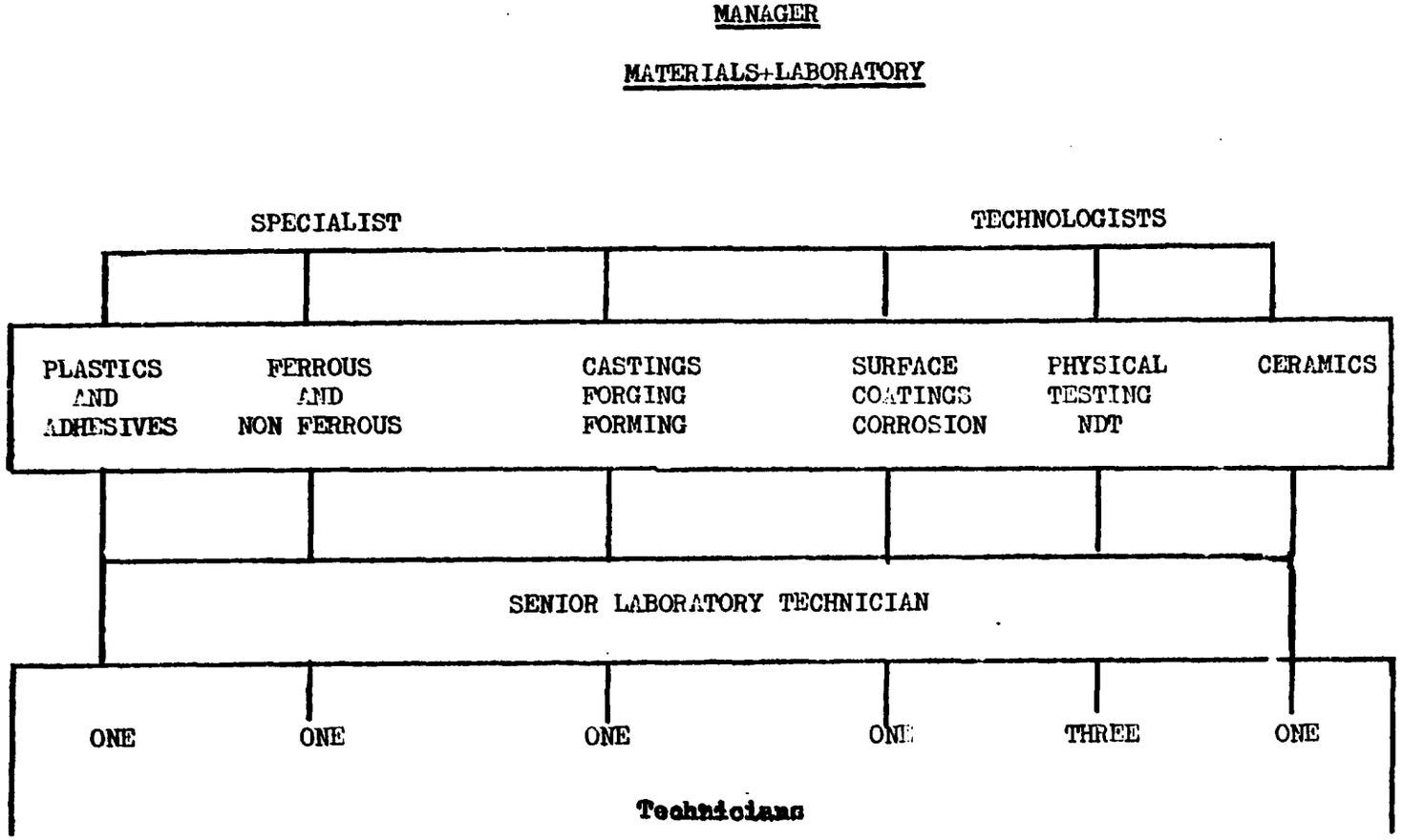

Figure 1. Proposed Staffing and Organization of the Materials Laboratory.

8.5.3. Materials Identification

To assist industry in identification of materials submitted to them by specifying the hardness, tensile and chemical composition and (if necessary) examination of the structure of the metals by metallographic means.

8.5.4. Failure Analysis

Failure analysis to determine the cause of premature failure or wear is an essential activity for the redesign of failed components; it has an important part to play in resolving problems. The investigation of failures of components in service; e.g. wrong material used, poor heat treatment, poor structure, fatigue, stress corrosion cracking, low temperature, brittle failure etc. The use of experimental stress analysis techniques, brittle lacquers, extensometers, electrical strain gauges to determine the distribution and magnitudes of stresses in components or structures for example around pipe and valve exists on pressure vessels, process tanks etc. The investigation of the reasons for porosity, shrinkage and cracking in castings. Determination of flow patterns in complex forgings. The investigation of performance of cutting tools, press tools, dies etc. Many of these activities will be of a multi-disciplinary nature.

8.5.5. Manufacturing Processes

The specialist technologist in manufacturing processes will be required to give advice to industry in casting technology (ferrous and non ferrous) sand die, pressure die and automatic casting machines. It is recognised that more than one specialist will be required as Tanzanian industry develops and that initially finding suitable options for in-factory training will not be easy.

He would also be required to answer queries and give orders on forming of metals and on forging. In this area an opportunity exists for some relevant applied research:- sources and suitability of local sands for use in foundries should be investigated.

8.5.6. Surface Coatings Activities

The surface coatings specialist will be expected to have a knowledge of the metallurgy of metal coatings and the applicability of organic coatings to metals, plastics, timber, etc. The activities will include advice and assistance in surface preparation, pre-treatment etc. Trial runs would be carried in the TIRDO facility to authenticate proposed treatment procedures.

The examination of coatings to determine their compliance with specifications will entail the certification of surfaces after preparation to ISO Standards (or their equivalent); the measurement of thickness; the checking of adhesion, peel properties etc., checking of adhesion, peel properties etc., checking on pre treatment coats, primers etc; the laboratory checking of materials, paint varnishes to manufacturers, national or international specification.

TIRDO should also carry out investigations on coating failures, and determine the reasons for corrosive attack. Training courses for industry in surface coatings making use of TIRDO's facilities for this purpose will be important.

Coating methods in the organic field would include, hand application, pressure spray and electrostatic composition; the materials being oil based paints and varnishes and synthetic resins including two packs. Metallic coatings would include hot dip galvanising, electro-zinc deposition, anodising, nickle, chrome, (including hard chrome) copper and tin plating; the latter two being important for the electrical industries.

8.5.7. Physical Testing

In addition to the facilities for metallographic preparation and examination a separate area should be equipped for carrying out tensile, compression, impact and bending tests on metals, plastics and other materials: it should be air conditioned so that a wide variety of testing can be carried out.

The activities would include the tensile testing of metals, measuring strain to proof and yield points, tests on concrete reinforcing bars, cable hoists, strength tests on electrical conductors. Tensile, bend and impact tests on welded butt and lap joints, low temperature impact tests on welding rods (all weld tests) 'Ad hoc' testing to clients specification is included and the staff would be available to witness tests at clients factories on behalf of overseas insurance companies.

The physical test laboratory should apply for approval to such bodies as Lloyds Underwriters, Norske Veritas Underwriter Labs and the American Society for Testing Materials. Arrangements can be negotiated with overseas standards institutions to carry out approval tests for products made in Tanzania to their specifications.

It is proposed to site the non-destructive test equipment near the physical testing laboratory but it must be housed in a specially designed building to protect workers from X-Rays. The laboratory should be equipped with dye penentrants, magnetic particle, eddy current, ultrasonic and radiographic equipment for use on site work and in addition a purpose built, magnetic crack detection plant for in house tests on a sub-contract basis.

Sub-contract work on locally made forgings, castings, etc. will form the bulk of the work undertaken in the laboratory. Field work will come mainly from local metal fabricators, food processing plants, petro-chemical plants and from Government departments or other purchasing authorities who wish to have an independent check on the quality of the goods purchased.

Three technicians are proposed - two for laboratory work and one for field oriented NDT work.

8.5.8. PLASTICS

Plastics processors who were interviewed were aware of the problem of purchasing polymers and resins from overseas when they had few means of checking purchase specification against delivery. This would be one of the primary tasks of the plastics laboratory. Further tasks would be in checking the properties of finished goods. Investigation of the characteristics of compounds or blends produced locally is important to processors firstly so that they are assured that they comply with specification but also to ensure the most economical and that the most easily processable blend is used.

It is forseen that more than one plastics technologist will be needed. Among the thermosetting plastics there are four in common use. In the thermoplastics range there are at least six types in common use and these are being used in Tanzania now. The complexity of this activity is added to when the number of means of processing are considered. Compression moulding, transfer mouldings, injection moulding, extrusion rotation moulding, blow moulding (of containers and film), calendering and vacuum forming.

It is proposed that TIRDO should concentrate in the short term on the thermoplastics, principally polystyrene, polyurethane, polyetheylene, polypropylene and polyvinly chlorides as those which are in most common use: the manufacturing process would be limited to compression, injection and blow moulding, and extrusion as well.

Specialised training in all these materials and processes will take a considerable time and selection of the plastics technologist should proceed without delay.

The plastics technologist will be required to give technical leadership to the laboratory technicians but his main function will be field oriented in assisting the plastics processing industry in the daily problems of material selection, process investigations, etc.

Strong links with overseas organisations such as the British Rubber & Plastics Research Association (R.A.P.R.A.) or the Dutch T.N.O. should be forged in the early stages of development of the facility to assist the TIRDO specialist.

The thermosetting resin furnan can be derived from rice hulls and cotton seeds : among its many uses are as a binding agent with foundary sands. Relevant applied research could be conducted to develop the local production of furan and other resins.

8.6. Manufacturing Technology

8.6.0. The Manufacturing Technology Division should be formed to cover the functions normally carried out by the Plant Engineer, the Production Engineer and to some extent the Industrial Engineer (bearing in mind the existence of the National Institute of Productivity). These functions are often aggregated in European and United States engineering circles, (particularly in smaller manufacturing companies) under the title Manufacturing Engineer.

Using an anology from the field of medicine the manufacturing engineer is the 'General Practicioner' from whose breadth of knowledge and experience most of the common, day to day problems in industry can be solved but who relies on specialists in the fields of design or materials technology etc. when a more specific solution is required. He has however his own 'specialities' as will be seen from the activities listed below.

He is essentially concerned with practical solutions which can be easily applied: his 'stock in trade' is an up-to-date knowledge of the most modern techniques and methods of production and plant engineering: his job is not only to solve current problems but to anticipate the demands of the future: his objective is to improve th efficiency of manufacturing industry.

8.6.1. Plant Engineering

To assist manufacturing and processing industries with the implementation of new projects by assessing plant requirements, specification of technologies, 'critical path' planning of all resources (time, material, men and money) to bring projects 'on stream' according to schedule.

The development and scheduling of planned and preventive maintenance activities; compilation of plant registers, the application of plant appraisal and renewal techniques, the organisation of stores, inventories etc. and generally the optimisation of the resources of manufacture - Terotechnology. These techniques would be applicable to the introduction of 'new product' line as well as to complete new installations.

8.6.2. Production Engineering

To carry out 'production studies' on existing factories or production lines; to seek out inefficiencies and suggest remedial action; to design work stations, to layout manufacturing facilities for optimum work or material flow; to devise new methods of manufacture or assembly; to advise on the most up to date machinery available, to use 'methods time measurement' techniques to evaluate alternative methods of manufacture; to identify and specify the correct materials handling equipment.

The choice of metal working machinery is now a complex problem with the introduction of computer numerically controlled machine tools which are coming more and more into use in developed economies. These machines have an output four to five times as great as conventional automatic or manual machines (some authorities claim as much as 10 times as great with certain machines in particular circumstances); the cost of the machines can be three to four times that of the equivalent conventional machines: a comprehensive analysis of the work to be undertaken and a strict financial appraisal must be made before the investment decision is taken. It might appear at first sight that the introduction of these high output-low manpower machines would be anomalous to the

the present situation in Tanzania. They cannot be ignored anymore than the introduction of mechanisation or automation could be ignored in the past. Although such machines could delay increases in employment temporarily, in the long run, by increasing productive efficiency and reducing unit costs they increase the availability of manufactured goods to the general public and thus create their own market.

TIRDO's Manufacturing Engineers can be put at the disposal of private entrepreurs or parastatal bodies (TISCO is a good example) to help with the planning of new industrial enterprises, the implementation and the management until the companies own staff is ready and available to take over. Thus a pool of experienced engineers is made available to industry at a crucial stage of its development.

A team of four professional engineers and two technicians during the next five years is proposed. Capital equipment requirements are minimal but access to computer facilities are essential. Links with overseas production engineers associations e.g. the British Production Engineer Research Association should be forged at an early stage as a consultancy support in the early years of development.

The Division must be continually aware of the application of microprocessors and computers in production and plant engineering and be conversant with Computer Aided Manufacturing Systems. One manufacturing engineer should receive specialised training in those topics. It is not expected that these engineers should be specialists in computers, they should concentrate their efforts on engineering but, at the same time be aware of the value of microprocessors in their work. They should also be able to operate a microcomputer and to write short programmes in Basic Language.

8.7. Design and Development

8.7.1. New Product Design

The design of complete new products possibly adapted for local manufacture or conditions in response to the needs of Tanzanian entrepreneurs.

8.7.2. Process Improvement

Design modifications to existing machinery or plant for process improvement or increased output. Design of special tooling fixtures etc. for manufacturing processes.

8.7.3. Welding Design

A specialist service for the design of welded joints: specification of welds and welding procedures (this is of particular importance to the chemical and food processing industries where the use of pressure vessels in the more exotic materials is common).

8.7.4. Design of Special Equipment

Design of manupulators, conveyors, pick and place devices, automated assembly equipment, small metal working machines, fixtures, automated inspection equipment, imaging devices etc.

8.7.5. Stress Analysis

A specialist service to other industrial designers and engineers in the process industries.

Since many mechanical designs now involve electronic components, the existence of a TIRDO Electronics Division enhances t Design and Development function.

8.7.6. It is proposed that a Chief Designer/Manager should be appointed immediately so that he can, from an early stage, participate in the development of the design facility. He should have a mechanical/production or mechanical/production or mechanic engineering qualification and should have had at least five years experience in the design of machinery or products. It might be necessary to appoint an expatriate engineer temporarily to this post, on contract, whilst the facility and staff develop.

8.7.7. Three Project Engineers are proposed during the first five years each with a separate speciality; hydraulics, pneumatics and an engineer with a broad concept of electrics and electronics; the Electronic Division will support him in detail design.

Each Project Engineer would be in charge at any one time of up to two major projects and two minor projects: he would be responsible for defining the project, negotiating with the client, drawing up the technical proposal outlining the technical and financial arrangements, maintaining contact with the client, reporting progress, etc. He would also be the link between the design office and the workshop manager on scheduling work prioritic etc. He would be supported from a pool of designer draughtsmen who in turn would be assisted by a team of 'detail' draughtsmen.

It is envisaged that the designer draughtsmen would eventuall undertake minor projects on their own initiative. Two of the detai draughtsmen would at times be made available to outside companies or organisations on a contract basis.

8.7.8. A specialist in stress analysis is proposed who would give a service to the designers when required but whose activities would in the main be generated from outside TIRDO. He would maintain close liason with the experimental stress analysis function. A specialist welding engineer is also shown, again whose main body of work would arise from 'outside' clients but who would be available to give support to designers and the NDT facility. The Design facility should be aware of the use of Computer Aided Designs Syste and of 'software' design package available for design of components A proposed staff organisational chart is shown in Figure 2.

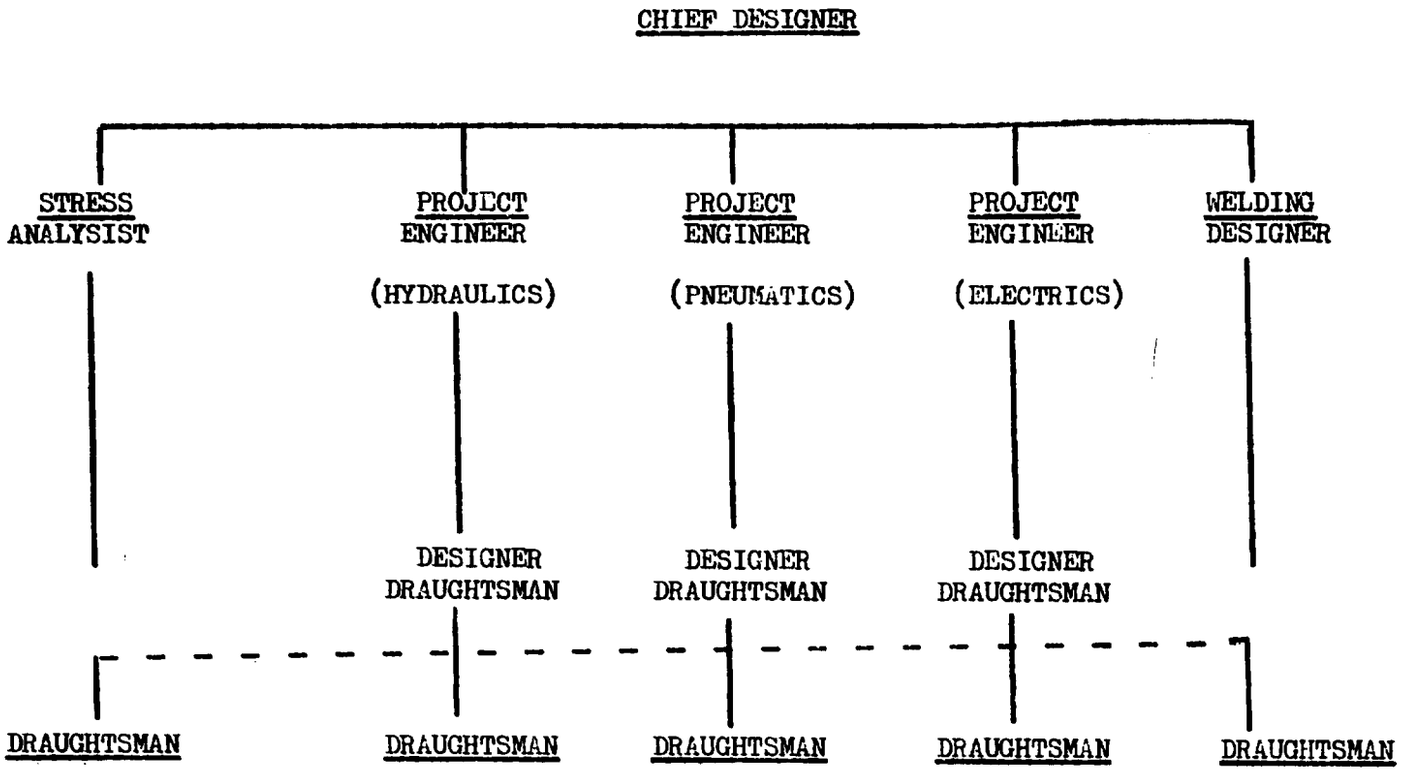

Figure 2. PROPOSED STAFFING OF DESIGN DEVELOPMENT FACILITY

8.8. ENERGY CONSERVATION

The measures suggested in Section 7.2 for immediate action in the problem of energy conservation should be a permanent feature in the Engineering Department of TIRDO. The conservation of fossil fuels is a world-wide problem which will be with us for the foreseeable future. What was observed in the installations visited, particularly the foundaries, suggested very strongly that the efficiency of operation of the oil burning equipment was far from optimum.

8.8.1. It is difficult to judge the magnitude of the problem in a brief survey and hence to determine the necessary resources for effective action; the Extension Service of TIRDO's Information Department has now got this as a priority enquiry in their visits to Industry. It is hoped that within a relatively short time the full magnitude of the problem in Tanzania will be better quantified.

8.8.2. Much of the routine work required to check industrial installations is simple, straight forward, easily understood and carried out. The instrumentation required is minimal, inexpensive and easy to use: most of the necessary and urgent work could be carried out by technician grades who would require only very short periods of training in the use of the instruments and interpretation charts. A boilerman, mechanic or fitter holding senior 'trade' examination certificates could undertake the work under the supervision and technical guidance of a professional engineer.

It has been suggested already that the Engineering Officer proposed for the immediate action programme should receive a short period of training in the instrumentation and techniques in a relevant organisation overseas, which is already carrying out this work. Following completion of this he would be able to instruct and train the technicians.

It is proposed that this engineer should take over the management and organisation of the Energy Division and that two technicians be appointed as soon as the Engineer has completed his own indoctrination and training and instruments have been purchased. Once the routine procedures had been organised, established and are running smoothly, he should then be available to undertake the deeper and more difficult theoretical studies which would be required in particular cases, for example waste heat recovery, and to carry out 'Energy Audits' of large consumers of energy.

8.8.3. The activities of the Division would include: boiler testing: stack temperature measurements; determination of fuel gas CO_2 levels; determination of smoke number; examination of heat transfer surfaces; examination of 'burner' performance; checking jet sizes, and condition; checking for damage to burner cups; checking for damage to refractories, insulation, etc.; checking for air leaks; investigation of boiler feed water treatment arrangements; and investigation of 'blow down' procedures.

These activities should be carried out on a regular basis so that industrial performance and improvement can be monitored. In certain industrial installations it may be necessary to measure energy usage department by department and relate it to product output to isolate those areas or activities which are most profligate in the use of energy i.e. where remedial action is required most urgently.

8.8.4. The conservation of energy is important from the point of view of the companies internal efficiency and the production costs of its products therefore a search for the inefficient use of electrical power should also be pursued. The urgency from the national point is not so great as for fuel consumption as most industrial electrical power is generated from hydro installations. Activities in the field of electricity conservation might be: demand management; load scheduling; power factor correction, peak 'lopping'; efficient use of electric motors; improved heat removal,

reduction of mechanical losses; voltage checks for bad connections, voltage imbalance. Other topics would relate to lighting systems, switching arrangements, condition of lamps and tubes; continuous operation of lights; use of time clocks, etc.

8.8.5. Good use could be made of the workers 'cell' systems in industry to improve the utilisation of all power. It is recommended that an extensive, positive publicity campaign should be mounted by the national government to make everyone aware of their responsibilities to conserve energy and of the means to do it.

TIRDO action in conservation of fuel oils and petroleum for transportation would be one of education through publicity in newspapers, radio, information bulletins, seminars, etc.

8.9. Machine Workshop

The workshop containing the metal cutting, sheet metal and welding equipment should be organised as a central service to other departments and divisions within TIRDO and also should be available to Tanzanian industry when required.

It should have its own manager, responsible to the head of administration and its own 'works ordering' and financial accounting systems so that jobs are allocated priority and costed out to the departments and divisions using it. Work carried out there should be regarded as capital projects as distinct from maintenance work.

8.9.1. The maintenance department should be confined to carrying out minor repairs, overhauls and planned preventive maintenance for machinery, electrical equipment, buildings, and TIRDO vehicles. During the next five years when many of the buildings will still be under the charge of the main contractor it is envisaged that maintenance will be a small section: it is suggested that staffing levels will use to one fitter/mechanic, one electrician, one plumber, and one general building worker organised and controlled by a manager or supervisor. Major alterations or new works should be 'contracted out'.

8.9.2. It is understood that the proposed building for the engineering department will not be completed until 1984 or 1985, and that in the meantime one of the pilot plant buildings will be made available for the machine workshop.

A layout of all of the metal cutting, and metal fabricating equipment shows that the pilot plant building will accommodate the machinery proposed up to 1986 and leave room for fitting benches, a prototype assembly area and unloading bay. Storage for small tools, instruments etc. will be on one of the mezzanine floors whilst the maintenance department for this period can be accommodated on the remaining part of this mezzanine. The ground floor area of the pilot plant building is 262 square meters with approximately 70 spuare meters of usable space on the mezzanines. This suggests that the size or usage of the original building proposed for the Engineering Department should be examined and reviewed.

A separate building should be provided for the foundry if it should be operational by 1984: the area required will be small; approximately 40 square meters will be adequate.

8.9.3. Only basic metal working equipment has been recommended. It is anticipated that the full list will be adequate for TIRDO's needs till 1986 and for some time beyond that. Experience has shown that milling machines are more frequently used in 'general' workshops than other equipment and two of these are suggested; one as first priority and the second to be acquired later. A small and a large lathe are also suggested; the proposed purchase for the larger lathe being of second priority. Circumstances may dictate that this should be purchased earlier.

The recommendation of a tool and cutter grinder is dictated by the current supply position in Tanzania for small cutting tools. It is proposed that this machine should be used almost exclusively to give a service to industry on a subcontract basis to extend the useful life of their tools, drills, milling cutters etc. Metal spraying equipment is also proposed as a means of rehabilitating worn out machinery components.

8.9.4. Detailed lists of small items e.g. cutting tools, hand tools, small power tools are not given but sums to cover the purchase of these, as required, has been allowed. Some basic items of the larger raw material stocks are suggested. These would be stored in covered racks outside the workshop. Again supplies of smaller stock items e.g. bolts, nuts, etc. are included in the estimate.

8.9.5. Staffing

The following staffing for the workshop is proposed:

1983	Appoint foreman supervisor (Fitter/Turner with Technical College qualifications and 7 years post apprenticeship industrial experience).
1984	One fitter/turner and one sheet metal worker
1985	One fitter/turner and one sheet metal worker
1986	Two fitter/turners.

It would be preferable to recruit 'development fitters' but it is extremely unlikely that any would be available in Tanzania at this time. The men recruited should therefore hold technical school certificates when recruited and they should be assisted by the designers and drawing office staff to become development fitters as soon as possible.

9.0. RECRUITMENT AND TRAINING 1982 - 1986

9.1. Figure 3 shows diagramatically a calendar covering recruitment appointments, education and training for the period 1982-1986. It should be noted that staff for certain specialities will have to be educated and trained abroad so recruitment is proposed in 1982 or 1983. It is also suggested that the existing mechanical engineering staff members be placed in the Manufacturing Engineering Department and that one existing Chemical Engineer should be used in the Energy Division. It is also suggested that one chemist should be trained in corrosion technology and surface coatings and that a second should undertake a course in polymer chemistry to enable him to work in the field of plastics.

Legend: R – Recruit T – Train NDT – Non Destructive Test SC – Surface Coat E – Electrics C – Ceramics
E – Educate S – Exist. Staff TT – Test P – Plastics CF – Cast/Forge H – Hydraulic/pneumatic

DIVISION	MATERIALS TECHNOLOGY															DESIGN DEVELOPMENT												ENERGY			MANUF.TECHNY.					
STAFF POST / TIRDO BUDGET YEAR	MANAGER	FEROUS/NON FER.	PLASTICS	TEST AND N.D.T.	SURFACE COATS	CERAMICS	CASTING FORGING	TECHNICIAN SENR.	TECHNICIAN (P)	TECHNICIAN (TT)	TECHNICIAN (SC)	TECHNICIAN (C)	TECHNICIAN (CF)	TECHNICIAN (TT)	MANAGER	WELD ENG.	PROJ. ENG (H)	PROJ. ENG (P)	PROJ. ENG (E)	STRESS ANALYT.	DESIGN D' MAN	DESIGN D' MAN	DESIGN D' MAN	DRAUGHTSMAN	DRAUGHTSMAN	DRAUGHTSMAN	ENERGY ENG.	TECHNICIAN	TECHNICIAN	MANUF. ENG.	MANUF. ENG.	MANUF. ENG.	TECHNICIAN	TECHNICIAN	
1982/83	R	R	S	–	S										R												S			S	S				
		E	E	–	T			R								R						R						T								
1983/84		E	E	R	T		R										R								R				R				R		
		E	T	T		R	E										T			R									R						
1984/85		E				E	E		R	R	R							R		T		R			R						R		R		
		E				E	E							R				T																	
1985/86						E	E								R				R				R			R									
						T	E												T																
1986/87							T					R															R								
							T						R															R								

FIGURE 3. PROPOSED ENGINEERING STAFF RECRUITMENT & TRAINING CALENDAR

9.2. The training of the technicians should be undertaken by the Research Officers to whom they report.

9.3. It is suggested that the managers of the Materials Technology and Design and Development Divisions should be expatriates under contract until at least the Autumn of 1985. All other staff should be Tanzanian Nationals.

9.4. The staff recruitment has been integrated with the tentative schedule for the purchase of equipment in so far as was possible.

9.5. It is understood that the construction of the building to house the Engineering Department will not commence before 1983 but that temporary accommodation will be available in the mean time. A preliminary examination of the architects drawings shows that the planned final accommodation is more than adequate to meet the projected staffing and equipment needs of the programmes laid down in this report.

9.6. It is strongly advised that for the next five years the priorities of staffing and equipment should take precedence over the completion of the engineering buildings as shown on the 1978 drawing

SUMMARY OF PROPOSED STAFF RECRUITMENT

BUDGET	1982 - 1986	
BUDGET YEAR	ENGINEERING OFFICERS	TECHNICIANS -
1982/83	4	3
1983/84	5	5
1984/85	2	10
1985/86	1	5
1986/87	2	2
TOTALS	14	25

Existing staff to be utilized.

2 mechanical/production engineers
1 civil engineer
2 chemical engineer
1 chemist

Total staff by 1987 45.

APPENDIX 1. RECOMMENDED EQUIPMENT AND SUPPLIES

The appended equipment and supply lists have been prioritized to be consistent with the staffing plan in so far as possible and to reflect the pressing needs of Tanzanian industries.

Specific manufacturers and models have been designated for most items as a convenient way in which to further specify the desired equipment. Items with equivalent capacity and quality may, of course, be substituted.

The quoted prices were obtained in late 1981 or early 1982 and, where appropriate, include costs for seaworthy packing and for delivery to the nearest port of exit. In the case of small parts and instruments, an allowance for air freight has been made.

Insurance, sea freight, clearing and forwarding charges are not included.

Provision has been made for an inventory of sheet, bar and section stock in steel, aluminium alloy and brass as well as bolts, nuts and washers. These items are not readily available in Tanzania and the stock shoule be resupplied on an annualar biannual schedule.

The summarized costs are as follows:

First Priority	U.S. $ 358,860
Second Priority	239,401
Total	U.S. $ 598,261

MACHINE, TOOL or INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE - FOB SEAWORTHY U.S. $	PRIORITY
	METAL CUTTING MACHINERY				
HACKSAW	RECIPROCATING	CUTTING CAPACITY 275 MM DIA. 165 x 215 FLATS BLADE 450 x 40 x 2 MM MOTOR 2 HP: 3 SPEEDS	SCORTEGAGNA 36013 PIOVENE ROCHETTE ITALY MODEL NO. ERCOLE 27	1, 600	1
BANDSAW	VERTICAL	THROAT DEPTH 610 MM TABLE 660 x 660 MM TILTING TABLE BAND WIDTH 12 MM WITH SPARE BLADES	JAESPA A S 6 KARL JAGER GmbH	6,964	1
LATHE	CENTRE; (STRAIGHT) METRIC	WING OVER BED 390 MM SPINDLE BORG 54 MM DIST. BETWEEN CENTRES 750 MM : 16 SPEEDS 25-2000 RPM: 5.5. KW	COLCHESTER LATHS CO. COLCHESTER CO_2 8LE ENGLAND: MODEL NO. TRIUMPH 2000/30 STR	9,549	1
LATHE ACCESSORIES	ACCESSORIES FOR TRIUMPH 2000	4 JAW CHUCK; TOOL POST TOOL HOLDERS FACE PLATE CHIP GUARD STEADIES; HORSE TAPERS ROTATING CENTRE ETC.	COLCHESTER LATHE CO.	2,449	1
MILLING MACHINE	UNIVERSAL (KNEE TYPE)	TABLE 300 x 1200 MM TRAVEL 900 MM x 460 MM SPEEDS 8; 32 TO 1500 RPH MOTR 6 H.P.	VERNIER S.A. 22 BD ANATOLE FRANCE MODEL No. FV 460	27,808	1

MACHINE, TOOL or INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE - FOB SEAWORTHY U.S. $	PRIORITY
	METAL CUTTING MACHINERY				
MILLING MACHINE ACCESSORIES	ACCESSORIES FOR VERNIER FV 460	SURFACING AND BORING HEAD 350 MM DIA : ROTARY TABLE 200 MM SWIVEL VICE EXTRA JAWS. UNIVERSAL DIVIDING HEAD	VERNIER S.A. 22, BD ANATOLE FRANCE	5,000	1
SURFACE GRINDING MACHINE	TOOL ROOM QUALITY	TABLE 600 x 180 MM AUTO FEED AND REVERSE AUTO LUBRICATION. DIAMOND HOLDER ALL WHEELS. 3 WAY VICE. BALANCING UNIT.	AA JONES SHIPMAN LEICESTER ENGLAND MODEL NO.1400 AR METRIC.	27,500	1
ACCESSORIES FOR SURFACE GRINDER	JONES SHIPMAN MODEL 1300 E1U	MACHINE VICE LD SELF CENTR UNIGRIP VICE: INDEX TABLE - METRIC INDEX JAW AND CHOCK MANDREL PRESS	Part No.4605 and 4630; 4608-001, 4012, 4914, 8411/7 + 8411/8/3 8601 - 003	2,650	1

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
CYLINDRICAL GRINDER	TOOL ROOM QUALITY	250 x 680 MM WITH DIAMOND FOR TABLE MOUNTED HOLDER AND SPARE GRINDING WHEELS	AA JONES SHIPMAN LEICESTER ENGLAND MODEL NO. 1300 E1U METRIC	33,500	1
BENCH DRILL	BENCH TYPE	CAPACITY IN STEEL 22 MM TRAVEL 130 MM 10 SPEEDS 80 TO 4000 MOTOR - 5 KW.	MEDDINGS MACHINE TOOLS DEVON. ENGLAND PL21 9LL MODEL NO. MF4 R.C.	970	1
DRILL	PILLAR	CAPACITY IN STEEL 32 MM 12 SPEEDS 75 - 2800 RPM	STARTRITE MODEL NO. FG2A PILLAR	2,700	1
BENCH GRINDER	TWO ENDED	200 MM WHEELS 1 COARSE: 1 FINE ADJUSTABLE TABLE	ARBOGA MODEL NO. EP 308 GENERAL SUPPLIER	680	1
MACHINE SHOP PEDESTAL GRINDER	TWO ENDED PEDESTAL	400 MM WHEELS 1 COARSE, 1 FINE WITH TOOL RESTS, LIGHTING AND EYE SHIELDS	UNION MODEL G14 P GENERAL SUPPLIER	1,760	1
TOOL AND CUTTER GRINDER	MULTIPLE PURPOSE	200 x 400 MM CAPACITY	AA JONES SHIPMAN MODEL 310T	14,500	1

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
ACCESSORIES FOR TOOL AND CUTTER GRINDER	TO EXTEND RANGE OF BASIC MACHINE	VARIOUS	A.A. JONES SHIPMAN	16,800	1
BENCH SHEARS	LONG HANDLE	FOR PLATES 5 MM THICK ROUNDS 12.5 MM. BLADE LENGTH 200 MM PRICE INCLUDES SPARE BLADES	KEETONA TYPE K3	280	1
GUILLOTINE (MECHANICAL SHEARS)	ELECT POWERED MANUAL BACK STOPPING	SHEET CAPACITY T= 3.25 MM L = 1270 MM MOTOR 5.5 KW	F.J. EDWARDS LTD. ENGLAND MODEL NO. 3.25/1250	7,000	1
BENDING ROLLS	HAND OPERATED	SHEET CAPACITY 1270 MM LONG 6.0 MM THICK	F.J. EDWARDS LTD ENGLAND MODEL EGS (HAND GEAR)	1,700	1
ALLOWANCE FOR CUTTING TOOLS, DRILLS REAMERS, SAW BLADING ETC.	GOOD QUALITY H.S. STEEL CARBIDE TIPPED	VARIOUS	GENERAL SUPPLIERS EG. SANDVIK CLARKSONS ETC.	3,000	1
ARBOR PRESS	FOR REMOVING BUSHINGS ETC.	ARBOR 50 MM DIA. 380 MM LONG	NORTON TYPE M3	800	2
DRILL	RADIAL	DRILL CAPACITY IN STEEL 50 MM VERT TRAV. 640 MM HORIZ TRAVEL 1250 MM 12 SPEEDS 30 - 1400 RPM	A BENGONSI SPA 27100 PAVIA ITALY MODEL NO. TM50 1250	13,800	2

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
LATHE	CENTRE GAP TYPE: METRIC MEDIUM BED	SWING OVER GAP 711 MM SWING OVER BED 433 MM DIST BETWEEN CTR 2 M SPINDLE BORE 76 MM 16 SPEEDS 20 TO 1600 RPM MOTOR 9.3 KW	COLCHESTER LATHE CO. COLCHESTER CO 28 LE ENGLAND MODEL NO. MASCOT 1600 EIGHTY GAP	13,819	2
LATHE ACCESSORIES	ACCESSORIES FOR MASCOT 1600	TOOL POST AND HOLDER MORSE TAPERS: 4 JAW CHUCK: CULLETS. FACE PLATE : STEADIES ROTATING CENTRE ETC.	COLCHESTER LATHE CO.	2,449	2
BANDSAW	HORIZONTAL	TO CUT ROUNDS 320 MM DIA, SPARE BLADES ETC.	KARL JAGER Gmb H JAESPA MODEL W320	3,567	2
MILLING MACHINE	UNIVERSAL (KNEE TYPE)	TABLE 300 x 1200 MM TRAVEL 900 x 460 MM 18 SPEEDS 32 - 1500 RPM MOTOR 6 H.P.	VERNIER S.A. 22 BD ANATOLE, FRANCE 06340 LA TRINITE MODEL NO. FV 460	27,600	2
ACCESSORIES FOR MILLING MACHINE	VERNIER FV 460	SURFACING AND BORING HEAD. 200 MM SWIVEL VICE EXTRA JAWS	VERNIER S.A. 22 BD ANATOLE. FRANCE 06340 LA TRINITE	2,000	2
	SHEET METAL MACHINERY				
SHEET FOLDER (STRAIGHT)	UNIVERSAL ST.	SHEET CAPACITY 1.6 x 1260 MM	F.J. EDWARDS LTD. ENGLAND MODEL BP 416 M	2,000	1

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
TUBE BENDER	HYDRAULIC	FOR TUBES 9 - 75 MM EQUIPPED WITH FORMERS	'STAFFA' MODEL NO. O.F.B. 1	1,300	1
PIPE THREADER	PIPE BENCH	FOR PIPES UP TO 40 MM DIA. WITH WRENCHES, DIES ETC.	GENERAL SUPPLIER	560	1
FLY PRESS	NORTON NO. 6	DEEP THROAT	GENERAL SUPPLIERS	720	1
BOX AND PAN FOLDER	HAND OPERATED	SHEET CAPACITY 1.6 x 1266 MM	F.J. EDWARDS LTD. ENGLAND MODEL NO. BP 416	2,280	2
NIBBLER	COMBINED NIBBLER, JOGGLER BEADER, DISHER SLOTTER.	SHEET CAPACITY 3.0 MM PRICE INCLUDES TOOLING ETC.	F.J. EDWARDS ENGLAND MODEL ASG3/1003 M	6,500	2
HYDRAULIC PRESS	PORTAL FRAME TYPE	60 TONNES CAPACITY STROKE 200 MM CLEAR WIDTH 1000 MM	ALMIND COPENHAGEN MODEL NO. HP 60	1,500	2
HYDRAULIC POWER PACK	ELECTRIC MOTOR DRIVEN	3000 P.S.I WITH PRESSURE GAUGES NON RETURN, CONTROL, RELIEF VALVES. RESERVOIR	-	4,500	2
MANUAL METAL ARC WELDING SET	WELDING EQUIPMENT A.C. 450 AMP.	220 VOLT SINGLE PHASE 50-60 HERTZ O.C. VOLTS 80 CURRENT RANGE 60-450 AMP.	B.O.C. TYPE 1198021 WITH WELDING LEAD RETURN LEAD UNDER GEAR	890	1

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
OXY. GAS WELDING	OXY/ACETYLENE	GAS REGULATORS: TUBES : WELDING, CUTTING AND BRAZING TORCHES. PANTOGRAPH	-	1,500	1
METAL SPRAYING EQUIPMENT	GAS.	GAS REGULATORS. TUBES MIXER VALVES. TORCH. STAND - WIRE UNIT	B.O.C. TYPE	3,000	1
T.I.G. WELDING SET	375 AMP AC/DC	220 VOLT; 3 PH. 50 HZ OUTPUT 80 V.A.C. OR DC CURRENT RANGE 10 - 350 A.	B.O.C. TYPE TRANSTIG AC/DC 375 PART NO. 1198061	3,100	1
T.I.G. WELDING KIT	ARGON	GAS BOTTLES : TUBES REGULATOR : TOOLS MASKS, ETC.	B.O.C. (T.O.1) PART NO. 1404064	4,100	1
MIG. WELDING SET	A.C. 350 AMP.	220 VOLT : 3 PHASE. 50 HZ. O.C. VOLTS 15-35 CURRENT RANGE 60-400 A.	B.O.C. TYPE TRANSMIG 350 PART NO. 1198012	1,765	2
MIG. WELDING KIT	ARGON AND CO_2	WIRE FEED UNIT TORCH MTZ:LEADS AND GAS TUBES ETC.	B.O.C. TYPE MIGPAK 350 TF2.OS WIRE UNITS	2,600	2
ALLOWANCE FOR SMALL TOOLS ETC	WELDING CONSUMABLES FILES, DRILLS, SPANNERS HAND GRINDERS, CHISELS - SAWS, ETC.	VARIOUS	GENERAL SUPPLIERS	19,000	1

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
	WOODWORKING EQUIPMENT				
UNIVERSAL WOOD WORKER	FOR SAWING THICKNESSING SURFACING MOULDING	MOTORS 2.2 KW SAW 1.9 KW MOULDER TABLE SIZES SAW 750 x 400 PLANNER 1750 x 350 THICKNESSER 655 x 350 MM	SCM : RIMINI ITALY MODEL C35	7,500	1
WOODLATHE	SMALL	SWING 200 MM CENTRES 760 MM PRICE INCLUDES TOOLING	MYFORD MODEL ML8	4,370	1
	WORKSHOP MEASURING EQUIPMENT				
M/c SHOP SURFACE PLATE	GRANITE GRADE 'A'	904 x 607 MM TO GERMAN STANDARD DIN 876	INSPECTION EQUIPMENT LTD. 42 LOWER DORSET ST. DUBLIN 1, IRELAND	900	1
ANGLE PLATE	GRADE 'A' C.I	177 x 127 x 101 MM	"	250	1
VEE BLOCKS	HARDENED STEEL	90 x 60 x 60 MM	INSPECTION EQUIPMENT LTD. 42 LR DORSET ST. DUBLIN 1, IRELAND	140	1
GAUGE BLOCKS	LABORATORY CALIBRATION GRADE	I.S.O. STANDARD 3650 112 PIECES. METRIC 1.0005 TO 100 MM. TUNGSTEN - CARBIDE	"	2,500	1

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
GAUGE BLOCKS	MICROMETER CHECK SET FIELD TEST	INSPECTION GRADE 8 PIECES : METRIC IN CARRING CASE	INSPECTION EQUIP. LTD. 42 LR DORSET ST. DUBLIN 1, IRELAND.	200	1
MICROMETERS	DIGITAL	0 - 25 MM 7 OFF 25 - 50 MM 7 OFF 50 - 75 MM 2 OFF 75 - 100 MM 2 OFF 100- 125 MM 2 OFF	"	2,100	1
MICROMETERS	DIGITAL	125 - 150 MM 2 OFF 100 - 200 MM ANVIL 1 OFF 200 - 300 MM ANVIL 1 OFF 300 - 400 MM ANVIL 1 OFF 400 - 500 MM ANVIL 1 OFF	INSPECTION EQUIP. LTD. 42 LR DORSET ST. DUBLIN 1, IRELAND.	800	1
SPECIAL MICROMETERS	DIRECT READING	POINT 0-25: 25-50 MM TUBE 0-25: 25-50 MM SHEET 0-25: BLADE 0-25 DEPTH 0-100 MM INSIDE 50-300: 200-1000	"	1,200	1
VERNIER CALIPERS	TWO SCALES INCH AND METRIC	180 MM 3 OFF 300 MM 1 OFF 600 MM 1 OFF	MEASURING EQUP. LTD. 42 LR DORSET ST. DUBLIN 1, IRELAND	530	1
DEPTH GAUGE VERNIER	METRIC	300 MM	"	100	1
HEIGHTS GAUGE VERNIER	METRIC	600 MM	"	520	1

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
COMBINATION SQUARE	-	-	MEASURING EQUP. LTD. 42 LR DORSET ST. DUBLIN 2, IRELAND.	100	1
CALIPERS AND RULES	SPRING TYPE INSIDE AND OUTSIDE STEEL.	OUTSIDE 200 MM 2 OFF INSIDE 200 MM 2 OFF STEEL RULES 150 MM 2 OFF 300 MM 2 OFF 600 MM 1 OFF	"	90	1
SURFACE TABLE MARKING OFF TABLE	CAST IRON GRADE 'B'	1828 MM x 1219 MM TO DIN D876 OR B.S. 817	INSPECTION EQUIPT. LTD. 42 LR DORSET ST. DUBLIN 1, IRELAND	3,900	2
VEE BLOCKS	HARDENED STEEL	150 x 100 x 100	"	200	2
ANGLE PLATE	GRADE 'B'. C.I.	457x304x208 MM	"	450	2
C.I. STRAIGHT EDGE	GRADE 'B'	1219 MM LONG	"	200	2
STEEL PARALLELS	GRADE 'A'	150x30x15 MM	"	240	2
OPTICAL PROJECTOR	DIGITAL READOUT	12" DIA. ROTATING SCREEN 4 MAGNIFICATIONS x 10 TO x 100 BUILT IN ILLUMINATION TO READ 0.002 MM	J.E. BATTY AND CO. LTD. PURGESS HILL ENGLAND RH 15 9LB MODEL SHADOWMASTER R122xL	4,900	2

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
ACCESSORIES FOR OPTICAL PROJECTOR	-	LENSES x 10 x 25 x 50 x 100 ILLUMINATION, REFLECTORS SPARE LAMPS. (6OFF) OVERLAY CHARTS	J.E. BATTY AND CO. LTD BURGESS HILL ENGLAND RH 15 9LB MODEL SHADOWMASTER R122 x L	1,250	2
DIAL TEST INDICATORS	METRIC MAGNETIC BASE	25 MM TRAVEL 4 OFF WITH MAGNETIC BASE IN CARRYING CASE	" MODEL No. 6	500	2
ROUNDNESS MEASURING INSTRUMENT	LABORATORY TYPE METRIC	WITH CENTRING AND LEVELLING DIA. OF WORK SURFACE 190 MM RANGE 0.5 FOR 127 MM STYL. MAGNIF. 6: 50 TO 2500	RANK TAYLOR HOBSON TALLYROND 100 MODEL S01	12,400	2
SURFACE ROUGHNESS MEASURING EQUIPMENT	PORTABLE TYPE, METRIC	DIGITAL DISPLAY TYPE TO INCLUDE PICK UP: LEADS ROUGHNESS STANDARDS IN CARRYING CASE.	INSPECTION EQUIP. LTD. 42 LR DORSET ST. DUBLIN 1, IRELAND RANK TAYLOR SUBTRONIC	2,700	2
ACCESSORIES FOR ABOVE		RECORDER UNIT CHART WIDTH 50 MM SUPPORT STAND PICKUPS BORE: RECESS	"	4,761	2
METALS TESTING EQUIPMENT					
UNIVERSAL TESTING MACHINE	600 KN (60 TON) SERVO-HYDRAULIC TENSION/COMP/BENDING	LOADCELL LOAD MEASUREMENT ACCURACY ± 1% SCALE GRADE A. WITH ALL EXTRAS INCLUDING CYCLIC LOADING	AVERY DENISON LTD. LEEDS ENGLAND LS10 2DE MODEL NO. 7152.	30,000	1

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
ROCKWELL HARDNESS TESTER FOR METALS	DIGITAL TYPE BENCH MODEL	PRESELECTOR FOR ROCKWELL SCALES A TO K BENCH MODEL WITH ALL NECESSARY ACCESSORIES	AVERY DENISON LTD. LEEDS ENGLAND LS10 2DE MODEL NO. 6409	6,800	1
VICKERS AND BRINELL HARDNESS TESTING MACHINE	DIGITAL TYPE BENCH MODEL	PRESELECTION OF 6 LOADS 1 TO 30 Kg COMPLETE WITH ALL ACCESSORIES.	" MODEL NO. 6408	11,000	1
PORTABLE HARDNESS TESTER	DIGITAL DISPLAY BATTERY OP.	50 - 995 HV FORCE 8.5 N ACCURACY ± 15 HV. HARD ± 5 HV. SOFT	KRAUT KRAMER GERMANY MODEL DHV 10.	1,400	1
IMPACT TESTING MACHINE	CHARPY AND IZOD TYPE	CAPACITY CHARPY 150J AND 2J 120D 300J x 2J POWERED PENDULUM LIFT	AVERY DENISON LTD. LEEDS ENGLAND LS10 2DE MODEL NO. 6706	11,000	2
NON-DESTRUCTIVE TESTING EQUIPMENT					
INDUSTRIAL RADIOGRAPHIC SET	PORTABLE	TUBE VOLTS 50 - 100 KV. RAD OUTPUT 300/5 KJ/MA 1050 MA/Kg. TO 100/5 KV/MA COMPLETE WITH CONTROLS AND HAZZARD WARNINGS.	PHILLIPS ELECT. B. RYAN VERBENA DUBLIN MODEL NO. G 301	14,600	1

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
ULTRA SONIC FLAW DETECTOR	PORTABLE BATTERY OPERATED	AUTO AMPLITUDE CORRECTION SELECTABLE PROGRAMMES COMPLETE WITH 15 PROBES CABLES-STEP WEDGE: CALIBRATION BLOCK	WELLS KRAUT KRAMER B RYAN VERBENA DUBLIN MODEL NO. USL 35	11,400	1
MAGNETIC CRACK DETECTOR	HAND MODEL	FIELD ST. 9 KA/M AT 170 MM 5 KA/M AT 260 MM POLE 30 x 30 MM	TIED GmBH MODEL TWM 220 B. RYAN VERBENA DUBLIN	1,450	1
ALLOWANCE FOR DYE PENETRANT KITS.	ANILENE DYE	-	GENERAL SUPPLY	500	1
X RAY DEVELOPMENT DARK ROOM	-	DARK ROOM EQUIPMENT 4 TANKS 60 x 30 x 60 MM HOLDERS: HANGERS: LAMPS: CHEMICALS	GENERAL SUPPLY	700	1
EDDY CURRENT CRACK DETECTOR	BATTERY OPERATED	COMPLETE WITH NI CD BATT. CHARGER: FLAT PROBES FERROUS AND NON FERROUS	KRAUTKRAMER MODEL 2. 835	2,900	2
WALL THICKNESS TESTER	DIGITAL BATTERY OPERATED	RANGE 1.5 TO 300 MM. ACCURACY ± 0.1 mm	KRAUT KRAMER MODEL D.M 2	2,900	2
LAB. MAG. PARTICLE	FIXED MODEL	HIGH CURRENT LOW VOLTAGE WITH PUMPS AND JETS AND SPEC. MOUNTING CENTRES.	MAGNAFLUX LTD. ENGLAND.	2,300	2

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
	PLASTICS TESTING EQUIPMENT				
TESTING MACHINE	LONG STROKE LOW LOAD TENSION - COMPRESSION TABLE MODEL	5 KN MAX CAPACITY WITH INTERCHANGABLE LOAD CELLS. LIGHT BETWEEN COLUMNS 400 MM TRAVEL 1000 MM GRAPHIC RECORDER.	INSTRON LTD., ENGLAND MODEL NO. 1121 5 KN	30,000	2
SPECIMEN CUTTING PRESS	TOGGLE ACTION	2000 KG.	DAVENPORT LTD. WELWYN GARDEN CITY ENGLAND	1,500	2
CUTTERS ALLOWANCE FOR CUTTERS TO INTERNATIONAL STANDARDS.	-	-	"	500	2
DENSITY GRADIENT APPARATUS.	TWO COLUMNS	TO COMPLY WITH ISO R1183	"	2,300	2
MELT FLOW INDEXER	40°C TO 400°C	TO COMPLY WITH ISO R 1183	"	3,500	2
PENDULUM IMPACT TESTER	BENCH MODEL	TO DO CHARPY AND IZ oD 2.7J TO 21.6J	"	3,750	2
DART IMPACT TESTER		TO COMPLY WITH BS 2782 AND ASTM 1894 - 78	"	3,600	2

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
FILM THICKNESS MICROMETER	WITH STAND	TO COMPLY WITH BS 2782	DAVENPORT LTD., WELWYN GARDEN CITY ENGLAND	250	2
TEAR TESTER	'ELMENDORF'	TO INTERNATIONAL SPECIFICATIONS	DAVENPORT LTD., WELWYN GARDEN CITY ENGLAND	2,200	2
BURST STRENGTH TESTER	HAND OPERATED	-	"	1,350	2
SOFTENING POINT TESTER	BEAM TYPE	WITH OIL BATH FULLY CONTROLLED 40°C-250°C TO GIVE DEFLECTION UNDER LOAD AND VICAT POINT	"	2,450	2
METALLURGICAL TEST EQUIPMENT					
LAB. CUT OFF MACHINE	FOR HARD AND SOFT METALS	3 HP MOTOR 3 PHASE. COOLANT SYSTEM 3 CUTTING WHEELS CUTTING CAPACITY 100 MM	STRUERS DK 2610 COPENHAGEN MODEL 'TRENE' 70111	2,900	1
ROUGH GRINDER	ROLL MODEL	WATER JET COOLING 4 ROLLS 220: 320: 500: 800 GRIT PAPER	STRUERS MODEL: 'LUMAJ'	550	1

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
MOUNTING PRESS	COMP MOULTING	MOTOR DRIVEN THERMOSTATIC CONTROL PRESSURE CONTROL	STRUERS MODEL 'PROIT'	2,800	1
ALLOWANCE FOR MOUNTING MATERIALS	2 YEARS SUPPLY	THERMOSET THERMOPLASTIC RESINS : HARDNERS CUPS : SERINGES:	STRUERS VARIOUS	500	1
ENGRAVER	HAND MODEL	220 VOLT WITH EXTRA CASE HARDENED POINT	STRUERS	50	1
2ND FINISH GRINDER.	FOR FLUSH BENCH MOUNTING	2 ROTATING DISCS TWO OFF 230 MM DIA WATER JET WITH EXTRA DISCS.	STRUERS MODEL ROTOX	2,500	1
POLISHING MACHINES	FOR FLUSH BENCH MOUNTING	AT 125 - 250 RPM 50W WATER COOLED TWO OFF WITH SELECTION OF DISCS	STRUERS MODEL 'DAPTO'	2,250	1
DIAMOND POLISHING MACHINE	FOR FLUSH BENCH MOUNTING	VARIABLE SPEED 475 W MOTOR. D.C. ELECTRONIC CONTROL 200 TO 1000 R.M.P. 300 MM DISCS PLUS ALLOWANCE FOR EXTRA DISCS.	STRUERS MODEL DEFOR	2,300	1

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ – FOB SEAWORTHY	PRIORITY
SPECIMEN STORAGE CABINET	10 DRAWERS	WITH DESSICANTS AND INDICATOR CAPSULES WITH SPACER TRAYS ETC.	METASERU MODEL C 211	450	1
INVERTED METALURGICAL MICROSCOPE	INVERTED PHOTOMICROGRAPHIC	TOTAL MAGNIFICATION 35X TO 2000X BUILT IN LIGHTING AND PHOTOGRAPHY	METALLURGICAL SERVICES LABORATORIES LTD., SURREY RH3 7HW ENGLAND MODEL NO. D2001	6,500	1
STEREOMICROSCOPE	ZOOM	CONTINUOUSLY VARIABLE MAGNIFICATION 5 RANGES 4.8 TO 112 WITH ADDITIONAL LENSES	MET. SERVICES LABS LTD MODEL NO. SMZ 2	1,100	1
ELECTRO PLATING EQUIPMENT	EXPERIMENTAL LABORATORY TYPE	8 TANKS 1Mx60MM DEEPx30MM SINGLE TRANSFORMER/RECTIF. SYSTEM TO COMMON BUS BAR INDIVIDUAL CONTROL EACH TANK	CANNINGS LONDON, ENGLAND TO CUSTOMERS SPECIFICATION	5,700	1
LABORATORY FURNACE	MUFFLE	STEEL CASE : REFRACTORY LINED CHAMBER DIMENSIONS 200x225x425 MM WORKING TEMP 1200°C. 220 VOLT 6 KW	CARBOLITE LTD., SHEFFIELD ENGLAND	3,200	1
PRESSURE GANG TESTER	DEAD WEIGHT	0 – 300 0 – 6000	BUDENDBERG U.K.	2,150	1

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
TEMPERATURE CALIBRATION BOX	-	CERTIFIED THERMOCOUPLES, ETC.	WALLACE	2,000	1
ENERGY CONSERVATION EQUIPMENT					
INFRA RED THERMOMETER	PORTABLE	RANGE 0°C TO 400° C. ACCURACY + 2% TARGET DISTANCE 1 TO 5M	MANOTHERM LTD., WACKINSTOWN RD DUBLIN 12 IRELAND.	4,000	1
DIGITAL THERMOMETER	PORTABLE HAND HELD	CHRO./ALUM THERMOCOUPLE RANGE TO 1000°C ACCURACY ± 1%	"	480	1
MULTI POINT RECORDER	FOR TEMPERATURE AND HUMIDITY	5 CHART SPEEDS 3 TO 1700 CM/HOUR FOR 15 SOURCES ACCURACY ± 0.5%.	LEEDS NORTHRUP IRELAND LTD., DUBLIN 5 IRELAND.	550	1
FLUE GAS ANALYSER	CO_2 TYPE	TO MEASURE CO_2 : O_2 TEMP. AND SMOKE NO. WITH EXTRA CHAINS	H.R. HOLDFELD LTD., STILLORCTAN DUBLIN 14, IRELAND	400	1
CLIP ON AMMETER		3-6000 AMPS 6-600 VOLTS AC 3-600 VOLTS D.C. CHART SPEEDS 20/60/240MM/HR	"	750	1

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
PHOTOMETER	-	0-2500 0-5000 LUX WITH FILTERS AND VISUAL CORRECTION	EAST KILBRIDE INSTRUMENTS SCOTLAND U.K.	200	1
PLANNED MAINTENANCE EQUIPMENT					
VIBRATION METER	SEISMIC	PORTABLE IN CARRYING CASE WITH PICKUPS ETC.	S.P.M. BOLTON ENGLAND.	450	1
TACHOMETER	DIGITAL	-	VARIOUS	250	1
HEAT DETECTOR	REMOTE INFRARED	DIGITAL READOUT ACCURACY ± 5° CELCIUS HAND HELD	VARIOUS	2,900	1
CORROSION TESTING EQUIPMENT					
CORROSION METER	PORTABLE	BATTERY OPERATED RESOLUTION 1000 DIAL DIVNS 1 DIVn = 1 MICRO INCH OUTPUT 50 MW INCLUDING PROBES ETC.	ROHR BACK INSTRUMENTS READING ENGLAND MODEL NO. PN 4300 CK3	3,500	2
CORROSION MONITOR	6 CHANNEL	RANGES 3: 0 - 1000 MPY ADJUSTABLE 0 - 100% F.S. 230 V 50 HZ 10 WATTS. OP. TEMP 0 - 50°C INCLUDING PROBES, ELECTRODES ETC.	" MODEL 1136 PN 113600/230	10,750	2

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
STRESS/STRAIN MEASURING EQUIPMENT					
STAIN GAUGE EQUIPMENT	MULTI POINT MEASURING SYSTEM	10 MEASURING POINTS 230V 50HZ SUPPLY ACCURACY ±0.2%	BRUEL AND KJAER NAERUM DENMARK MODEL NO. 1545A	3,700	2
PRINTER	ALPHA NUMERIC	FOR USE WITH MODEL NO. 1545 A	"	2,500	2
DRAWING EQUIPMENT					
DRAWING BOARDS, INSTRUMENTS, STENCILS DIAZO COPIER	-	3 sets	GENERAL SUPPLIER	6,500	1
DRAWING BOARDS, INSTRUMENTS, ETC.	"	9 sets	GENERAL SUPPLIER	8,770	2
FOUNDRY EQUIPMENT					
FURNACE	'BALE OUT' ELECTRICALLY FIRED	FOR ALUMINIUM BRASS AND ZINC. MS CASE CAST REFRACTORIES 30KW	STINCHCOME WALSALL WOOD ENG. TO MELT 90Kg AL.	6,500	2
FURNACE	TILTING CRUCIBLE	FOR AL BRONZE OR CI. CAST IRON CAPACITY 80Kg IN 105 MINS. /OIL FIRING.	"	13,500	2

MACHINE, TOOL OR INSTRUMENT	TYPE	PRINCIPAL SPECIFICATIONS	MANUFACTURER	PRICE U.S. $ - FOB SEAWORTHY	PRIORITY
FOUNDRY ACCESSORIES	SAND PREP.	POWERED SHAKERS, RIFFLE BOXES, SIEVES MOULDS BINDERS ETC. (ALLOWANCE)	-	5,000	2
	MATERIALS HANDLING				
FORKLIFT	2 TONNE	2 TONNE 2 METER LIFT PETROL ENGINE	HYSTER	5,700	1