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EQUIPPING OF LABORATORIES IN DEVELOPING COUNTRIES AND CRITERIA FOR EQUIPMENT MAINTENANCE AND PROCUREMENT 1/

by

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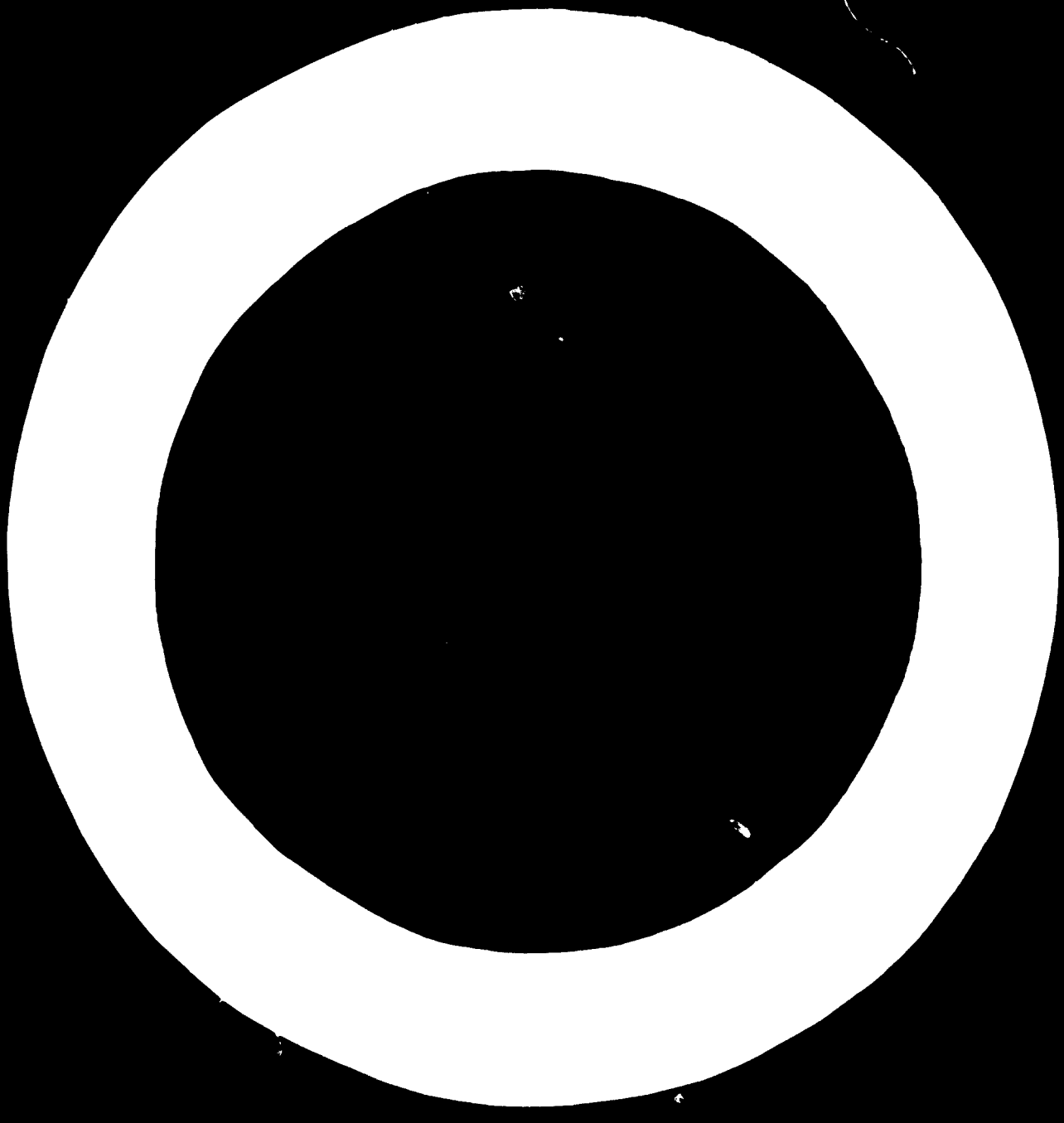


CONTENTS

SUMMARY

This paper describes the intricate problems faced by developing countries in selecting the most suitable equipment based upon the specific tasks to be performed in the institutes planned. Procedures are suggested for obtaining precise and complete equipment specifications. The importance is pointed out of selecting experienced equipment suppliers, who are able to provide technical assistance for equipment selection and installation and maintenance service. Examples of several such supplier-aided complete deliveries of laboratories for testing, research and industry are given. The need is stressed for operators to be properly trained, and also for the institutes to have attached to them fully equipped workshop facilities staffed by highly qualified engineers and technicians. Suggestions for improvements in purchase and delivery procedures are made, and the importance of good cooperation between the project and its supplier is pointed out.

I. INTRODUCTION

With today's continuous advances in technology the equipping of laboratories, particularly in developing countries, has become an extremely difficult and multifarious task. This paper, presented at the Expert Group Meeting on Building and Facilities, Design and Lay-out for Industrial Research and Development Centres, organized by UNIDO, is intended to contribute towards finding practical solutions by describing the problems and the role the suppliers of the equipment can and should play.

The author is Managing Director of a company which has, for more than 25 years specialized exclusively in equipping laboratories in developing countries all over the world. His personal activities in this field extend over more than 20 years, out of which he has resided 2 years in Iraq and 11 years in Pakistan. This extremely close contact with the problems faced by scientists in developing countries, the company's worldwide activities, and many visits to other countries in Asia, Africa and Latin-America allow him to draw on a considerable amount of experience in this field.

II. SELECTION OF EQUIPMENT

Any new research institute or laboratory requires in its initial stage of planning a clear definition of its intended activities. This must include detailed specifications of immediate and future extent and volume of work to be performed, and a list of staff members needed.

These particulars are essential for any effort towards the selection of equipment, which not infrequently dictates special building design and lay-out. It cannot, therefore, be over-emphasized that the selection and specification of laboratory equipment together with space requirements for all departments (including flexibility for future expansion), and adequate planning for supporting sections such as workshops, photographic darkrooms, pilot plants, lecture and meeting rooms, libraries, administrative offices, staff facilities, etc., should always precede or at least go hand-in-hand with building design.

It goes without saying that it is almost impossible to submit a so-called "standard equipment" for any industrial testing, research or development centre. The only exception to thie is perhaps an absolutely insufficient "basic minimum outfit" with no specialized equipment, which no scientist anywhere has difficulty in compiling without much effort. Tasks to be performed in such laboratories vary considerably from country to country.

Specialized equipment, therefore, has to be carefully selected and provided with the correct accessories to meet the requirements of the intended laboratory procedures.

National and international agencies, extending support to developing countries, usually employ experts on a short-term contract basis to advise in the selection of equipment. Although this system has proved to be successful in many instances, one drawback to it may be pointed out. The short association period of the expert with a particular project and his possible lack of experience of local conditions may not allow him to realize, in connection with his equipment recommendation, the many intricate problems involved in the operation and maintenance of sophisticated instruments, or the difficulties in regularly obtaining operating supplies for them.

Developing countries, as in many other ways, have very similar problems with the local availability of laboratory supplies and equipment, technical assistance and maintenance services. The limited overall marketing potential, and large variety of laboratory and scientific instruments available from hundreds of suppliers and manufacturers, make it in general economically impossible for local businessmen to establish stocks or to maintain qualified service engineers. This situation in many countries is aggravated by foreign exchange and import restrictions, which often do not even permit the commercial import of spare parts. As a result, scientific laboratories in developing countries cannot, or can only to a limited extent, find local technical assistance. The institute, therefore,

has to rely on the support and cooperation of suppliers situated thousands of miles away; who are in other words, not available at a telephone call's notice.

Several conclusions are to be drawn from this situation. Before selecting any equipment a careful study should be made to determine:

1. Which of the many possible suppliers and manufacturers of suitable equipment maintain local representatives or technical offices capable of providing installation and maintenance services.

2. What experience do potential suppliers have in dealing with special situations in developing countries (e.g. servicing, climatic, administrative, and other local conditions).

For the benefit of the scientists who have to work with the equipment procured, suppliers should, therefore, be subject to a pre-qualification before their equipment is selected.

One further very important conclusion to be drawn is that equipment specifications must be prepared very carefully and clearly. There are countless examples where lack of detail in such specifications has led to the receipt of incomplete or unsuitable apparatus. It must be understood that supplementary equipment or accessories, if not specified will not be quoted for in the suppliers bid.

It will be observed that most brochures or catalogues published by equipment manufacturers give only general information without complete order specifications. A selection based purely on such literature will necessarily lead to misunderstandings: no indication is normally given about essential accessories not included in the basic instrument, optional accessories with explanations for their particular application, or essential operating supplies and recommended spare parts.

Scientific Institutions in developing countries have often had the experience that because of insufficient specifications, or of lack of experience on the part of the suppliers, they were supplied with, for example, testing machines without specimen clamps; a vacuum drying chamber without a vacuum pump or at least without the parts connecting the two pieces of equipment; a manometer without mercury; a thermostatable cell compartment of a spectrophotometer without a thermostat; or a distillation apparatus without stand, clamps, tubing etc. This list could be continued indefinitely.

While the supplier could usually expect the non-specified equipment to be already available, the scientist in the laboratory has to suffer painful and annoying delays in putting the equipment into operation. New orders have to be processed and up to 12 months may be required to obtain the necessary additional supplies.

Most manufacturers restrict their supply to the parts they produce in their own works. They are used to the situation within their own country where minor accessories such as stands, clamps, tubing, glassware, and even the small instruments like pH-meters, balances, and thermostats commonly found in any laboratory are either available or may be quickly obtained from a local dealer. When dealing with developing countries, this is, of course, frequently a wrong assumption.

It can, therefore, only be stressed again that every effort should be made to establish precise specifications in order to ensure the correct and complete supply of equipment.

Large laboratory supply companies can in general offer a more comprehensive range of supplies, better than an individual manufacturer, as they have in their delivery programme the full range of instruments and auxiliary equipment.

The company represented by the author of this paper, for example, has published a comprehensive laboratory equipment catalogue, comprising 1300 pages, that has been specially prepared for scientific institutions in developing countries. Unlike catalogues which have been written primarily for use in highly developed domestic markets, this catalogue is based on many years of experience and the equipment specifications have been prepared to give complete performance data and particulars

of the basic outfit, its essential and optional accessories, supplies and spare parts. The main objective has been to provide absolutely complete instruments ready for operation. For the convenience of users, the instruments offered are in many instances pre-selected equipment combinations, consisting even of items taken from different manufacturers. A score of cross-references and other useful hints have been incorporated in order to assist users in making their selection and to avoid the need to ask for otherwise essential clarifications.

Another advantage offered by the large laboratory equipment supply companies is the economy gained by dealing with only one single source rather than having to deal with a large number of individual manufacturers.

Service facilities for installation and maintenance of the equipment can also be coordinated and provided much more easily by a larger organization, such as that of an international laboratory equipment supply company. If experts have to be deputed for each individual piece of sophisticate equipment the expense will be prohibitive.

The company just referred to above has again set an example in this field by establishing technical service offices in currently 10 developing countries, staffed with their own highly qualified factory trained engineers, and operated in cooperation with local businessmen. The criteria for maintaining these technical offices must necessarily be a regular volume of business, made possible only by the comprehensive range of supplies and the many advantages

such an organization can offer to the scientist. In developing countries, where the company does not have permanent offices, service and maintenance for any specific project handled are provided by visiting engineers. Follow-up visits are made at regular intervals.

The fact ought not to be overlooked that sophisticated apparatus will require special training for the operators. Engineers performing the installation will provide basic operational training. Depending on the experience of the scientist who is to work with the equipment, a more far-reaching programme of training may be necessary, which cannot be imparted by the engineer in the field. In such cases special training programmes should be arranged at the factory, or at a recommended scientific institution, preferrably before the equipment is delivered. Such far-reaching training programmes can, of course, be arranged through the supplier, but the extra expenditure involved in travel, accommodation and possibly other fees should be supported out of the project funds. This very important aspect of development assistance is a suitable field of activity for international aid organizations.

Within the scope of the subject under review the following interesting yet economical approach to the selection of equipment should be dealt with. The company represented by the author of this paper has offered a unique advisory service for developing countries for many years.

Based on the essential facts pointed out at the beginning of this chapter, advisory assistance has been enlisted by the company from leading German scientists working in newly equipped institutions. Strictly following their recommendations, and bearing in mind service and maintenance aspects, proposals for complete laboratory outfits are prepared and made available to the project leader and his colleagues without charge. The proposal serves as a guide to determine final requirements and to complete the selection of equipment. Any changes desired by the scientists involved in the project are incorporated with the concurrence of the scientist who has provided the original recommendation. The most important point here is that the company, knowing both the conditions in the country where the institute is to be set up - and the possible lack of appreciation of these conditions at the source of supply - plays a very important role in coordinating and supplementing final specifications.

A few projects executed in this way may be named as follows:

Pakistan Council of Scientific and Industrial Research

Coal Research Laboratory. Under this project a German laboratory technician was delegated to the laboratory for a period of 2 years.

Pharmacological Research Laboratory

Institute for Glass and Ceramics Research

Leather Research Laboratory (at Dacca, now Bangla Desh)

Paper Research Laboratory (at Dacca, now Bangla Desh)

PAPER PILOT PLANT (at Dacca, now Bangla Desh)

University of Valparaiso, CHILE

Department of Chemistry

University of Teheran, IRAN

Faculty of Veterinary Medicine

Agricultural Test Station, Karadj, IRAN

Acos Finos Piratini S.A., Porto Alegre, BRASIL

Complete Test Laboratory for a Steel Plant

Sugar Test Station, Parusuan, INDONESIA

Cane Sugar PILOT PLANT

Secretariat d'Etat à L'Hydraulique, Kouba-Alger, ALGERIA

Equipment for a Complete Institute for Land Surveying and Mapping, comprising Geodesy, Aereal Mapping, Cartography and Map Printing.

This German Marks 7 million project is still under execution. The Ministry of Water Resources in Algeria had published in 1971 a project for planning and equipping an Institute for Land Surveying and Mapping. The proposal prepared by the company's own experts, aided by recommendations of expert scientists, was selected as being the best amongst a number of international bidders. The proposal was supported by a complete organization plan for the entire institute. It suggested methods of work, offered the neccssary equipment and submitted a complete training programme for the entire technical cadre of the institute. By now 50 Algerian technicians have been trained, 2 departments have started operation, and higher staff are still under training. The institute will become fully operational during 1975.

III. EQUIPMENT MAINTENANCE

In the following chapter the author would like to emphasize a particular aspect of equipping laboratories in developing countries, namely the incorporation of fully equipped electrical, electronic, and fine-mechanical workshops. In institutes equipped with perhaps millions of dollars worth of instruments, some very sophisticated, a well equipped workshop is an absolute must. Even more important is the recruitment of highly qualified staff for these workshops. It has frequently been observed that the grades fixed for the workshop section heads only attract ordinary technicians. Considering the fact that very expensive and highly technical instruments must be handled, it is not far-fetched to suggest that only qualified engineering graduates should be attracted to these jobs, both by status and pay. Their status after training and qualification in instrument maintenance should perhaps compare to that of an assistant head of a laboratory department, if not to that of the department head. Training courses in instrument maintenance should be arranged in suitable educational institutes, or abroad under the support of international organizations such as, for example, UNIDO. Suppliers of equipment will also provide training facilities on specific instruments available in their own laboratories.

It is obvious that the investment, both in workshop equipment and in well trained and qualified personnel, will pay for itself, considering the fact that any maintenance service performed by the supplier's engineers, beyond a guarantee period, will have to be paid for.

Equipment should be initially installed by the supplier and maintained for a certain guarantee period, which does not usually exceed 12 months after shipment. Many manufacturers may not even be ready to offer these facilities, because of their inability to provide any technical assistance in the country of destination. However, equipment might not be maintained after the guarantee period, because quite often it can be found that scientific institutions do not have a budget to pay for instrument repair.

Under such circumstances it seems quite fair to suggest that a certain percentage of the original purchase price should be set aside annually into a fund for the service and maintenance of the equipment; a practice which, although quite normal with respect to the institute's cars, is often overlooked when it comes to equipment maintenance.

It must be pointed out that a well equipped workshop facility can produce many special devices and instruments for the various departments of the institute. Last but not least it might be mentioned that the workshop of scientific institutions have been the cradle of quite a number of today's most well-known manufacturers of scientific equipment.

A final remark may be permitted on the subject of instrument maintenance. For reasons of economizing in the running expenditure of research centres it may be thought in developing countries, that air-conditioning systems can be dispensed with. Much more than the human being, who has

learnt to adjust even to adverse climatic conditions, sophisticated electronic or electron-optical and analytical instruments require protection from heat, humidity and dust. Building design must provide these facilities. Sophisticated instruments also require an emergency generator to supply electricity in case of power failure or fluctuating current supply.

IV. CRITERIA FOR PROCUREMENT OF EQUIPMENT

Procurement rules demand, almost everywhere, that the cheapest offers must be accepted. Applied to the purchase of scientific equipment strict observation of such rules may turn out to be the most expensive way of equipping a laboratory.

It will already be clear from the explanations given in the preceding chapters that precise specifications are a good means of obtaining correct and reliable offers. Only such offers allow a just comparison of the scope of delivery and the prices of different bidders.

In order to obtain an undistorted picture of comparative data, only technically experienced and commercially capable manufacturers and suppliers should be invited to submit offers. A suitable pre-qualification procedure is highly recommended. Thereby only a limited number of tenderers is selected, consisting of such firms who can satisfy every requirement as to quality, experience in handling comprehensive supplies, reliability in connection with delivery schedules, technical assistance and maintenance service. Such pre-qualification may even lead to individual firms being selected as suppliers for entire laboratory outfits, whole equipment lots, or specialised instruments on a proprietory or single tender basis.

Invitations to bids should always give clear indications of the currency and of the terms on the basis of which offers are to be submitted, i.e. if individual prices are to be quoted ex-works, fob port of shipment, caf or cif port of destination; if shipment is desired by air or sea; and whether or not the cost of packing must be included. It may be pointed out here that American firms have a different interpretation of the term "fob", (literally : free on boardship), from European suppliers. The latter strictly observe the correct definition of the international INCO-Terms, whereby fob-prices include cost and all charges of delivery including packing up to "on board ship" in the seaport or airport of shipment. In the United States "fob" is normally understood as fob factory and such prices do not include packing, inland freight, loading charges, documentation and export handling, which are charged seperately.

Any deviation by a bidder from such terms laid down in the tender invitation should make his offer liable to be ignored, as it may have been intended to obtain a superficial advantage in price comparison only.

A careful technical scrutiny of the specifications given in a bidder's offer, and a comparison with the illustrated literature attached to the bid, will in many cases eliminate quotes which only at first glance look cheaper in price. Accessories may have been purposely left out to gain an advantage over other bidders. Sometimes minor but important differences in performance data cause considerable price differences.

National and international aid-giving organizations for many years have followed the practice of requesting offers from original manufacturers only, demanding that any commissions usually allowed to agents should be offered as a discount. Orders were then quite frequently placed with such firms who readily accepted this demand, but had neither experience nor any agent in the country to which the equipment was shipped. The disadvantage of this procedure was painfully felt by the scientists in the developing countries, who were denied the benefit of any kind of technical assistance.

The realization that full consideration must be given to all aspects of equipment supply, and the fact that administrative setups continue to become more and more expensive have, meanwhile, caused most purchase offices to prefer dealing with fewer comprehensive orders rather

than with a score of individual equipment orders split up among many manufacturers and suppliers. Economy in paper work is a useful method for reducing overall expenditure on a project.

When comparing price quotations the offer of an international laboratory equipment supplier may occasionally be found to be more expensive than that of a manufacturer. In such cases it can only be recommended that the experience and after sales service capabilities which may have been incorporated in the offer should be duly considered.

One of the aspects of equipment purchase which causes problems at times is the too short closing date given for the submission of offers. It should be realized that large lists of specifications having been prepared for the project over an extended period of time, cannot normally be quoted for in a space of only 2 or 3 weeks. A supplier frequently is allowed only this period when delays in mail before receiving the inquiry and on submitting the bid are taken into account. The quality of offers could be considerably improved if more time were to be allowed.

Decisions on bid acceptances should not be delayed beyond the normal validity of offers, particularly at the current time, as worldwide inflation necessitates frequent adjustment of prices.

Another serious problem usually encountered in the delivery of equipment is that of damage in transit and the insurance covering such risks. Extensive transport damage,

occasionally even total loss, often is caused by extremely rough handling of consignments in ports where no mechanized means of moving cases, such as fork-lift trucks etc. is available. Considerable delays in clearing consignments through customs, thus leading to congestion of ports, make the existing sheltered storage facilities absolutely insufficient. It may very well happen that cases containing expensive equipment are subjected to the most adverse climatic conditions such as humidity, heavy tropical rains, extreme heat, and dust. No economically justifiable method of packing can prevent damage to equipment under these conditions.

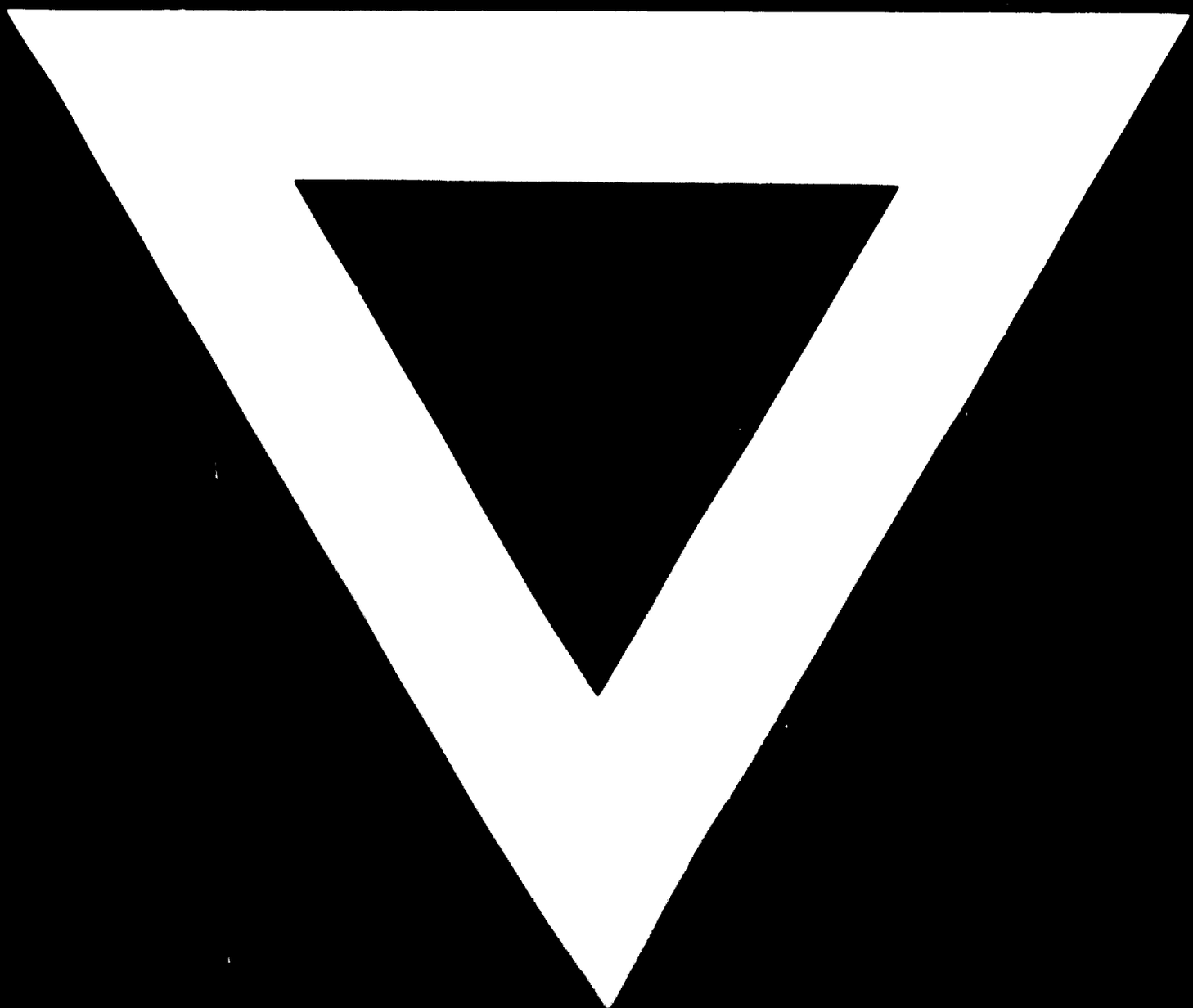
As a result of often unavoidable delays in receiving the deliveries at the laboratory building, caused by customs formalities and administrative delays in having the consignments unpacked and examined, insurance cover in many instances has already expired by the time a claim could be looged. More time and effort is usually spent on the question of responsibility for the damage suffered, or for the insurance cover not having been extended, rather than on how such damages could be prevented or how facilities could be drastically improved. It is felt that an international effort by any suitable organization should be made to solve this problem. For any one investigating this situation it should appear obvious that the amount of reduction in damage or loss would pay for the necessary investment in a very short time.

A further suggestion may be added here. Replacement parts required to repair transport damage should be obtainable with a minimum of delay and administrative red-tape. Researcl

and development centres should, therefore, be provided with the authority to place small orders directly with suppliers. A system as practiced by the FAO with so-called field purchase orders or by UNESCO by means of UNESCO COUPONS may be pointed out as examples.

Such purchases are usually limited in value for a single order and for a total yearly budget, but are quite sufficient to obtain emergency supplies, even of small devices or chemicals, without which the work in hand could not be continued.

With or without such emergency order facilities the scientists usually depend on and prefer cooperation with the experienced and much more flexible supplier, who is in regular and not sporadic contact with his customer, who extends unbureaucratic help, providing even if necessary free replacements and repair facilities in order to contribute to what is after all, the prime objective of all effort in the establishment of a scientific institute: useful and effective work and uninterrupted operation.



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