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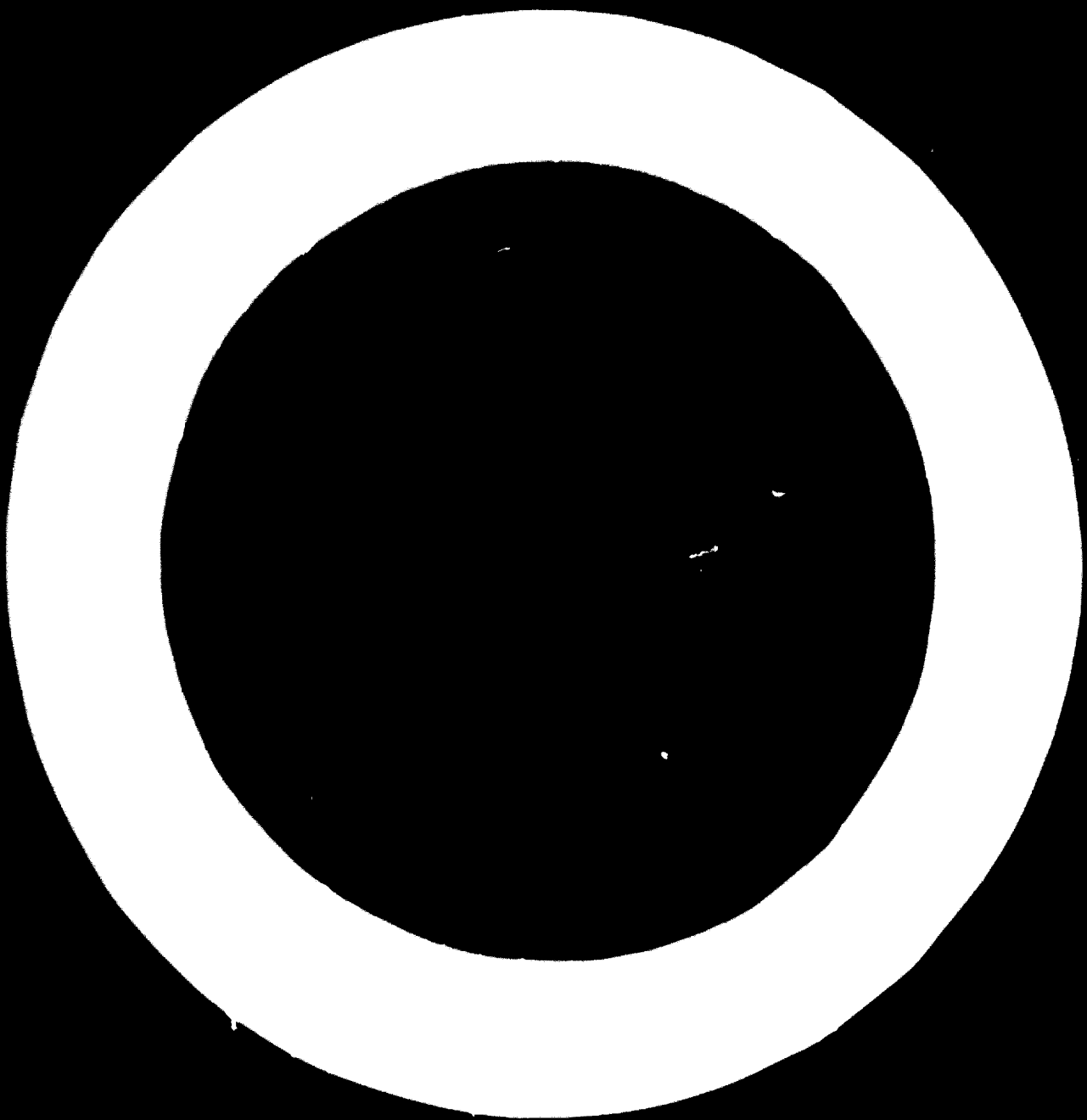
INDUSTRIAL RESEARCH IN AFRICA

(Note by the secretariat)



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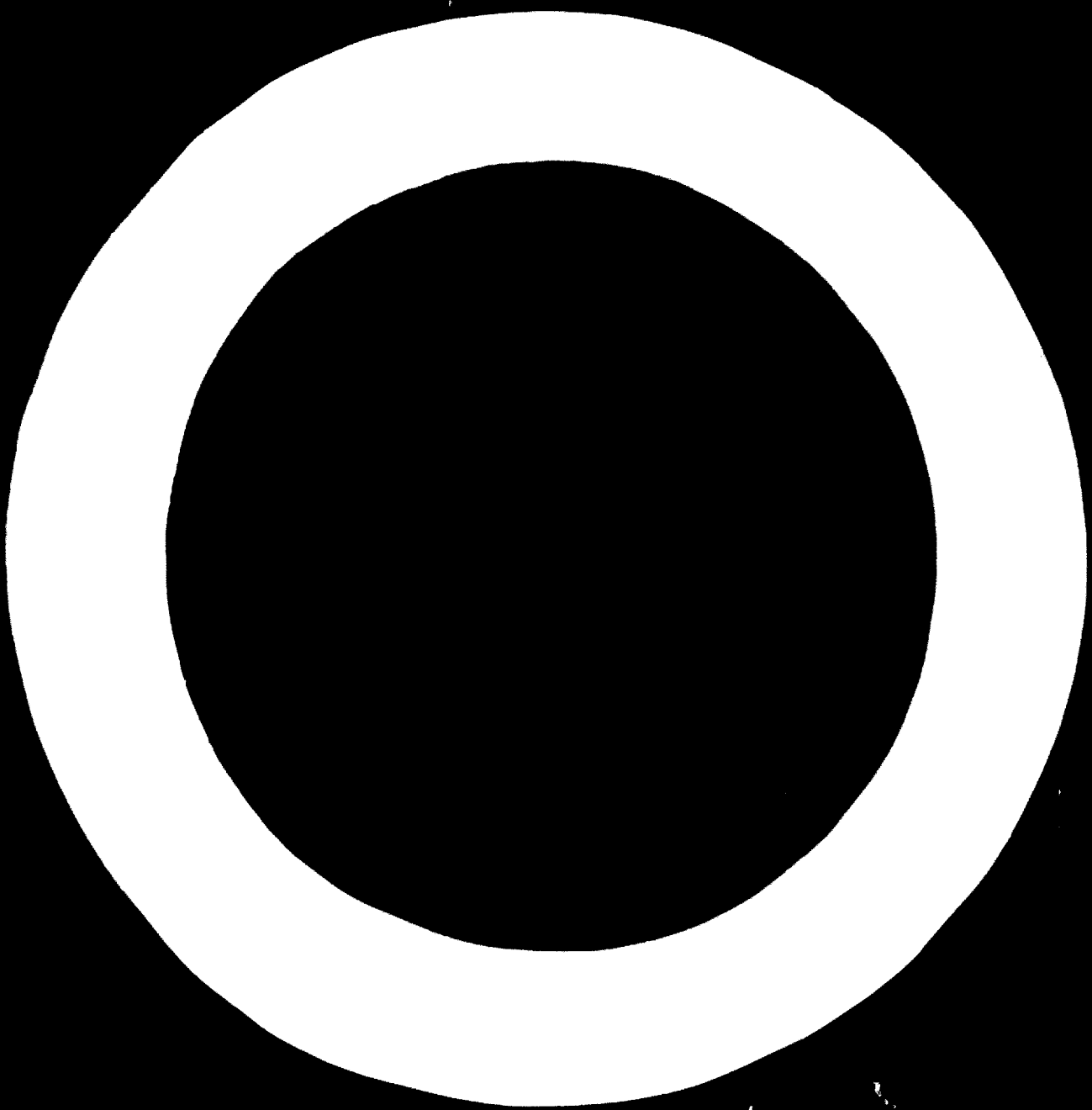

CHAPTER I

INTRODUCTION

1. The Standing Committee for Industry, Natural Resources and Transport of the Economic Commission for Africa at its second session, held in December 3 - 13, 1963, considered a report (E/CN.14/INR/41) on Institutes of Industrial Development and Research on sub-regional basis for Africa, based on a study of needs in selected countries in Africa by a consultant from the United Nations Centre for Industrial Development in New York.

2. This study discussed in broad and general terms the role of science and technology in development and, in particular, the development of industry in the new countries of Asia and Africa. It examined in some specific detail the urgent need for African countries to establish local centres of technology which would draw in the specific know-how from developed countries, make such adaptations as are necessary for local conditions and circumstances, carry out research into raw materials and processes in order to develop new uses for indigenous materials and new products, disseminate the imported and created know-how to industrialists and entrepreneurs, and offer direct technical services towards obtaining more efficient operation and management of both new and existing industrial ventures in these countries. It was rightly argued that these functions and services are essential if industrial development is to be accelerated at the rate desired and hoped for in African countries.

3. The objects in broad terms were "to aid in the development of selected natural resources which require research, in the establishment of new industries, and to render technical and engineering assistance to existing industry to improve its products, processes and economic status". In order to achieve these objects an industrial research and development institute would require a staff of scientists with high academic background in the physical sciences and engineering besides extensive and varied experience in industrial technologies, costly equipment and other facilities. Developing countries in general are, however, faced with acute shortage of scientific personnel and scientists with the experience

and qualifications described earlier are scarce even in the more advanced countries and, when available, are expensive. Consequently, even the cost of operation of a modest unit with the minimum staff required to undertake effectively the range of services described was outside the financial resources of most countries in Africa. The sub-regional institute was therefore suggested as a means of overcoming both the problem of scarce personnel and the funds necessary for this essential institution of industrial development.

4. The Standing Committee, in consideration of this report, made the following points in the discussion:

(i) "It was generally agreed that there was danger of research institutes concentrating their activities too much on theoretical research; the main emphasis should be on applied research closely linked with industrial development.

(ii) A distinction should be made between full scale industrial research institutes and smaller scale centres concerned with applied research and development.

(iii) The sub-regional approach suggested was one possibility but careful consideration should also be given .....to smaller industrial development centres mainly concerned with and to serve individual countries".[1/]

5. These points endorsed fully the thesis presented that applied research and adaptive research are the greater need for African countries. On the other hand, and while accepting that the scope and functions assigned for an institute of industrial development and research, are necessary to ensure that plans of industrialization of a country are properly formulated and implemented with the least delay and minimum failures, there was tacit reluctance to giving unqualified support for the sub-regional approach. A multi-discipline integrated industrial research institute preferred in

1/ United Nations Economic Commission for Africa, Report of the Second Session of the Standing Committee on Industry, Natural Resources and Transport (E/CN.14/245, E/CN.14/INR/54).

that report confers many advantages to the country in which it is sited. The other countries served by this institute will not have even a nucleus or centre to which local industrialists can turn for direct assistance. The geographical distances between the only centre of technology and the industrialists in countries other than the country in which it is situated may often be too great for consultation. These real difficulties necessarily limit the use of the research institute by the associate countries, while the country in which it is situated will increasingly use its services. Since distances and cost of travel inhibit effective consultation and development of research market, the needs of these countries will also not be known and would in course of time be neglected. These fears perhaps led to the belief that even a centre with limited scope and resource in one's own country was better than a full-fledged multi-discipline sub-regional institute elsewhere.

6. These thoughts found expression in the final recommendations of the Committee, which required the Executive Secretary of the Economic Commission for Africa, in consultation with the United Nations Commissioner for Industrial Development and interested countries, to carry out further investigations on the establishment of such industrial development and research institutes on a national or sub-regional basis. A technical adviser of the Centre for Industrial Development visited selected African countries during July and August 1964, to develop information and discuss preferences in order to lay out an action programme for institute development that could be jointly undertaken by the appropriate members of the United Nations family and the countries of Africa.

7. This latter study, based on discussions with public officials and those of other development institutions in several countries, came to the conclusion that in spite of the acute shortage of scientific personnel that is prevalent, a start towards providing even the most meagre industrial research facilities should be made. It suggested that many countries have a nucleus of industrial research effort in the form of testing laboratories, food processing institue, government departmental laboratory, project evaluation centre or even the science laboratories

of a national university and that on this nucleus could be built the beginnings of an industrial research effort. Emphasis was placed on the dictum that a start now, albeit modest, is better than none. The study recommended that the Standing Committee authorize the Economic Commission for Africa secretariat and the Centre for Industrial Development, with the aid of consultants, to detail, country by country, the type and scope of in-depth studies needed to accomplish the amended programme of industrial research effort.

8. The present study follows on the two previous reports made in 1963 and 1964, incorporates the discussions, recommendations and conclusions reached at the Inter-Regional Seminar on Industrial Research and Development Institutes in Development Countries, held in Beirut, November 30 - December 11, 1964, re-emphasizes the need for urgent action in establishing centres of technology and provides a new approach to sub-regional institutes which permits specialised laboratories to be sited in a number of countries of a sub-region. Each laboratory will specialize in a field of industry or discipline, e.g., Food Technology, Textiles and Fabrics, Chemical Technology, Leather, Rubber, Plastics, Building Materials, and serve the whole sub-region in that particular field. All the units in a sub-region will, however, come under the over-all control and direction of a Council, which will determine the research programme and priorities for each laboratory. The study proposes concepts capable of general application.

CHAPTER II

CONCEPTS OF INDUSTRIAL RESEARCH AND THE NEEDS OF DEVELOPING COUNTRIES

9. Research, until the 17th century, referred to any studious inquiry or examination in any field of knowledge. Since the advent of science and the clear recognition of the fundamental principles of scientific method in which experimentation is coupled with both inductive and deductive reasoning, research has become almost synonymous with scientific research.

10. The objects of research may appear to be different from the viewpoint of the scientist and that of the rest of the community. Often there are divergences in objectives between the scientist working on fundamental problems in a university laboratory and another working in an industrial laboratory on problems that require practical solution. This has led to false distinctions between different categories of research termed background, basic, applied, adaptive, industrial and developmental, obscuring the fact that scientific method is the common factor in all such research.

Types of Research - Definitions

11. The definition of these different terms is provided by the Research Board of the US President. The main divisions are recognised - basic research and applied research. "Basic research includes fundamental research and background research, and is the theoretical analysis, exploration or experimentation directed to the extension of knowledge of the general principles governing natural and social phenomena. Background research is the systematic observation, collection, organisation and presentation of facts using known principles to reach objectives that are clearly defined before the research is undertaken, to provide a foundation for subsequent research or to provide standard reference data. Applied research is the extension of basic research to the determination of generally accepted principles with a view to specific applications, generally involving the devising of a specified novel product, process, technique or device.

Adaptive research is the adaptation of existing process, technique or device to suit special conditions prevailing. Finally comes the definition of development, that essential link between research and the industrial application of research results. Developmental research is related to work on an existing model, device, equipment, material or product process. Developmental research differs from applied research in that work is done on products, processes, techniques or devices that previously have been discovered or invented".

12. It is, however, accepted that scientific research is a broad spectrum shading from basic and background research at one end, through applied research and adaptive research, to development research at the other end. Industrial research is basic, applied, adaptive and developmental research undertaken with the object of application of results to industry.

Industrial Research

13. Industrial research is therefore not only concerned with exploiting fundamental discoveries made by basic research. It bases itself squarely on the accumulated store of knowledge, attends to the needs of the particular industry or industries it serves and through its work brings new manufacture a stage nearer. This may be simply an improvement of an existing process, but it may be an entirely new one and the product may also be new.

14. Industrial research has extended its scope to include the systematic study of industrial operations, the handling of materials and layout of the plant. And since it is concerned broadly with the economic efficiency of industry, it works to raise the level of productivity through the better use of resources human and material.

Type of Research to Meet African Needs

15. The functions implied in these definitions may be satisfactory in industrialized countries possessing high scientific infrastructure development, but may be inadequate to meet African needs where little or no

scientific or industrial tradition exists. In this context, the statement of the Secretary-General of the UN, on the UN Conference on the Application of Science and Technology for the benefit of less developed areas is of particular relevance. He stated, "First it is necessary to build centres of scientific and technological strength in the less developed countries. Second, it is necessary to focus more resources in the advanced countries on science and technology for the benefit of the less developed countries. Third, it is necessary to make a judicious assessment of priorities ...."[1/] He further expressed the view that science and technology cannot be exported or "pushed" out from their habitat in the advanced countries, but that they have to be imported or "pulled" in for definite needs by the developing countries themselves. Such import of science and technology as was suggested can only be achieved through the centres of technology established in developing countries and effectively manned with qualified applied scientists capable of defining the needs of the country, acquiring the specific know-how, of adapting to local conditions and circumstances, and of disseminating this knowledge in the form suggested by adaptive research. This same conclusion was reached by a Working Group on Science and New Developing Nations at Stanford Research Institute.[2/] Their initial approach was to consider the needs of developing countries in terms of scientific discoveries and technological inventions which might benefit them significantly. This "needed breakthroughs" approach was examined area by area only to lead to the conclusion that sufficient knowledge is already available on many of the areas needed in the developed countries and that lack of available science and technology was not the principal problem. The major problem is that the world reservoir of existing knowledge is not being adequately drawn on by the developing countries.

1/ Thirty Sixth Session of the Economic and Social Council; Press Release No. ECOSOC/1588, 8 July 1963.

2/ Scientific Research and Progress in New Developing Countries, by E. Staley and D.C. Fulton. Stanford Research Institute, 1961.

Borrowing Known Technology

16. There are, however, particular limitations to borrowing known technology from advanced countries, although a large reservoir of such knowledge exists and awaits drawing upon. Most of the developing countries are in or near the tropics, while all of the developed countries are in temperate zones. Consequently, the technologies available are for adoption in the temperate areas and cannot be transferred in that form directly to tropical conditions. Also, the developed countries have abundant capital, skilled industrial manpower which is scarce and expensive, while in the developing countries there is abundant labour, inexpensive though unskilled, and scarcity of capital. The industrialized countries therefore base their development and consequently their research effort on labour saving and capital intensive processes and techniques. The developing countries, on the other hand, with abundance of labour and scarcity of capital, would require techniques and processes which use comparatively larger labour and smaller quantities of capital. In particular cases, therefore, the use without the necessity adaptation required, of the results of research or of technology developed in the industrialised and advanced countries can even be harmful.

Adaptive Research

17. It would therefore be apparent that in the transfer of techniques and know-how from an advanced to a less advanced country, some adaptive research will be required. In many cases the extent of the adaptation may be minor, while in others considerable changes in design and process may have to be effected to suit local conditions. Adaptive research is particularly useful in developing countries, as it not only provides a means of drawing upon the reservoir of existing world knowledge, but in the process also improves on it from the standpoint of suitability for particular needs or conditions. Some of the changes involved in adaptation are:

(a) Modifications necessary because of variations in properties of locally available or substitute raw materials;

(b) The difference in relative availability of capital and skilled labour,

(c) Modification of a process or operation to a scale (generally smaller than considered economic in developed countries with large markets) imposed by smaller local market conditions;

(d) A series of combinations of the above and of such factors as scarcity of foreign exchange available for import of capital goods; and modifications to machinery design.

Japan achieved considerable success in this area in their initial phase of industrial development some 40 years ago and demonstrated that considerable industrial development can be achieved using imported technology and adaptive research. The importance of adaptive research cannot be over-emphasised and this activity deserves the greatest emphasis in countries in the early stages of development.

Processing Research

18. Adaptive research alone would not meet the requirements of the new countries in Africa. The economies of African countries are largely dependent on agriculture and mining. Very few products are exported in the form in which they are harvested from the land. Some processing is almost always necessary, if only for preservation and storage. The degree and control of processing undertaken in the country also determines its quality and value. In mining, problems of beneficiation, refining, purification, preliminary processing to raise quality of ore and reduce impurities, might present themselves. Consuming countries of these export materials are also the industrialized countries. Their interest in these primary materials is at the lowest cost for conversion into manufactured products, and they are therefore unlikely to have mounted research programmes to improve the economic value or to develop new uses for these materials. Consequently, new knowledge on improved processing or new uses will not be available from the reservoir of knowledge and, unless generated within the country, will result in a number of resources, both

agricultural and mineral, either obtaining uneconomic returns or being under-utilized. Overcoming this economic handicap by providing processes and techniques for improved export processed materials and finding new ones is the domain of applied research.

Basic Research and Applied Research

19. Basic research, which is undertaken more with a view to contributing to new basic knowledge in science and less to financial or economic rewards, has long been thought of as a higher order activity than applied research, which is expected to provide new knowledge principally in the technologies and the application of which provides new wealth. While the subject has been vehemently debated with the university dons all in favour of basic research and of total exclusion of the money oriented applied research, the planners, economists, politicians and industrialists in most countries, and particularly the newly developed countries, have, however, demanded that research should be directed towards meeting established and planned needs of a country. They have emphasised the urgent need for increased production and creation of new wealth through industrial, agricultural and mining development. This supports the view already emphasized earlier in the 1963 report and reconfirmed in the deliberations of the Beirut Seminar that applied research, including developmental research, is the greater need. This does not exclude basic research which has been described as the fountain of knowledge. In fact, some basic but oriented research will be necessary, in order to make breakthroughs in applied research, and given the necessary manpower basic research should also be given pride of place. With the severe limitations of scientific manpower and funds that exist, considerable benefits and early development can be achieved through the preferential utilization of scarce funds and scarcer personnel in adaptive and applied research.

20. The objects of industrial research are to provide the technology, adapted and/or created, required for industries in existence and planned for the future and to provide the reservoir of systematized knowledge regarding raw materials, by-products, waste-products and other resources.

It provides these through a spectrum of research services such as background, basic oriented, applied, adaptive and developmental research,

Variety of Services and Scarcity of Funds

21. Such research, to be effective in new development, will have to be undertaken in a wide range of industrial fields and these will necessarily include food processing and manufacture, mineral processing, production engineering, chemical technology, forest products, fibre technology, building materials, rubber and plastics, leather and footwear, to name only a few. To this already overburdened responsibility have been added other necessary services in developing countries, such as industrial extension, consultation with industry and trouble-shooting, industrial testing and standards, and feasibility studies.

22. These are essential needs in Africa and some mechanism will have to be found to meet these needs quickly. The complexity of the problems involved in providing these services will be seen from the gross inadequacy of funds and personnel available by a comparison of expenditure in developed countries with those of the developing countries. The annual expenditure in scientific research per capita in USA is $78.40; in UK, $35; in France, $27, and in Poland, $9, while in the majority of developing countries the corresponding expenditure is only $0.10 to $0.30. The need in developing countries is great and they are severely limited in both the financial and human resources in mounting the necessary research facilities.

23. Considerable economies in resources, through efficient organisation, judicious choice of research programmes and priorities directly linked to the sub-region's development programme, will be required to bridge the inexorable gap between need and available scarce human and financial resources. These aspects have been examined in some detail by the Beirut Seminar and their conclusions will be reviewed before presenting the recommendations for the sub-region.

CHAPTER III

BEIRUT SEMINAR ON INSTITUTES OF INDUSTRIAL RESEARCH AND DEVELOPMENT

24. The United Nations inter-regional seminar on this subject, held in Beirut, November 30 - December 11, 1964, with participants from 24 developing countries in Asia, Africa, Latin America and the Middle East, deliberated on the concepts and objectives of industrial research, industrial extension services and organizational problems, surveyed the problems and evaluated the experience in the participating countries and made specific recommendations as a guide to countries establishing such institutes. These recommendations and conclusions are of special significance to countries of the East African sub-region and are therefore reproduced as an Annex to this paper.

Concepts and Objectives

25. Industrial research, it was averred, is of basic significance in laying the foundation of a sound industrial base and in accelerating the economic growth of countries. It was the considered view that, while industrial research should not be involved in the executive functions of government, it does and should play a supporting role in the formulation and implementation of national policy and economic development plans.

26. The institutionalization of industrial research was considered to be one of the most effective means of promoting industrialization in developing countries, and it was emphasized that investment in industrial research should be recognized as an investment in industry and even in the future of the nation. It was noted that developed countries were spending as much as 2 per cent of their large national incomes on research in order to maintain and develop their economies, and that this large expenditure was considered necessary and essential by these countries. It was recognized that, while the developing countries may not be able to afford this order of expenditure, a minimum investment in industrial research of 0.1 per cent of G.N.P. was essential for the development these countries desired. This low investment would entail strictest economy in use of manpower and funds and new countries were advised to exercise

the greatest care in the selection and formulation of projects and to emphasize applied or adaptive research in preference to basic research, in order to obtain the greatest benefit from the use of their scarce resources in scientific men and money.

Functions of Industrial Research

27. The basic functions have already been discussed earlier in general terms under Chapter II, and the participants in the seminar spelled these out to include discovery of new products; prospecting for and utilisation of raw materials; development improvement or adaptation of production methods, techniques, processes or equipment; pilot plant trials; formulation of standards; quality control and testing; industrial extension and promotion; information and technical dissemination; marketing research; preinvestment and feasibility studies; choice of technology; and research training.

28. It was further underlined that industrial research should cater for all types of industry, regardless of size, public or private, and should develop technologies to suit local needs and conditions. Mention was made of separate organisations for small-scale industries and in the context of the necessity to conserve both manpower and finance, it was unequivocally rejected on the grounds that problems of small industry and approaches and techniques for solution are no different from medium and large-scale industries. It was, however, felt that methods of extension and consultancy services should to improved and expanded to meet the needs of small industries operated largely by indigenous entrepreneurs, as indeed they should for larger scale industries.

29. The general concensus inclined to the view that industrial research institutes should offer those services which are required for the formulation, evaluation and implementation of industrial projects, both large and small. Such services include feasibility studies covering, inter alia, such aspects as markets, raw materials, plant location, capital requirements, production cost and profitability, besides consultancy services on design, construction supervision, experimental and initial stages of production, trouble-shooting, maintenance and management.

Organization

30. The organizational forms in developed and developing countries were considered and their experiences evaluated. The choice of form was, however, thought to be dependent on a number of factors, such as:

(a) The special needs of any predominant raw materials - agricultural and mineral - and accessibility to the centres of these productions.

(b) The type and scale of operations of industries existing and/or planned.

(c) The level of economic and industrial development and expected growth.

(d) The financial resources and availability of scientific and technical personnel.

(e) The scientific infrastructure that exists in the form of universities, technical institutions and government agencies.

31. Certain successful principles and procedures of organization, operation and financing, however, emerged, and these were particularly emphasized and recommended for adoption in new institutions to be established or in the reorganization of existing organizations. These can be briefly stated as follows:

(a) The most successful organizations for research are independent corporate bodies set up under an autonomous board or council vested with the powers and duties of the research institute.

(b) Government, or governments, has the responsibility and obligation to guarantee adequate financial support on long-term basis to ensure continuity, although ad hoc services to the private sector might yield a sizable income when industry has learned the value of research and the institute gained its confidence.

(c) Close co-operation should be cultivated with universities in order to bring about a free interchange and cross-fertilization of ideas. Basic problems may also, with advantage, be framed out to universities, but the primary responsibility for industrial research should rest with the institute.

(d) Industrial research institutes should maintain close working relationships with other research organizations, local and foreign, as well as institutions concerned with industrial development and finance, the government agencies for industrial policy and planning, and industries themselves. Some countries have closer ties between research institutes and financing organisations through inter-linked boards.

(e) The main deficiencies in existing organisations were poor liaison with industry, lack of adequate industrial extension and communication with industry, entrepreneurs and government agencies, inadequate training of indigenous staff, and the non-identification of research problems.

These last named aspects are essential pre-requisites for success and are therefore discussed in some detail in succeeding chapters.

CHAPTER IV

THE PROBLEMS OF TRANSFER OF TECHNOLOGICAL KNOWLEDGE AND INDUSTRIAL EXTENSION

32. The image of research in the minds of most people stops with discovery, but if a scientist only discovers he would not have contributed to world well-being. The applied scientist transforms a new discovery into a technology for producing goods. Technology thus created has little value by itself. It has to be used towards making a new, improved or lower cost product. Its use implies finding a sponsor or entrepreneur who will invest money, machinery, materials and men to produce new wealth. Technology has, therefore, to be sold. The function of selling technology and finding the markets for the products of both search and research is as important to the success of an industrial research institute as creating the technology itself.

Sources of Technological Knowledge

33. In the field of technology, the needs of users not only cover the most recent developments and modern techniques, but also the large body of knowledge already used elsewhere. The sources of this information are diverse. Books and journals only provide a small part of this information, and to translate even this to industrial practice requires both knowledge of the appropriate technology and expertise. This is understandable if one recognizes that treatment and diagnosis of various diseases are adequately treated in books and yet it would be considered insane for an average person to consult a medical library instead of a physician. The library is essential to an institute and is its most important equipment. It is the depository of scientific journals which disseminate scientific information in a precise form and of other books which deal with fields of technology and the scientific principles involved in general terms. No book published, however, gives you a blue-print of a factory or the detailed information which will enable a layman to set up a factory to suit particular conditions of a market, size, or of type of labour. The information that can be gathered from books of

practical value is therefore limited - although in the hands of a technologist with wide experience in a particular industry it has high value and purpose.

34. A good part of technological knowledge is largely unpublished and in the hands of technicians and scientists in the industry, in the skills of industrial personnel, and in procedures and practices in individual industrial enterprises. These, sometimes referred to as 'know-how', are rarely transmitted except by special agreements between concerns and, invariably, at a price. It includes also much of the written technological information of a specialized nature, such as patents, drawings, confidential and classified documents, specifications of materials in process and of end-product, etc.

35. The major and direct sources of technological knowledge still available are industry research institutes in advanced countries, machinery manufacturers, chemical manufacturers, independent consultants, international agencies of aid, and friendly governments. The 'pulling in' of this knowledge is by no means simple. It demands the capacity not only to acquire systematically, codify and document such information, but also to discriminate carefully with respect to what does need to be acquired and what should be avoided. This, then, is the first problem, and can only be overcome by a proper library and trained librarians and scientists to gather and sift the information and make it readily available in assimilable practical form.

Choice of Technology and its Adaptation

36. Some comments on the adaptation of technology have already been made. It is generally accepted that methods and procedures of operation and technology in the advanced countries should not be transplanted directly in the developing countries. A careful appraisal should be made to find more appropriate solutions to suit local environmental conditions of materials, markets and labour. The general problem of choice and adaptation can be broken down into two related problems:

(a) The choice among several methods on which reasonably complete information is available.

(b) The incorporation of changes in processes, machinery, equipment, procedures, and practices requiring technical work and re-design.

Choice of Technology

37. The problem of the choice of technology does not lend itself to easy solution. The choice is dependent on two factors - technological and economic. To evaluate the technological factor, several alternative designs of the plant, employing different processes, will have to be worked out in detail - which would involve accurate information on costs of machinery and equipment, materials and labour. This type of information is difficult to come by since channels of communication in the technological field are varied and full of obstacles. There is therefore a large degree of uncertainty involved in the choice.

38. The second factor is the economic appraisal of different technological alternatives. The choice may depend on the economic criteria which are given priority in a country, such as large employment generated per unit of capital, or lowest capital cost per unit of output, or lowest foreign exchange utilization. One or more of these factors may have to be taken into consideration and a choice may be easier if the experience in other developing countries on the technology becomes available. When such information is not available, it leads, in many cases, to a choice made on offers of machinery through salesmen, who are more interested in selling the most costly equipment than in the economic interests of the country. In many cases, the offers of machinery are for production levels very much in excess of the low market requirements of a country.

39. Different industries present a wide range of technological characteristics and while in some special cases such as the major chemical processes, there is no alternative to an up-to-date plant of minimum economic size using automated control, there are, however, a large range of industries which provide alternate, if not so up-to-date technologies more suitable for developing countries with lower skills, poor maintenance of machinery, smaller market and scarce capital. It is in the interests of developing countries to explore the latter possibilities

and this function of choice is an important activity of an industrial research organization.

Industrial Extension Services

40. The preceding paragraphs discussed the problems of gathering technological knowledge from the advanced countries, sifting such information, codifying it, and making the choice. The task is, however, not complete until the information is disseminated to those who need it or are seeking it, the transferred technology is used in local production and assisted through various services, such as trouble-shooting, testing, quality control, etc. The dissemination and associated technical services are termed industrial extension.

41. Several problems arise. First, the institute must identify the users of technology, the potential entrepreneur, and the existing industrialist in need of technology and other services. Second, it should establish liaison, render services even at lower than actual cost and win the confidence of the public it serves, the press and government. In order to stimulate the interest in technology and to bring to the country the availability of its varied services, the institute should make maximum use of various tools of extension, such as personal visits and contacts, demonstrations, training courses, in-plant trials, radio, press articles, exhibits and seminars, technical inquiry and answer service, field days, etc.

42. Industrial extension is of importance not only because it provides a means of direct technical service, but also because it brings to the knowledge of the institute the needs of industries and their live problems. Industrial extension is a dynamic activity and the institute, to be successful, should take the lead in industrial management and training for industry, in bringing handicaps faced by industry to the notice of government, in improving productivity, in assuring quality to the consumer by standards and testing, and generally in promoting industrial development. If efficiently carried out, it could be the most satisfying and acceptable function of an industrial research institute.

CHAPTER V

PROJECT FORMULATION AND SELECTION[1/]

43. The role of a national industrial research institue is that of active assistance to the nation in implementing its industrial plans and policies in all its phases. A sub-regional institute, or a number of specialized institutes under one sub-regional council, on the other hand, will be charged with this same responsibility, but for a group of countries. This responsibility it would discharge only if it provides the technology of the right amount and the right kind at the right time. Research should, therefore, be directed towards meeting established and planned needs of the country or countries a research institute serves.

44. Too many research institutes have failed to contribute to the economic well-being of the countries they served principally because of their poor selection of programmes for research. Often they considered research a superior intellectual activity, and one to which no one else except the scientific staff could contribute. They operated in an ivory tower, divorced from policy makers, planners and even the industrialists. Consequently, the projects did not always reflect the needs and a development of high scientific merit, which the scientists believed was going to revolutionize the economy, found no takers. The Industrialists consulted at this stage would point out several economic factors which had not been taken into consideration. The development had, consequently, no economic value to the country. The scientist usually retires hurt, feeling his development is not being utilized and the industrialist feels that scientists live in a world of their own and have no appreciation of mundane problems. Both sides may be wrong in their estimations of each other, but considerable time, energy and effort of highly trained and intellectual manpower have been misdirected in

1/ Formulation and Selection of Projects for a National Institute of Industrial Research by A.Sundralingam. Discussion Paper No.6, Inter-Region 1 Seminar on Industrial Research and Development Institutes, Beirut, November 30 - December 11, 1964.

relation to essential needs and this could have been avoided had prior consultation on the project been sought in the selection.

45. The developing countries with scarce financial resources need to harness their scientific manpower to areas and to solutions of problems which will bring immediate and sizable gains. Planners, economists and industrialists may not understand the language or method of science, but they know what break-through are necessary for the development planned and can also provide useful information on limits of cost, capital, quality and quantum. Scientists are expected to translate these into specific problems build in the economic factors, and work out techniques to provide a solution satisfying the limits set. Consultation is essential in order to determine essential needs and to identify the live technological problems of the country and its industry, and it is a pity that scientific organisations avoid this for fear of interference by non-scientific administrators and others. While scientists thrive in an atmosphere of intellectual freedom and this should be guaranteed by the state and administration, it is incumbent on them to think in terms of development of the money economy, which alone contributes to their country's well-being.

46. The research programme can spell failure or success of a country's development and is therefore of paramount importance to a research institute. The preconditions of formulation of such a programme would include the objectives in relation to economic plans, the identifiable needs of technology to meet the industrial plans, and a critical review of the mineral, agricultural and other resources.

Industrial Plans and Identifiable Needs of Technology

47. A new country passes through three stages of economic development: the exploitive stage, the stage of industrial development, and the stage of industrial maturity. Only one country in the sub-region, Rhodesia, has reached the stage of industrial development and is entering the last stage. Most of the countries are still in the exploitive stage with little or no industrial development and some are entering the second

stage through plans of industrial development based on sound economic decisions.

48. Each of these countries will build the industrial sector on the strength of what it has - agriculture, mining, or both. Basic industries of fertilizer will evolve from availability of oil, rock phosphate, or extremely large forest reserves, of iron and steel on rich iron ore, of aluminium on both bauxite and cheap power, of heavy chemicals on salt, sulphur or other inorganic deposits, of cement on clay and limestone, of fabricated copper on rich copper ores, etc.

49. The basic industries are generally specified in the plans but secondary industries producing consumer goods are rarely mentioned. The latter have larger employment potential in relation to capital employed and the sum total of goods substituting for imports can also be sizable; yet, because the industrial units are usually of small - or medium-scale and this field comes generally under the private sector, the country's plans indicate only over-all investment and employment, and not even a list of viable industries is included. While basic industries, because of their size and complexity, have built-in know-how and management arrangements provided, the secondary industries in the private sector are not so provided. As overseas expertise and know-how would be too expensive for such small units, entrepreneurs would not enter industry, unless some reliable institution or source is available to assist them.

50. The industrial research institute should therefore seek detailed information on the nature of these secondary industries from the trade and entrepreneur groups, and establish liaison and intelligence on the new industries to be established in order to determine the adaptation of technology, raw material substitution that will be required. In addition, the basic industries planned, process industries existing and planned, and secondary industries existing and planned would have to be listed, their raw materials and processes examined to reveal those problems which require immediate and future solution.

Resources

51. The resources of a country and their optimum utilization in industry are key factors in development. Consequently, these are of vital importance in research and in determining the research programme. There are two distinct ways in which the subject of resources and industries can be handled. One is the descriptive method which is a description of the mineral, agricultural and other resources known and available, their nature, quality and quantity, and the other is the functional method. The latter places emphasis on analysis, correlation and appraisal. For the purpose of project formulation, it is necessary to use both methods. One would therefore catalogue the resources, their quality, nature, and quantity, and also apply the technique of analysis and questioning in order to elicit the problems associated with the resources.

52. It is necessary to know the composition of a resource to determine whether beneficiation is likely to enhance the quality to the extent desired for use within the country or for export. One will question why a particular resource is either not exploited or under-exploited, either unutilized locally or under-utilized. A material similar to a local resource in use in a process or industry already existing will suggest an investigation into that resource. Lowering of quality in the final product by the use of a local resource would again suggest a project on the pre-processing of the resource or adaptation of the technology used in the particular process. Some minerals and most of the agricultural resources provide by-products often going to waste because no immediate use is found in the area. Investigations into finding uses for these waste products can often be rewarding and fruitful.

53. The African continent is the richest source of minerals and power resources in the world. The mineral resources include copper, lead, zinc, tin, mica, asbestos, bentonite, iron, diatomite, felspar, gold, diamonds, corundum, bauxite, tungsten, wolfram, meerschaum, gypsum, limestone, graphite, dolomite, silver, soapstone, tale, pumice, vermiculite, quartz, salt, kyanite, mullite, magnesite, kaolin, carbon dioxide, beryl, soda ash,

arsenic, phosphates, and others. The agricultural resources are large and varied, the principal ones being coffee, tea, tobacco, cassava, cane sugar, cotton, cashew, sisal, papain, pyrethrum. The minor resources include oil-seeds, tannin extracts, timber and forest products, abaca, corn, gum copal and arabic, kapok, beeswax, vegetables and fruits.

Over-all Programme and Final Selection

54. The over-all programme would be an inventory of projects resulting from an analysis and appraisal of the needs of technology and services necessary for enhancing the resources and developing the existing and planned industries of a sub-region. The projects formulated at this stage will represent ideas, with perhaps concise information on scope, disciplines, and state of existing knowledge. Because the council serves a group of countries and controls a number of laboratories in specialized fields, the spectrum of disciplines and the number of projects will be extremely large. A preliminary evaluation and screening will then be necessary.

55. Preliminary evaluation and screening will entail consideration of the relative importance of a group of projects in a particular industry or on a resource, and elimination of those which involve small gains in relation to research effort, those which require technologies which are scarce or unobtainable, those on which existing technology is satisfactory and may be postponed for later consideration, and those on which outside knowledge has since been found to be available and could be adopted at lower cost.

56. After the preliminary screening, the projects remaining will have to be prepared in some detail for the final selection. The scope and object of the project and the specific problems to be solved should be stated first. Then follows a brief summary of the literature search made on the particular subjects and the gaps in knowledge which the project is expected to fill.

57. The utility factor should be presented next. A basic research project to provide new knowledge towards solution of other applied

problems has utility, even though it would be difficult to estimate in advance the time required for completion of such a project and, hence, the cost. In applied research, the utility factor can be more specifically stated as a new or better raw material, improved product or process or operation, or a new product. The time, cost and magnitude of the attack on such problems can only be, at best, an intelligent prediction based on previous experience of similar problems. Research is essentially an exploration into uncharted areas and therefore defies more definite estimates. What is presented as time and costs are notional probabilities.

58. In the case of developmental projects which involve pilot plant operation, determination of unit cost of production, market research and evaluation of final product, it would be possible to determine more closely the utility and usability factors and to predict within close limits the results that will be achieved in a particular time and at a particular cost.

59. The final selection and establishment of priorities should be the responsibility of the Research Council or a Committee of Directors of Research, assisted by representatives of planning and the governments. The final list as approved should be for a definite period of five years and be the research plan. On the basis of the plan, it would be possible to work out manpower requirements, disciplines, equipment and facilities and annual cost of operation for the full period. Having provided the budget, the Director should be given a free hand to implement the plan and to report progress to the selection body once in every six months.

CHAPTER VI

AN INSTITUTE TO MEET AFRICAN INDUSTRIAL NEEDS

60. In Africa an institute must effect break-throughs in technologies particularly in areas where utilization of indigenous materials would be an advantage and would develop these to the production stage. Such break-throughs are rare and even if an institute did have the good fortune to have more than a normal share of these, it would still have failed in its major purpose of adaptation of technology to meet immediate production needs. It would have failed industry in that certain essential services, such as industrial testing, in plant standardization quality control, industrial engineering, trouble shooting, feasibility studies, project evaluation, machine maintenance and design, etc. would not have been provided. It would have therefore failed the country in not assisting in the implementation of its industrial plans.

61. In order to justify these assertions, it is necessary to review the factors and problems of industrialization in African countries. The peoples of Africa are predominantly engaged in agriculture, pastoral and fishing activities, and forestry. Consequently they understand agriculture, which has been the traditional occupation for centuries and capital resources which are modest are preferentially directed to this and related activity. Because of the non-existence of industrial tradition, lack of knowledge of the technologies and know-how of production, lack of technical and industrial skills, lack of entrepreneurial talent, and lack of an institute where technical services could be obtained to overcome these handicaps, Africa has failed to attract sufficient internal capital to generate industrial activity at the rate and expectation most of the new countries have planned for industrial investment from the indigenous population has therefore been meagre. In addition to this, limitation of national boundaries and inability to offset this by economic integration of a group of countries, coupled with low consumption of goods, have meant poor

markets for industrial products.

62. Against this background let us examine the areas of support [illegible] required before entrepreneurs will venture into industry. For this purpose four different groups can be envisaged.

(a) Local entrepreneurs wishing to enter industry where some limited knowledge and experience exists.

(b) Local investors wishing to enter into a small-scale industry where no local knowledge or experience is available and it is not proposed to import know-how from abroad.

(c) Local industrialist entering into medium-scale industry, in technical and or financial collaboration with an overseas manufacturer or trading company.

(d) The Government intending to set up a large-scale plant for a basic industry such as cement, oil refining, heavy chemicals, fertilisers, paper and pulp, iron and steel, or a large-scale textile mill.

63. In the first category will be a majority of products now exported in the raw or unprocessed forms and a number of products locally consumed such as processed food, timber products, bricks, tiles or weaving. If the products replace hitherto lower priced export commodity, it is necessary to know whether this would be preferred in the traditional market and if so in what quantities, price and quality. When raw products are imported into a consuming country for use in various manufactures, there already exist units for processing them into forms acceptable to an end-product manufacturer and these interests are likely to thwart attempts of a primary producing country entering into competition with them. Consequently the traders who supply the processing factories abroad will also be unhelpful, not because they are unpatriotic but because they have no contacts with the end use manufacturers and will therefore lose an existing trade. The enthusiasm of the local entrepreneur is likely to vanish at the end of

this preliminary enquiry unless he has ready access to an impartial organization which could advise him of the end uses of the processed product and direct him to information regarding manufacturers to whom he can apply for details of price, quality and specification, and quantities required.

64. Having obtained this information and established a potential market at a price which appears to be advantageous both to country and the sponsor, he will now search for details of size of economic production, type and cost of machinery, industrial skills required, management, supplies of raw material, etc., attainment of quality specifications, cost of processing etc. He will require specialized assistance in all these areas and continual services of testing his product, assistance in overcoming process or machinery breakdown and in improving efficiency of operation. In the case of production for local consumption he would require information on total demand, what proportion of this is already met, and what plans if any the local manufacturers have for expansion and if these do not exist the reasons for not expanding production. If the reason is lower demand caused by poor quality or too high a price further information may be called for on the desired quality optimum price and the techniques and technologies of production required to meet both quality and price. This will lead to further enquiries on size of production, source and type of machinery, specifications of quality of raw material, capital required, and cost of production. Where a local entrepreneur enters a field of industry on which no know-how or experience exists - he will require the assurance of competence and availability of sources which can also provide the adaptation of technology, layout of selected machinery and technical supervision of production besides other services referred to earlier.

65. In the case of medium scale industries which are to be established by local enterprise in collaboration with foreign technical know-how and or financial participation, the problems are many and varied. Foreign know-how is in many cases that supplied by machinery salesmen with

access to persons experienced in the industry and their main objective is to sell the most expensive equipment at the best possible price. The machinery offered may not be the best of its type, or the most desirable for the size of production envisaged. Where industrial skills are unavailable it may be unwise to have ultra modern equipment with push button controls, as these would require accurate adjustments and high maintenance which involves higher skills, even if the higher cost of such type equipment may not be a major factor. The machinery may on the other hand use a technology without modification to local conditions, or have a capacity several times in excess of anticipated production. The know-how is of limited value as it does not have the assurance and reliability of a reputable manufacturer. The manager supplied by the machinery manufacturer is an industrial who might make unreasonable demands on the local company and hold it to ransom. Many cases of this type have been reported in the less advanced countries of Asia and elsewhere and this may well be the experience in Africa. It can only be avoided if the local industrialist has access to competent help in the formulation, supervision and operation of his concern.

66. Where collaboration with a foreign manufacturer is envisaged the above mentioned particular problem may not arise but advice will be required on the minimum and maximum number of local personnel in various categories of management and their training, the disclosure of know-how, the conditions of purchase of raw materials, and generally on the type and contents of a technical agreement between a local sponsor and an overseas manufacture.

67. In the case of basic industries, which are becoming increasingly under public ownership in the underdeveloped countries, largely because of high initial capital and inadequate return on investment, a local institute may not have the competence to prepare full and detailed project reports and to make technical and economic feasibility studies. It could, however, make the initial survey of the quantity and quality of raw materials available, of the availability of technical and skilled manpower for the particular industry, of the market existing with pro-

jection for consumption at the time when industry will be established, and make a preliminary feasibility study for consideration of the government. If in the view of the institute the prospects of economic operation seems satisfactory or even marginal, it could make recommendations for the choice of a specialized consultant in the particular industry, and provide such a consultant with all the local background data he will require. When the consultant arrives, he can be based on the institute where both technical and other data would be available or special information obtained for him through analyses and tests on water, and raw materials of local origin.

68. There is yet another and important field of activity by which an institute would assist industrializations. As indigenous industrial investment in industry is likely to be meagre for some considerable period of time, the entrepreneur looks to industrial banks, development corporations and commercial banks to provide loans on long term credit but unfortunately the banks themselves require evidence of fundability to come to them. The local entrepreneur will be unable to prepare a project report with all the details of capital cost of land, buildings, machinery, cost of installation and services, raw materials and labour required, market potentials, cost of production, etc. and consequently a worthwhile project might never be started. Assistance in the preparation of feasibility studies which would lead either to a bankable project or to the rejection of uneconomic projects which are a drain on the resources of the country will be a service of great value to industrialization in the less advanced countries and should therefore be included in the functions of an institute.

69. Against this background of needs it is necessary to review the scope, objects, and organization of industrial research institutes already existing in some of the African countries, so as:

(a) To effect the desirable co-ordination and avoid duplication;

(b) To effect economies in very scarce scientific personnel and costly equipment,

(c) To make such services available to a wider region;

(d) To determine complementary needs which have to be met.

CHAPTER VII

INSTITUTES IN AFRICA ALREADY PLANNED OR EXISTING [1]

70. In this review of existing institutes only those organizations which either principally or partly assist in industrial development will be considered and these will include industrial research institutes, food processing and research centres, building research and materials testing laboratories, industrial consulting services, standards and testing institutes and productivity centres.

Sudan

Industrial Research Institute

71. An institute with functions identical to those proposed in this study for an industrial development and research institute will become operative early in 1964. Assistance in the establishment of this institute was sought by the Government of Sudan from the United Nations Special Fund early in 1962 and the project received approval of the Council in June 1963. The institute will have research and development functions and services rendered will include industrial consulting, feasibility studies, loan surveys, industrial testing and assistance in production. Specialised fields include technology of oil and fats, silicate technology and textile technology. It will be established as an autonomous corporate body with powers and duties vested in a governing board. Co-ordination with other institutes and bodies has been provided for to avoid duplication of both research and other services in Sudan through a Technical Advisory Committee consisting of representatives of the University, Food Research and Processing Centre, Industrial Bank, Public Works Department, Labour Department, government chemist, etc., with the Director of the Institute as Chairman. "The Institute will as far as its competency and finances permit conduct and render research and technical services for the benefit of the Government, or any public authority or any industry or any financing institution in Sudan" and will make charges for its services.

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[1] This chapter is taken from a document prepared in 1963, and the information has not been revised.

Building materials testing laboratories

72. A testing and research unit for building materials, well equipped with testing equipment, has been established within the Engineering Faculty of the University of Khartoum. It has no senior professional staff of its own. The professor of mechanical engineering is in charge, and he has the assistance of other teaching staff and students in providing a testing service on building materials both for government and private sector. It has an advisory committee composed of representatives from various departments to assist in determination of research programmes.

Food processing and research centre

73. This project approved by the United Nations Special Fund in June 1963 has now been taken to the operative stage. It has as its objectives:

(a) Processing of food and food products and to provide demonstration units;

(b) The development of standards and testing of food;

(c) Extension services and training in food processing and preservation.

74. The FAO acts as executive agency and will provide seven to eight experts in food processing, food technology, microbiology, canning, packaging, standardization, etc. Counterpart training both in Sudan and abroad has been provided for.

Hides and skins demonstration and training centre

75. The objectives are

(a) Raw hides and skins improvement;

(b) Improvement of rural production of semi-tanned hides and skins;

(c) Development of leather production on an industrial basis;

(d) Introduction of improved tanning and finishing techniques; and

(e) Developing methods of utilization of by-products.

The Centre was officially opened on 19 November 1963 and experts on tanning, finishing, utilization and marketing have been supplied by the FAO.

Productivity and feasibility studies

76. The Industrial Bank has obtained the services of a team of consultants through US AID Mission and this team undertakes loan surveys, project evaluation and vetting for the Bank.

Ethiopia

77. The Ethio-Swedish Institute of Building Technology was established with aid from Sweden and is concerned with teaching, research and documentation. It conducts a four-year course for building supervisors and contractors. It is also conducting research into building materials. Its latest studies include the production of hand made bricks, soil stabilisation and use of local materials in construction. It undertakes testing of materials besides providing advisory services to the Ethiopian Government on various aspects of construction.

Kenya

East African industrial research organisation

78. This was originally established in 1942 to serve the British East African region and has recently been brought under the control of the East African Common Services Organisation. The main laboratories are in Nairobi, and it has modest facilities in regard to buildings and specialised pilot plant equipment. The library is inadequate and the Organisation has been handicapped by the limited land area available, by inadequacy of funds for expansion and by an unattractive scale of salaries which prevents recruitment of persons of the calibre required. At the present time five out of nine professional posts are vacant and the recruitment situation is likely to get worse on the scales applicable.

79. In spite of these handicaps it has carried out useful work in the examination, analysis and listing of raw materials, in providing a fuel advisory service, and in investigations on ceramics, coffee processing, dehydration of vegetables and drying of papain, sisal and pyrethrum flowers, as well as in the utilization studies.

80. The internal organization consists of three sectors, i.e. Chemical Research, Ceramics Section and Advisory Services. A metallurgical section laboratory which was established in Entebbe, Uganda has since been closed down and the metallurgist transferred to the service of the Government of Uganda. The advisory services are in the narrow field of fuel efficiency in factories and this too may have been already reduced by the retirement of the fuel technologist in 1962. Industrial consulting services, feasibility studies and loan surveys are not part of their functions. The liaison with industries and industrialists could have been better.

81. The present budget is £50,000 and their income from fees from the private sector approximately £4,000. It was established to undertake applied research for industries in East Africa which are in the course of development and also to give technical assistance and advice to established industry on their day to day problems. It has functioned only as an industrial research organization in a limited way, largely due to difficulties in staffing and the limitation enforced by the budget which is grossly inadequate.

Materials testing and research

82. This was established in 1949 under the Ministry of Works and still functions under that Ministry of the Kenya Government. Although in buildings not specifically designed as laboratories, it has 42,000 sq.feet of floor space. The senior staff consists of the chief materials engineer, eight materials engineers, a physicist and a chemist. The other staff consists of 20 materials assistants including 3 other chemical assistants, 39 laboratory assistants, 4 executive staff and 55 subordinate staff. The laboratories are well equipped and adequately staffed to undertake research and testing of building materials and of buildings. The main divisions consist of soil testing, chemical analysis, building materials, bitumen, physics, paint, timber. They have two small laboratories at Nakuru and Mombasa.

83. The investigations carried out by this unit have included:

(a) The removal of excess fluoride in water, a process developed and patented;

(b) Manufacture and use of pumice concrete in building construction which has resulted in reducing cost of building;
(c) Development of the use of pre-stressed concrete;
(d) Tests to develop use of local vermiculite deposits;
(e) Studies in soil stabilization resulting in the successful use of anilene/furfural and the laying of a test road.

84. The services of this unit are available to governmental departments and members of the public in Kenya, Uganda, Tanganyika, Somalia and countries outside Africa. The existing equipment is valued at £60,000 and the present cost of operation is around £6,000 per annum. However, it recovers fees for tests and services rendered to private sector and government and public bodies outside Kenya and its income from this source is approximately £12,000.

Nigeria

Industrial research

85. Industrial research for Nigeria is conducted in the Federal Institute of Industrial Research situated at Oshodi, 10 miles from Lagos. It was established in 1955 on the recommendations of the International Bank for Reconstruction and Development. It has 25 acres of land and ample space exists for further expansion. It possesses a library of 3,000 volumes devoted to chemistry, chemical engineering and industrial technology. Specialized equipment other than normal chemical laboratory equipment includes a pulp and paper laboratory, a ceramics laboratory and a pilot plant equipment. The Institute is administered as a division of the Federal Ministry of Commerce and Industry and the entire budget is provided for annually by the Government estimates.

86. "The aim of the Institute", as stated in their booklet, "is to help anyone to set up as quickly as possible, new industries based on Nigerian raw material. Another subsidiary aim of the Institute is the development of industries which already exist, especially those industries b based on Nigerian raw materials. The services of the Institute are at

the disposal of any Government, private company or individual, on terms to be agreed upon. Advice is given free of charge".

87. The cadre of the institute consists of 27 senior technical officer posts. Less than half of these were filled and the situation was further aggravated by absence on leave, consequently only a third of the cadre was available. The posts of director, deputy director, chief engineer, 2 senior research officers, 1 senior engineer, cost accountant, 8 research officers, engineer and designer engineer were vacant at this time. One of the two principal research officers will be leaving at the end of December 1963. The Institute's major problem is finding the staff. Five new graduates from Ibadan University were taken temporarily last year but four resigned after a few months to accept scholarships for higher degree.

88. The Institute disposes of good facilities and can be expanded with proper staffing and reorganization, under an autonomous Board, to function more efficiently than it does at present. Research work carried out includes:

(a) Gari processing from cassava;
(b) Pulp and paper making characteristics of four varieties of Nigerian timber;
(c) Protein fortification of starchy foodstuffs;
(d) The occurrence and utilization of plant gums.

The present budget is £100,000.

Hides and skins demonstration and training centre

89. A project similar to that described under Sudan was approved by the Special Fund in June 1963. Its purpose is to provide demonstration, training and research in order to improve the quality of hides and skins and to develop industrial methods of leather processing and manufacture.

Ghana

Building Research Institute

90. The Ghana Building Research Institute, formerly known as the West African Building Research Institute, was one of the seven organisations controlled and financed by the Governments of Ghana, Nigeria, Sierra Leone and Gambia. It was established in 1952 and sited in Accra. With the dissolution of the West African Inter-territorial Research Organisation in October 1962 it was incorporated into the Ghana Academy of Sciences. The Institute has moved from the original site in Accra and has been re-established at the University of Kumasi.

91. The activities of the Institute include:

(a) Investigations into the nature and behaviour of materials;
(b) Development of indigenous materials and techniques;
(c) Application of existing knowledge to all aspects of the building industry;
(d) The exchange and dissemination of knowledge;
(e) Technical apprenticeship and training in industrial research.

It has a well stocked library and its internal organisation has four divisions.

Food Processing and Research Centre

92. A project under FAO and approved by the United Nations Special Fund will become operative in 1964. Its main objects are the processing of food products and the operation of pilot plants as demonstration and training units. It also includes food standards and testing and research into local food products.

Productivity

93. There are two consultants of the Ford Foundation attached to the Planning Commission working on manpower survey and productivity. Two ILO members are believed to be attached to the Ministry of Industry.

Libya

Libyan Date Laboratory (Trust Fund)

94. This laboratory undertakes research on date processing, and manufacture of date syrup is carried on in the government packing house where a pilot plant is also available for process work. It receives assistance from FAO. There has recently been established, also with FAO assistance, a pilot plant for the processing of citrus juice, jams, jellies and other citrus products.

Egypt

95. Egypt has a large number of research institutes under its Department of Scientific and Industrial Research. For the purpose of this survey only the Productivity Centre, Standards Institute and Building Research Institute will be described.

Productivity Centre

96. In July 1954, with the assistance of the ILO, a Productivity and Vocation Training Centre was established in Cairo. The functions of the Centre are:

(a) To undertake productivity studies in selected plants;
(b) To organize practical courses in industrial engineering and management;
(c) To apply modern industrial engineering and management in selected plants.

The Centre is also required to promote the adoption of cost accounting and statistical techniques, train supervisory staff, advise on designs and layout of plants. The Centre is under Egyptian direction and is fully manned. It has carried out useful work for industries in Egypt.

Standards Institute

97. The Standards Institute was established some years ago. It formulates and develops standards and has its own laboratories. The Institute could serve the whole of North Africa, including Sudan, Ethiopia and Somaliland.

Building Research Institute

98. This Institute is a large organization and forms part of the Department of Scientific and Industrial Research and has plans for expansion. Their work has so far been on research on building materials and their testing. They expect to extend their activities to functional requirements, building economies and building techniques. The Institute is adequately staffed and can serve the sub-region of North Africa.

General observations

99. In the review of existing institutes no claim is made as to completeness and it is quite possible that other institutes exist particularly in the French speaking countries. Of the countries in the region under study, only Egypt has institutions which meet most of the industrial needs. Sudan will have met the requirements when the Special Fund projects on Industrial Research, and Food Processing become operative and when they make suitable arrangements for standards with Egypt and for building research either with Egypt or Ethiopia.

100. Kenya with the East African Industrial Research Organisation and the Materials Section of the Ministry of Works comes close to meeting its requirements. No facilities exist, however, for feasibility studies, loan surveys, project evaluation and liaison with industry and entrepreneurs is lacking. The two institutions should be combined and additional services and functions incorporated. With additional staffing and reorganisation this combined organisation would be in a position to serve a wider region.

101. Nigeria has good facilities and its Federal Institute of Industrial Research should, with additional functions and services, be capable of serving a sub-region.

102. Ghana already has a Building Research Institute and a project on food research and processing has been approved; the industrial research functions can be incorporated into either the building research or food research organizations with added functions of industrial consulting.

103. It will therefore be seen that except for Sudan and Egypt, which have or will have adequate facilities to meet industrial needs, and Kenya, Nigeria and Ghana which have facilities but inadequate to meet the total needs, particularly in the area of industrial extension, direct technical services, and industrial consultation, the other 31 countries have no facilities at all. In order to meet the need the institutes of industrial development and research are being proposed on a sub-regional basis. These institutes will take into account existing establishments and the whole programme would be co-ordinated in order to avoid duplication of services and to effect maximum efficiency.

CHAPTER VIII

AN INSTITUTE OF INDUSTRIAL DEVELOPMENT AND RESEARCH

104. From the discussion which preceded it will be apparent that to meet the needs of industrialization of the 36 countries covered in this survey, it is necessary to establish several institutes having competence in a variety of fields. The functions should include those of industrial research, technical information, industrial consulting, testing and standards, feasibility studies and loan surveys. The institute has been named institute of industrial development research in order to indicate its wide scope and functions.

105. The functions which stem from the discussion of needs can be specifically stated as follows:

(a) Surveys and studies of the natural resources, by-products of industry and agriculture and their utilization;

(b) Investigations and research into and development of new products and processes for industry, and the development of new technologies for the utilization of local raw materials;

(c) Laboratory services of analysis and testing of industrial products and export products;

(d) Assistance to governments in the formulation and development of standards for industrial products;

(e) Techno-economic feasibility studies, loan surveys and project evaluation for financing institutions, public and private sector of industry, and other bodies;

(f) Consultation service to industry on production management, industrial engineering, marketing, cost accounting, quality control, inventory control, in-plant standards, and general engineering and production problems;

(g) Technical information services based on a specialized library for the purpose of disseminating information on known processes, operations, and technologies; and publication of suitable pamphlets or brochures on the characteristics, utilization and industrial possibilities of the natural resources;

(h) Foster training in collaboration with the universities, and other educational institutions, of research workers, engineers, technologists, managers;

(i) Produce liaison with other institutes both in Africa and elsewhere and thereby foster the spirit of co-operation and the universality of knowledge.

Staffing

106. The efficiency of any industrial research institute depends almost exclusively on the quality and calibre of its staff. The professional research staff should be qualified in industrial economics, chemistry, chemical engineering, mechanical engineering or physics, have a post graduate degree in a field of industry or full professional qualifications, a diploma in industrial management and at least one year's work in a factory. Ceylon experience shows that it takes five to seven years after the first degree to make an officer of the calibre required. It is common experience in the under-developed countries for persons to believe that educational attainments or university degrees is all that counts. In the field of research, this is only the beginning, a graduate should do at least three years of post-graduate work and acquire techniques of research before he could claim to status of research officer. He would then be expected to specialize in a selected field, but having specialized in one field he must also acquire additional specialised knowledge in others by practical experience and study. A research officer cannot delegate, he should carry out each and every operation himself, however menial this may be, as this is the only way for every experience conducted to result in accurate observation. In most of the

under-developed countries, the educational and social systems have given a prominent place to white collar jobs and consequently young men have come to believe that working with their hands is degrading. This attitude is out of harmony with industrial development and is disastrous for research activity. If an insti ute of the type suggested is to be efficient and to provide the services expected of it, its staff must believe in and practice dignity of labour.

107. With persons of the training and attitude mentioned it is possible to operate an institute of the type envisaged with a professional staff of as low as 16 to 20 persons. The requirement of professional staff will be determined by the areas of specialization to be included in each institute.

CHAPTER IX

NATIONAL VERSUS SUB-REGIONAL INSTITUTES

108. The Standing Committee on Industry, Natural Resources and Transport at its first session, stated that, owing to the high cost involved, the institutes should be developed on a co-operative and on a sub-regional basis, taking full account of the existing facilities. In addition to the high initial capital cost and annual recurrent expenditure there are other factors such as the great scarcity of trained scientific research personnel, the greater interests of developing the smaller and less privileged nations of Africa and the necessity to utilize scarce resources for the maximum benefit of the whole community which favour sub-regional institutes.

109. Of the 36 independent countries there are possibly four countries which can afford the necessary expenditure, and only one which can find the highly trained research scientists among its nationals in the quality and number required to staff an institute. There are also three or four other countries which, because of their own pressing needs and advanced plans, might be tempted to establish institutes with limited scope and functions in order to satisfy their own individual national interests and aspirations. This step would serve to develop only the nations which have already attained by comparison a higher growth and surrender some twenty-eight countries to a bleak future which offers no hope of development.

110. The African countries which through the OAU have recently found new political unity and strength are also looking for means of integration in economic and other fields in order to obtain co-ordinated development and general upliftment of the whole region. The unequal sharing of the fruits of development with the relatively more advanced countries making greater progress will strain any attempts at economic or political unity and it is believed that the countries will endeavour to avoid such calamity. The more developed countries have in addition a role to play in leadership of their sub-regions and in providing the scarce personnel

required for development. Of all the various fields of economic and social activity, science provides, by its very nature of universality, the easiest area of co-operation and African nations are unlikely to throw out this opportunity of building goodwill and co-operation among themselves which might later lead to still greater and more fruitful collaboration in the economic and political fields.

111. The international agencies such as the United Nations and its specialized agencies and the governments of the developed countries which are anxious to assist the new nations of Africa are also unlikely to subscribe to a philosophy of aid to those who are already comparatively advanced and abandon the relatively poorer countries to greater poverty. Their intentions are forcefully described by Prof. W.W. Rostow of America who stated: "We must face the fact that a lenders' club is not enough. The borrowers must have a role in the whole process, they have the possibility and the duty of working together on a self-help basis. Here regional arrangements might prove useful". In the establishment of these institutes a large quantum of aid is envisaged and required from these agencies in the initial staffing, training of counterparts, and the supply of equipment.

112. These considerations favour single multi-purpose sub-regional institutes, or a number of specialized institutes in a number of countries of a sub-region co-ordinated and co-operatively run under a sub-regional council of industrial research. One of the arguments adduced against sub-regional institutes is that they might not give priority to individual and urgent needs of individual countries in their programmes of research and services. This can be overcome by the provision that a third of each country's contribution will be considered a deposit from that country with the institute, to be used on request on any specific project which that country may consider to be of immediate importance. This permits identification of every country with the work of the institute while it contributes to the well-being of the whole group through a programme of research and technical services based on the raw materials and industrial plans of the sub-region. The funds which constitute

two-thirds of the contribution of each of the countries will be used on the support of overheads and cost of such a general programme of research with the approval of the council.

113. An alternative to a single multi-purpose institute in a sub-region is the chain of specialized institutes in a number of countries in a sub-region under a Council. This solution has found warm acceptance in Africa and the Eastern African countries accepted, at the recent Lusaka conference, a proposal for the establishment of an Eastern African Industrial Research Council with five specialized institutes in Food, Textiles, Fibres and Rubber, Metals, Building Research, Chemical Technology and Process Engineering, with each institute in a different country.[1/] The specialized institutes provide a nucleus of technology for the country in which it is situated and an industrial extension team capable of advising local industrialists on a wide range of industries, harnessing know-how not only from other institutes in the sub-region under the same Council but also from sources outside the sub-region and from developed countries. The Council in which is vested the powers and duties of all the institutes will direct and administer the institutes and determine over-all policy and programmes of research. Thus each country will obtain at low cost the benefits and results of research of five institutes, each of which will function as a sub-regional institute in its specialized field.

1/ Industrial Research in the East African Sub-region (Document E/CN.14/INR/94). A paper presented to the Conference on the Harmonisation of Industrial Development Programmes in East Africa, Lusaka, 26 October - 2 November 1965.

CHAPTER X

ESTABLISHMENT - LEGAL IMPLICATIONS

114. The establishment of a single multi-purpose institute on a sub-regional basis or a Council with a number of specialised institutes distributed over several countries in a sub-region poses particular problems. The countries of the sub-region are required to subjugate their individual national interests for the general upliftment and greater prosperity of a group and to jointly and severely assure the autonomy of the institute or institutes under the Council. The legislation establishing the Council will therefore have to be passed by all the Governments in the sub-region in identical form. The countries in which the institutes may be sited would have in addition to agree:

(a) To import of chemicals, equipment, instruments, vehicles etc. free of customs duty and excise duty;

(b) To exempting the Council or its institutes from stamp duty, income tax, etc;

(c) To permit the Council to maintain and use equipment for laboratory and experimental services without any licence, permit or approval;

(d) To permit the Council to negotiate and receive aid in personnel or equipment from other governments, international agencies, foundations, etc.

(e) To afford such privileges and exemptions to personnel of United Nations and other international organisations as are already in force;

(f) To permit the unrestricted use of exchange for the import of its specialised equipment, books, etc;

(g) To permit free entry and exit for the members and staff of the Council.

115. The draft of the Act included to enhance which provides for establishment of a multi-purpose institute or a number of institutes under a Council has been based on similar acts elsewhere. It provides for the establishment of a Council vested with the powers and duties of the institute or institutes under it and consisting of the representatives of each of the participating countries of a sub-region. Financing of the operation of the Council is provided for by contribution from each country of .02 per cent of its Gross Domestic Product each year. The Act also provides for the institute or institutes under the Council to work for Governments, public bodies, and the private sectors of industry, finance and trade and to make charges for services rendered to non-government agencies.

CHAPTER XI

ROLE OF INTERNATIONAL AGENCIES AND DEVELOPED COUNTRIES

116. A number of developed countries and particularly the United States of America, the Union of Soviet Socialist Republics, the United Kingdom, France, Netherlands, the Federal Republic of Germany, Japan and Sweden are already providing both financial and technical assistance to many countries in Africa. The extent of this aid is large but it is channelled into areas of limited usefulness and often to countries which because of their greater affluence and well-being are better able to determine their requirements and ask for such aid. Consequently, the greater needs of the smaller or poorer countries are overlooked and a number of projects with inherent duplication often result in others. This is unfortunately true in many cases of even the United Nations and its specialized agencies, which because of the limitations of their individual terms of reference restrict a project to the area of its own mandate or competence. Avoidance of such defects calls for greater co-ordination of aid not only by the donor countries but also within the family of the United Nations. It also requires the determination of the total needs and priorities of each country or group of countries of a sub-region. The aid to be effective and fruitful requires not only a donors' club but also a receivers' club.

Governments of aid giving countries

117. Bilateral aid has preferentially gone into the provision of (a) equipment, and (b) technical personnel. Both have certain implications and reasoning and for these reasons they are also suspect by receiving countries. Technical assistance is suspect because as advisors they may influence ideology or attract custom for capital goods and services to the country giving aid. This is not felt so strongly in the case of aid in the form of equipment, and donor countries would prefer for sake of identification to give this form of assistance if requirements have been closely determined in relation to the important needs of the country.

118. The donor countries have therefore been assigned assistance in the provision of the equipment required for these seven institutes. The over-all cost of such equipment will be $8 million.

The United Nations and its specialized agencies

119. The United Nations because of its international character, means of support and ideology has served principally in the field of technical assistance and training. These are unaltruistic fields, but they are precisely the fields of strength of an international organization. Consequently, they have been assigned these areas of assistance.

120. The United Nations Special Fund has already a number of projects in Africa executed through its agencies such as the Centre for Industrial Development, FAO, ILO, UNESCO, IAEA, etc., and it will have to determine what co-ordination is necessary within its own family in order to obtain the maximum competence in the staff to be provided for the many fields in which the institute will work.

121. In order to assist the institute in its study, advice and execution of projects in the very specific and specialized industrial fields of basic industries such as petroleum refinery, heavy chemicals, steel, fertilizers, cement, machine tools, etc., the United Nations Special Fund, ECA, and the Centre for Industrial Development should also explore the possibility of having a pool of high grade consultants to be made available to the institutes for short terms up to three months.

122. The total cost of experts in the field and short term consultants, and the training of local counterparts is estimated at $8 to $10 million.

Economic Commission for Africa

123. The ECA has a dominant role to play in establishing liaison between the institute and the governments of the countries of the sub-region and in providing the liaison between the institutes and the United Nations family. It could further provide the means of co-ordination of the research programmes of the institutes in Africa and act as central agency for the dissemination of inter-territory information. In the hope and expectation

that ECA will fulfil this important role, a representative of ECA has been recommended to be on the board of each of the sub-regional institutes.

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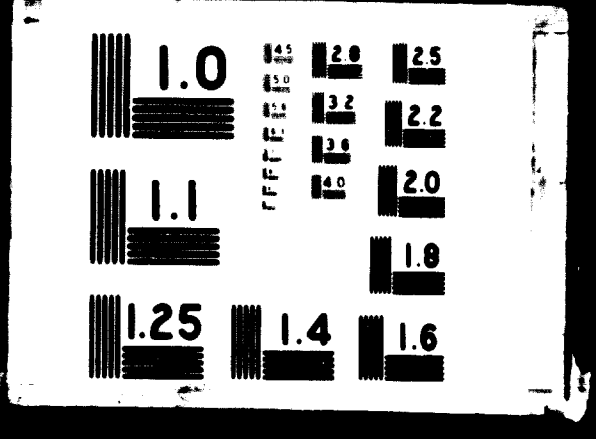
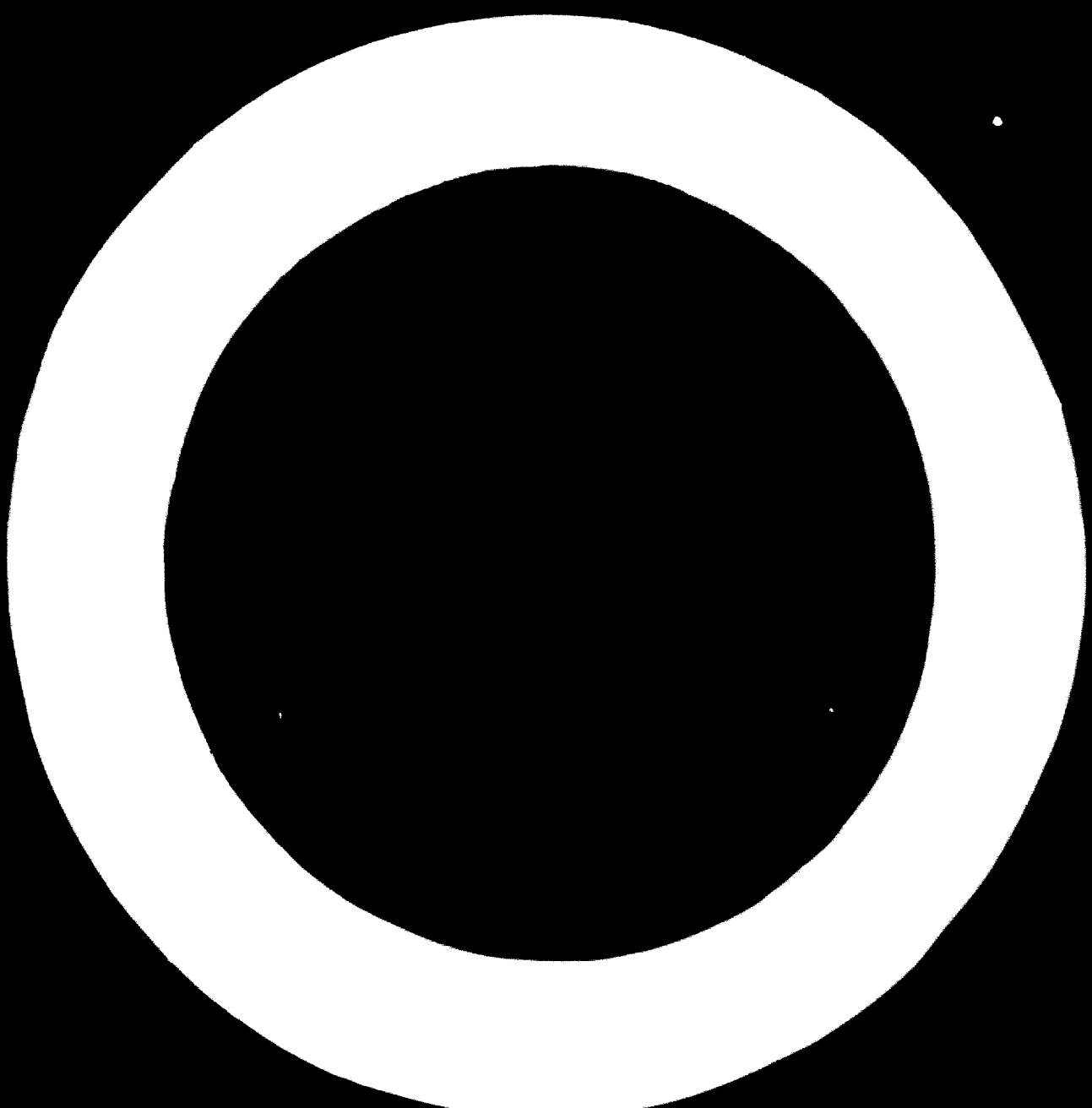




ANNEX

AN ACT TO PROVIDE FOR THE ESTABLISHMENT OF A COUNCIL OF INDUSTRIAL DEVELOPMENT AND RESEARCH ON A SUB-REGIONAL BASIS

(For the text, an East African sub-region has been chosen)

1. This Act may be cited as the East African Council of Industrial Development and Research Act.

2. (1) There shall be established in accordance with the provisions of this Act, a Council which shall be called the East African Council of Industrial Development and Research hereinafter referred to as "the Council".

(2) The East African Council of Industrial Development and Research shall in that name be a body corporate consisting of the persons for the time being holding office as members of the Council thereof as hereinafter provided, and shall have a common seal and may sue and be sued in its corporate name.

(3) The headquarters of the Council shall be in ..... or in such other place within the sub-region as may be chosen by the Council. The Council in consultation with the representative Governments may also establish and operate institutes in a number of countries and each such institute will have an industrial specialization particularly suited to the need of that country.

(4) The sub-region shall consist of Madagascar, Kenya, Uganda, Tanzania, Malawi, Zambia, Rwanda, Burundi, Somalia and Ethiopia.

3. The objects of the Council and the institute or institutes under the Council shall be:

(a) To undertake testing, investigation and researches in such manner as the Council may deem advisable with the object of improving the technical processes and methods used in industry, of discovering processes and methods which may promote the expansion of existing or the development of new industries in the sub-region or the better utilization of the raw materials or waste products of the region;

(b) To advise the Governments of the countries of the sub-region on questions of scientific, technological and industrial matters affecting the utilization of the national resources of the sub-region, the development of their industries, and the proper co-ordination and employment of scientific research to those ends;

(c) To assist the Governments of the sub-region in the formulation and development of standards and to provide services of testing of industrial products;

(d) To render to industry, Government enterprises and entrepreneurs technical assistance in the formulation, planning, execution of industrial concerns, and in the organization and operation of industries existing or to be established in the sub-region;

(e) To undertake or to collaborate in the preparation, publication and dissemination of useful technical information;

(f) To provide through a technical and specialized library a technical information service to the general public of the sub-region;

(g) To co-operate with departments of Governments, universities, technical colleges and other bodies in order to promote scientific and industrial research and the training of investigators in pure and applied sciences and of technicians, craftsmen and artisans; and

(h) To assist otherwise in the advancement of industrial research and technical training;

4. (1) The Council shall have power:

(a) To acquire in any manner whatsoever and hold any movable or immovable property and to dispose of any such property acquired or held by the Council;

(b) To negotiate and receive aid in personnel or equipment from the United Nations Agencies, Governments, Foundations and other organizations of aid;

(c) To impose and receive charges for its services;

(d) To apply for, purchase, receive by assignment or otherwise acquire any patents, brevets d'invention, concessions, licences and the like conferring exclusive or non-exclusive or limited rights to use, or any information as to, any invention or discovery, and to develop, use, exercise, assign, transfer, sell, grant licences in respect of, or otherwise turn to account the property, rights and information so acquired; and

(e) To perform all such acts as may be necessary for, or incidental to, the carrying out and performance of its objects and duties.

(2) Subject to the provisions of sub-section (3) of this section, it shall be the duty of the Council as far as its competency and finances permit:

(a) To conduct and render research and technical services for the benefit of:

(i) The Governments of the sub-region or any department or agency thereof; or

(ii) Any public authority or regional organisation;

(iii) Any industry which is or is to be carried on in the sub-region;

(b) To take all such measures as may be necessary for the fulfilment of its objects;

(3) The institute or institutes shall not undertake or perform any work which, in the opinion of the Council, is contrary to public interest.

5. (1) Subject to the provisions of this Act, the powers and duties of the institutes shall be vested in the Council.

(2) The Council shall consist of:

(a) Ten members, each of whom has distinguished himself in science or industry or is otherwise specially qualified in relation to some aspect of the institute, to be appointed by the Prime Minister of each of the ten countries of the sub-region;

(b) The representative of the Executive Secretary of the Economic Commission for Africa;

(c) The two following ex-officio members:

(i) The person for the time being holding office as the Secretary-General of the East African Common Services Organization;

(ii) The person for the time being holding office as Director of the Institute in the case of a multi-service single institute or the Director-General and Chief Executive in case of a number of specialized institutes under a sub-regional Council.

6. A person shall be disqualified for being a member of the Council if, having been adjudged an insolvent or bankrupt, he has not been granted by a competent court a certificate to the effect that his insolvency or bankruptcy has arisen wholly or partly by unavoidable losses or misfortune.

7. Any member of the Council who is not an ex-officio member shall, unless he vacates his office earlier or is removed from office by the Prime Minister or Head of Government who appointed him, hold office for a term of two years and shall be eligible for re-appointment.

8. (1) A member of the Council shall vacate office:

(a) If, not being an ex-officio member,

(i) He resigns office;

(ii) He is removed from office by the Prime Minister of the country he represents;

(b) If, having been adjudged an insolvent or a bankrupt, he has not been granted by a competent court a certificate to the effect that his insolvency or bankruptcy has arisen wholly or partly by unavoidable losses or misfortune; or

(c) If he is adjudged by a competent court to be of unsound mind;

(2) A member of the Council who is not an ex-officio member may resign office:

(a) If he is not the Chairman of the Council, by writing under his hand addressed to such Chairman; and

(b) If he is the Chairman of the Council, by writing under his hand to the Vice-Chairman.

9. (1) The Chairman of the Council shall be elected from amongst the appointees of the Prime Ministers or Heads of Government of the constituent Governments by the members of the Council. He shall, unless he earlier vacates office as Chairman or is removed from office as member under section 8, hold that office for two years; but shall be eligible for re-appointment to that office:

Provided, however, that where the Chairman ceases to hold office as Chairman prior to the expiration of his term of that office and a successor to him is elected, such successor shall, unless he earlier vacates office as Chairman, serve as the Chairman for the unexpired portion of such term;

(2) The Secretary-General of the East African Common Services Organization shall be the Vice-Chairman of the Board. The Vice-Chairman shall perform the duties of the Chairman in the absence of the Chairman or when there is a vacancy in the office of Chairman.

10. The Chairman shall in addition to his normal duties be responsible for liaison with the Governments of the countries of the sub-region, the

United Nations and its specialized agencies, and for the collection of funds from Governments, and other international agencies which support the operation of the Institute. The Chairman may be paid a remuneration to be determined by the Council.

11. The other members of the Council shall not be paid any remuneration, but shall be reimbursed from the funds of the Institute for such travelling, hotel, and incidental expenses as they may incur for the purpose of attending meetings of the Council and for any such expenses as they may incur by prior authorization of the Council in connection with any special mission performed within the sub-region or outside it on behalf of the Institute.

12. (1) The procedure for the transaction of business of the Board shall be determined in accordance with the provisions set out in the Schedule to this Act.

(2) All acts done at any meeting of the Council shall notwithstanding that it be afterwards discovered that there was some defect in the appointment or election of any member thereof or that any such member was disqualified, be as valid as if every such member had been duly appointed or elected and was qualified to be such member.

(3) No proceedings or act of the Council shall be invalidated by reason of any vacancy in the membership of the Council.

13. (1) The Council shall appoint persons qualified in relation to the work of the institutes as the Directors of the Institutes or as Director-General in the case of specialised institutes under a Council. The conditions of employment, including remuneration, of the Directors or Director-General shall be determined by the Council.

Provided, however, that in the event of such person or persons being provided by an international agency the remuneration would be determined by that agency in relation to the scales applicable to their officers.

(2) The Director of any specialized institute or the Director-General shall not be an officer of the Government of any country or political sub-division thereof.

14. (1) The Council may appoint such officers and servants as may be necessary for the performance of the work of the Institute. The conditions of employment, including remuneration, of any officer or servant appointed under this sub-section shall be determined by the Council.

(2) The Council may delegate to the Director all or any of its powers of appointing officers and servants under sub-section (1) of this section but not the power of appointing the Accountant. The conditions of employment, including remuneration, of any officer or servant appointed by the Director under any power delegated to the Director under this sub-section shall be determined by the Director with the concurrence of the Board. Any person dissatisfied with any decision made by the Director under any power delegated under this sub-section to the Director may appeal therefrom in writing to the Board and the decision of the Council on such appeal shall be final.

(3) The Director shall not, except with the prior approval of the Council, request the services of, make agreements for obtaining, or appoint, any person who is not a citizen of the countries specified in the sub-region, as an officer or servant of the Institute.

(4) The dismissal by the Director of any officer or servant shall not have effect unless it is approved by the Council.

15. No officer or servant of the Council or any institute under such a Council shall, except on behalf of the Institute to which he is attached and in the capacity of a member of its staff, render service to any other employer without the consent of both the Director and the Council.

16. The Director shall determine the duties of the officers and servants of the Council and of any institute established.

17. (1) The Council shall have disciplinary control over the Director.

(2) The Director shall have disciplinary control over the other officers and servants of the Institute.

(3) The Council shall determine generally the punishments that may be imposed on officers and servants of the Institute for improper conduct, remissness in the discharge of duties and inefficiency.

(4) Any officer or servant of the Institute on whom the Director orders the imposition of any punishment may in writing appeal from that order to the Board and the decision of the Council on such appeal shall be final.

18. (1) The Government of each country in the sub-region shall contribute on the first day of January of each year a sum equivalent to .02 per cent of the National Income of the country as its contribution towards the maintenance and operation of the Council.

(2) The Council shall determine the purposes to which the contributions made under sub-section (1) shall be applied. One-third of the contribution of each country shall be made available for application to such research work as the Government of that country may from time to time request the Institute or institutes to undertake.

19. (1) The funds of the Council shall be deposited in such bank or banks as may be determined by the Council and the account of the Council in each bank shall be in the corporate name of the Council.

(2) Such funds of the Council as are not immediately required for the purposes of the Institute may be invested in Government securities determined by the Council.

(3) No payment out of the funds of the Council shall be made without the approval of the Council:

Provided, however, that the Council may authorize the Director to incur on behalf of the Institute such reasonable expenditure in the month as does not exceed a sum determined by the Council.

(4) Any cheque drawn on the account of the Council in any bank shall be signed by the Director and the Accountant of the Institute, and, if either of them is absent, a member of the Council whose signature is registered for the purpose by that bank shall sign that cheque in place of the absentee, and, if both the Director and the Accountant are absent, two members of the Board whose signatures are so registered shall sign that cheque.

20. (1) The Institute or Institutes shall keep accounts of the receipts and expenditures, contractual obligations, investments, allocations of funds for specific purposes, the distribution of actual cost amongst the various research operations and activities of the Institute and such other accounts as may be required by the nature of the Institute's work or as may be requested by the Council.

(2) The accounting of the Institute shall be audited annually by a qualified auditor approved by the Council.

21. (1) The Director shall submit to the Council annually, in such form and detail as the Council may approve, a written report of the Institute's work and finances during the year completed, and upon the acceptance of such report by the Council, the Council shall transmit to the Prime Minister (or Minister for Industry) of each of the countries in the sub-region a copy of that report and a copy of the audited statement of income and expenditure.

(2) As soon as may be after the acceptance of the annual report by the Council, the Director shall prepare and cause to be published at the expense of the Institute for the general information of the public an appropriate summary of such report in such manner as may seem useful in informing the public of the Institute's progress.

22. The Council shall furnish to the Minister of any of the countries of the sub-region such information as he may call for from time to time in respect of the activities and financial position of the Institute or institutes, provided, however, that no information in relation to matters

which the institute are bound to treat as confidential by any agreement with any party private or Government shall be disclosed under the preceding provisions of this section.

23. (1) The affixing of the seal of the Council to any instrument other than an instrument referred to in sub-section (2) of this section shall be in the presence of and be attested by:

(a) The Chairman and the Vice-Chairman of the Council, or

(b) The Chairman or the Vice-Chairman and any other member of the Council, or

(c) Such one member of the Council or of the staff of the Institute as may have been authorized by the Council to act on its behalf on such an occasion.

(2) The affixing of the seal of the Council to an instrument containing an agreement for the rendering of any service by an Institute shall be in the presence of, and be attested by, the Director or, in his absence, any member of the staff of the Institute who has been authorized by the Council to act on behalf of the Director on such an occasion.

24. (1) The Institute may enter into any agreement with any party to carry out any special investigation with the specific object of the discovery, invention or improvement of any process, apparatus or machine subject to such conditions, and the payment of such charges, as may be agreed upon.

(2) The rights in any discovery, invention or improvement under any agreement referred to in sub-section (1) of this section shall, as may be provided by such agreement, be vested in either the Institute or the person who requested the investigation.

25. (1) Subject to the provisions of section 24, the rights in all discoveries and inventions and in all improvements in respect of processes, apparatuses and machines made by officers of the Institute shall be vested in the Institute, and such discoveries, inventions, and improvements shall be made available for use

in the public interest subject to such conditions, and the payment of such fees or royalties, as the Council may determine.

(2) The Council may, out of the funds of the Institute, pay to any officer of the Institute who has made any discovery, invention or improvement referred to in sub-section (1) of this section such bonus, or make provision for such financial participation in the profits derived from that discovery, invention or improvement, as the Council may determine.

(3) The Institute may apply for letters patent in respect of any invention made by any officer of the Institute, and shall, for the purposes of the Patents Ordinance, be regarded as the assign of the inventor.

26. The Director shall cause to be maintained and preserved complete and accurate records of the dates, performances and results of researches, studies, tests, experiments and other investigations conducted by the officers of the Institute and of discoveries or inventions made by them.

27. (1) The officers and servants of the Institute may, without any such licence, permit or approval as may be required by any other written law, maintain and use, on any premises lawfully occupied by the Institute for laboratory or experimental purposes, such installations, equipment, and materials as they may consider necessary or desirable for those purposes.

(2) The provisions of sub-section (1) of this section shall not be deemed to relieve the Institute of responsibility for taking reasonable precautions for the safety and protection of persons and property or for liability for the consequences of the acts of its officers and servants in the course of their employment.

28. The Council may establish and regulate a provident fund for the benefit of all or any of the employees of the Institute and their dependents or nominees, and may make contributions to any such fund out of the moneys of the Institute.

29. (1) The Institute shall be exempt from the payment of:

(a) Any tax on the income or profits of the Institute, and

(b) Any stamp duty on any instrument executed by, or on behalf of, or in favour of, the Institute.

(2) The Institute shall be exempt from the payment of any customs or excise duty on any goods imported or purchased out of bond by the Institute.

(3) In the case of any instrument containing any agreement between the Institute and any other party and providing for payment to the Institute for services rendered or to be rendered by the Institute, or otherwise in support of the Institute's work, both the Institute and such other party shall be exempt from the payment of any stamp duty on such instrument.

(4) Any person making a payment to the Institute for services rendered, or as a contribution to the general support of the Institute, may claim the amount of such payment as a deduction from income, in the year in which the payment is actually made, for the purposes of computing liability for income tax and profits tax.

30. No member of the Council or officer or servant of the Institute shall be liable for any damage or loss suffered by the Institute unless such damage or loss was caused by his misconduct or wilful act.

Schedule

Proceedings of the Council

(1) The Chairman shall summon a meeting of the Council once in every three months.

(2) The Chairman shall summon a special meeting of the Council within fourteen days after being requested in writing to do so by two members of the Council.

(3) The Chairman shall give at least ten days' notice in writing of every meeting of the Council to each of the members, and shall specify in such notice the business to be dealt with at such meeting.

(4) The Chairman or in his absence the Vice-Chairman shall preside at all meetings of the Council.

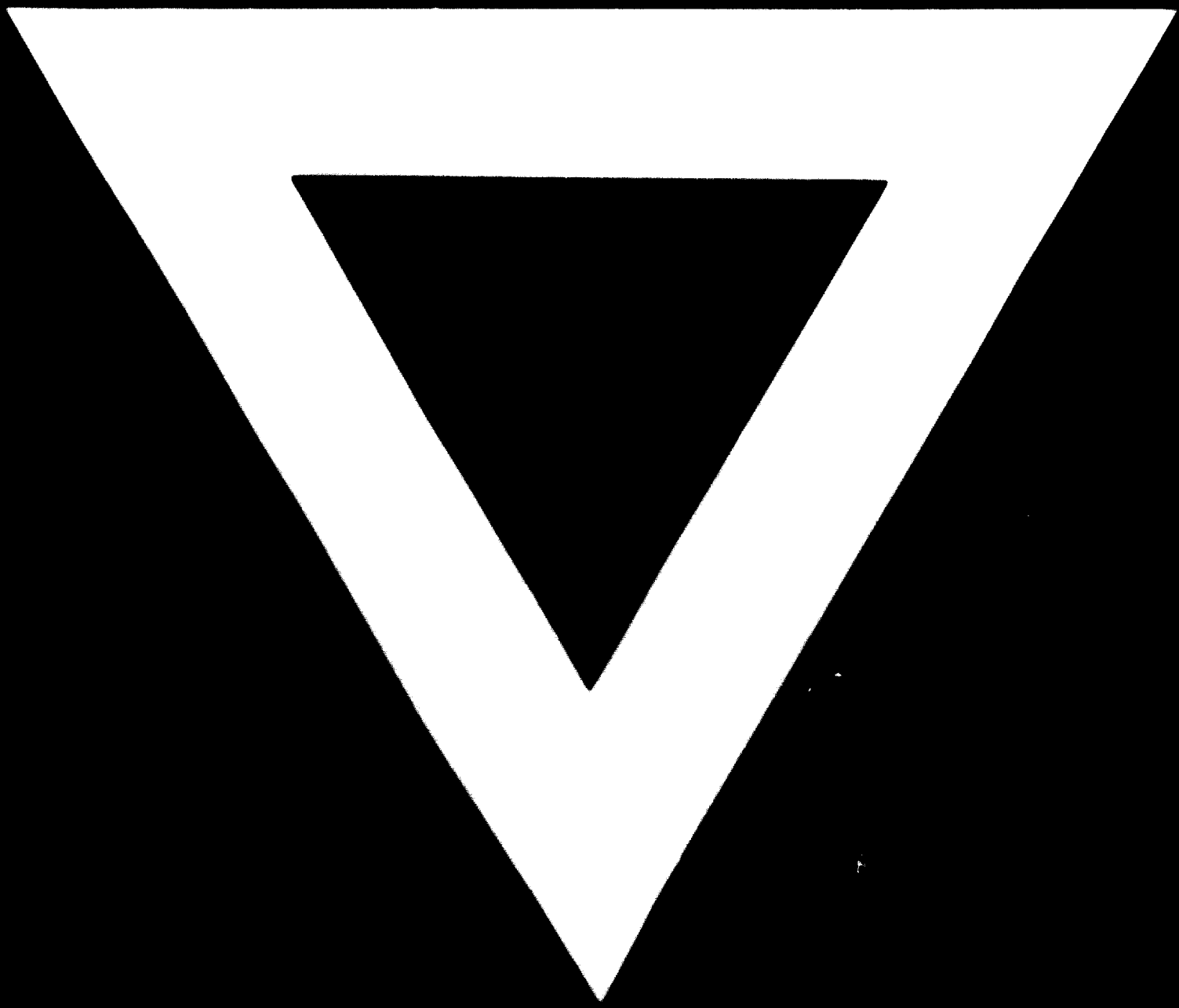
(5) Four members of the Council shall form a quorum at any meeting of the Council.

(6) All questions for decision by the Council shall be decided by the vote of the majority of the members present. In case of an equality of votes the presiding officer shall have a casting vote.

(7) If at least four members of the Council are present in the sub-region, any question may be decided by the circulation of the relevant papers to the members present, and by such members' recording in writing their views and their votes on that question; and in such a case a report of such question, views and votes shall be made to the next meeting of the Council and shall be recorded in the minutes book, and, if there is an equality of such votes, such question shall be submitted for decision to a meeting of the Council.

(8) The proceedings at every meeting of the Council shall be recorded in a minutes book.

(9) Subject to the provisions herein, the Council may determine its own proceedings.



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