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LONG-TERM PLANNING

Joint memorandum by the Board of Governors and the Director General

1. By Resolution GC(V)/RES/105 the General Conference requested the Board of Governors and the Director General to initiate the preparation of a long-term programme for the Agency's activities, as well as to present the Conference at its sixth regular session with a progress report on the steps taken to promote that objective. That report was duly made to the Conference last year as document GC(VI)/203, and during its discussion [1] two draft resolutions were introduced [2] which led to the eventual adoption of Resolution GC(VI)/RES/131 on a programme of technical assistance to the developing countries.

2. During the final months of 1962 consultations with groups of experts on various aspects of the Agency's scientific and technical work continued and first drafts were made of parts of the programme itself. Early in February 1963 the Scientific Advisory Committee was consulted about all the scientific and technical parts of the programme, and at the end of March the views of the Technical Assistance Committee of the Board were obtained on those sub-sections that relate to the exchange and training of scientists and the provision of experts and equipment. The Board, which had received in February a report from the Director General on the progress of the work, finally examined in June the draft of the whole programme which the Director General laid before it and made a number of changes therein.

3. The long-term programme as thus elaborated is now presented to the General Conference in the Annex hereto. It will be seen that two monographs are appended to it - one on the Agency's activities in relation to the development of nuclear power, and the other on the application of radioisotopes and radiation sources. These monographs reflect the views of the Government experts whom the Director General consulted in the course of the preparation of those parts of the long-term programme that deal with these subjects. Both the Board and the Director General consider that although the material in these monographs is too detailed to be included in the programme itself, it is nevertheless likely to be of interest in connection with the year to year planning of those activities to which it relates. It is for this reason that they have decided to present it in the form of appendices.

4. The Board and the Director General suggest that it would be desirable for the General Conference to endorse the long-term programme, and accordingly submit the following draft resolution for its consideration:

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[1] Summarized in document GC(VI)/COM.1/OR.51, paras. 10 - 51.

[2] GC(VI)/COM.1/67/Rev.1 and GC(VI)/COM.1/73.

THE LONG-TERM PROGRAMME FOR THE AGENCY'S ACTIVITIES

The General Conference,

Recalling its request to the Board of Governors and the Director General for the preparation of a long-term programme for the Agency's activities [*],

1. Endorses the long-term programme for the Agency's activities annexed to document GC(VII)/227 subject to the availability of financial resources; and

2. Invites the Board of Governors and the Director General to take the long-term programme as a guide in planning and executing the Agency's work over the years, beginning in 1965.

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[*] GC(V)/RES/105.

ANNEX

THE LONG-TERM PROGRAMME FOR THE AGENCY'S ACTIVITIES

Contents

I. INTRODUCTION

A. GENERAL

1. At its fifth regular session the General Conference requested the Board of Governors and the Director General to prepare a long-term programme for the Agency's activities, which shall have regard to the difficulties of financing the Agency's operational programme. This document has accordingly been prepared taking into account the views expressed by the Scientific Advisory Committee, government experts and the Board of Governors.

2. The purpose of the long-term programme is twofold:

(i) To provide general guidance for the direction and scope of the Agency's work in the years to come; and

(ii) To define, in the light of past experience and expected future developments, what role should the Agency play in furthering the peaceful uses of atomic energy.

3. National long-term plans often contain detailed provisions prescribing not only the direction of activities to be undertaken, but also the scope and exact rate of implementation of projects over successive years. It was found inadvisable to adopt such a method for the Agency's long-term programme. The establishment of a programme along these lines would have taken more time and efforts than originally anticipated, and would have produced prognosis the more likely to be later disproved by actual experience. It seemed sounder at this stage to limit the programme to general guiding lines and directives sufficiently detailed, however, to permit further elaboration in the Agency's annual or biennial programmes, and to reflect their financial implications in the annual budget.

4. The long-term programme will begin in 1965. Once its planning has started it will become a continuous and evolutive process and should therefore be revised at regular intervals so as to bring its contents in line with new technological developments. The initial year should provide the basis for more detailed programmes for the next five or six years.

5. The long-term programme has been established on the basis of the present state of knowledge of atomic energy and in the light of the present and foreseeable technological development. A large degree of flexibility is essential in its implementation as its evolution may be considerably affected by scientific and technological developments.

6. It was already apparent in 1957 that some of the basic assumptions reflected in the Agency's Statute did not provide a realistic basis for an immediate programme of activities; this has affected the scope and character of the Agency's work. Recent technological developments however point to the possibility of atomic energy making its impact on economic and social progress somewhat sooner than expected. Increasing national efforts to develop atomic energy have been again taken up and should open broader possibilities for international action in the future. In this sense, the next few years should be envisaged as a period of transition and preparation from the Agency's point of view.

7. The Agency's role and principal task during this period will be twofold:

(i) To strive by international action, whenever such action seems to afford the most appropriate means, to assist in preparing Member States for the introduction of atomic energy in its manifold peaceful uses, and especially nuclear power; and

(ii) To stimulate and co-ordinate work on the development of science and technology with a view to making the advantages of the peaceful uses of atomic energy available to the maximum number of countries in the shortest possible time.

8. The long-term programme contains only few significant departures from the Agency's present activities. The direction and scope of the Agency's work at any time must obviously reflect the current technological, economic, financial and political circumstances; it would therefore be inadvisable to introduce new untested ideas and ambitious projects for the realization of which necessary conditions, especially as regards finance, do not exist. On the other hand, the adoption of the long-term programme should not later prevent the Agency from including new and feasible projects. The programme at this stage mainly reaffirms the Agency's goals and rationalizes the existing patterns of its activities, but there is no doubt that its successful realization would enhance the Agency's ability to undertake new and greater tasks.

9. The programme is based on the conviction that in time the Agency's most important contribution to economic development and general welfare will be in nuclear power. A gradual concentration of effort in that field is therefore necessary. For example the use of reactors to desalt sea-water on a mass scale and make arid zones available for cultivation holds great promise. The expected growth in the use of nuclear power will justify the Agency's continued concern with the problem of safeguards. At the same time, scientific and technological developments in the various applications of isotopes and radiation sources warrant continued and increased efforts to obtain as soon as possible, particularly in the developing countries, tangible results in medicine, agriculture, hydrology and industry.

10. Questions of health, safety and waste management are viewed essentially as an ancillary field where the solution of various existing problems may facilitate to a large extent the economic use of nuclear power and the application of radioisotopes on a wider scale. The international acceptance of safety standards and the publication of regulations and codes on this subject is of course the ultimate goal. During the coming years the Agency is also expected to enlarge the scope of its interests in the development of sciences and techniques related to atomic energy, by making full use of the existing research reactors and atomic energy centres where research can be combined with training on a national or regional scale in co-operation with established institutions of higher learning. Attention will be given to stimulating research, disseminating information, and centralizing documentation.

11. In technical assistance priority will be given to co-ordinated programmes of training, exchange of scientists and experts, provision of equipment and the grant of research contracts, but in every case methods of assistance will be adapted to the particular needs of countries.

12. Monographs on the Agency's activities in relation to the development of nuclear power and the application of isotopes and radiation sources reflecting the views of government experts are appended to the present document. The monographs contain details which have been omitted from the relevant sections of the long-term programme.

B. THE AGENCY'S RELATIONS WITH THE UNITED NATIONS AND THE SPECIALIZED AGENCIES

13. The increasing scope and cost of the activities of the United Nations and related agencies, and especially the growth of their operational programmes, have led to a growing emphasis on the need for closer co-ordination in the decisions of their governing bodies. This trend toward more effective co-ordination should be actively supported by the Agency and in particular closer collaboration with the United Nations, with which the Agency has a special relationship under its Statute, should be further developed. A notable example of such co-ordinated endeavour to focus international action on the problems of economic and social progress is the development decade. The Agency's long-term programme coincides with the second half of the decade during which period details of the Agency's programme will be integrated as far as possible with its objectives.

14. The Agency already participates in the United Nations Expanded Programme of Technical Assistance (EPTA) and is serving as executing agency for United Nations Special Fund projects. EPTA and the Special Fund will play an increasingly vital role in stimulating economic development during the decade. As a result of the growing interest of developing countries in atomic energy programmes, it may be assumed that a larger proportion of their requests under both programmes will consist of projects falling within the scope of the Agency.

15. The Agency should be prepared in principle to include in its own programme, if so requested, activities in atomic energy on behalf of the United Nations and related agencies. The work performed by the Agency in support of the programmes of the United Nations Scientific Committee on the Effects of Atomic Radiation is an example of such a delegated activity; it is logical that the Agency's specialized scientific staff and facilities should be taken advantage of for activities in various other branches in which atomic energy plays a role. In this manner the Agency could serve as an operational organ for atomic energy activities of certain programmes of the United Nations or of a related organization.

16. Although it may be sometimes difficult to draw a precise and rational division of activities between the Agency and some of the specialized agencies, close and continuous collaboration in the spirit of the various relationship agreements concluded in recent years is the best practical method of overcoming such difficulties. In these agreements the Agency is recognized as the body primarily responsible for international action concerned with the peaceful uses of atomic energy. It should be noted particularly that under the Statute the Agency has the specific obligation to establish standards of safety for protection of health and minimization of danger to life and property including such standards for labour conditions; these regulatory activities are to be implemented in consultation, and where appropriate in collaboration, with the competent organization of the United Nations and with the specialized agencies concerned.

17. The Agency will play its role in the new machinery for co-ordination which will be set up within the United Nations family following the recommendations of the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas. This will particularly affect power questions. In view of the considerable capital cost of power development it is imperative for developing countries embarking on new power programmes to examine simultaneously the advantages of conventional as well as nuclear power.

C. REGIONAL ARRANGEMENTS

18. The United Nations and related agencies rely more and more on a regional approach in meeting common problems of countries in the same area. This tendency is reflected in the increased activities of the United Nations Regional Economic Commissions and in the establishment of regional offices of the specialized agencies. So far the Agency has met these problems on an ad hoc basis either by appointing regional experts or by organizing regional centres. It is possible that in the future decentralization of the Agency's work will require a more systematic approach in order to ensure more effective assistance to developing countries.

19. The ultimate economic effects of the Agency's work in various regions must be of growing interest to the economic commissions of the United Nations since the primary task of these commissions is the economic development of the regions concerned. When the need for organized regional arrangements arises the Agency might explore the possibility of integrating both the programmes of work and the administrative aspects, as closely as feasible, with those of the economic commissions of the United Nations.

20. The Agency should also maintain and develop the relations it has established with the regional organizations already set up in various parts of the world to foster the peaceful uses of atomic energy.

II. SUBSTANTIVE ASPECTS OF THE PROGRAMME

A. NUCLEAR POWER

Foreseeable trends

21. The development of nuclear power is advancing rapidly both in its technical and economic aspects. In the latter half of this decade nuclear power will become economically competitive with conventional power particularly in those areas where no indigenous fossil fuel deposits are available or where the cost of conventional fuel is high. This may even be true in respect of smaller stations of 50 - 100 MW(e) built in countries where conventional fuel is especially high. It is probable that more such situations will be identified in the near future. Furthermore, some degree of standardization of small and medium type reactors may well result in a decrease of their unit price and consequently increase their applicability especially in developing countries.

Summary of programme

22. The Agency should regard these expected developments as an enhanced opportunity to advise Member States upon request on their nuclear power programmes, particularly with regard to the economic feasibility of national or regional projects for nuclear power plants.

23. The Agency should also be prepared to give technical advice in connection with siting, reactor type selection and safety evaluation. It should further be prepared to meet requests for assistance beyond the purely advisory function, by preparing requests for United Nations Special Fund projects, acting as executing agency for such projects, and by securing nuclear fuel or, on request, helping to facilitate the financial arrangements.

24. It will therefore be necessary for the Agency to have on its staff not only scientific and technical specialists in nuclear power, but also a team of experts on nuclear power economics, and experts on conventional power, so that the advice given is based on an impartial evaluation of all existing alternatives of power generation. Since it is important to co-ordinate all work on power, the Agency should seek increased co-operation with the United Nations and other international organizations interested in power, including the International Bank.

25. In order to be in a position to give sound advice to Member States the Agency should undertake and promote a series of technical studies on problems of nuclear power economics, in accordance with a plan elaborated by a group of governmental experts.

26. While the Agency cannot itself lend active support to development and research work in nuclear power, except in some peripheral sectors, it should keep abreast of progress achieved by national institutions and continue to disseminate the result, generally on the same scale as heretofore. In addition the Agency could attempt to identify gaps in available information, the filling of which could be of particular assistance to developing countries.

27. It would seem worth while to hold at regular intervals a major conference for the purpose of reviewing technological progress contributing to the economically competitive utilization of power reactors. Particular attention should be paid to developments which might have a decisive influence on the future of nuclear power generation, such as nuclear superheat reactors and breeder reactors, as well as to developments of special importance, such as desalination reactors and small standardized power reactors, suitable for developing countries.

28. The Agency should be ready to help Member States or groups of Member States that take the iniative of launching joint research projects on nuclear power by such means as the provision of expert aid in programming, the grant of fellowships and research contracts and the supply of materials and equipment.

29. While a shortage of nuclear fuel is not likely to occur in the near future, the expected growth in nuclear power installations may modify the present world market with regard to uranium and thorium. The Agency should therefore continue to assist Member States upon request in their programmes of prospection for nuclear raw materials, fuel production and fuel element fabrication. Handling, storage and reprocessing of nuclear fuels are other aspects which may require attention in the future.

30. In providing training facilities special attention should be given to practical training, including on-the-job training in the design, construction and operation of power reactors, not only for scientists and engineers but also for technicians.

B. APPLICATION OF ISOTOPES AND RADIATION SOURCES

Foreseeable trends

31. At present the most widespread application of isotopes is in medicine; however, routine diagnostic procedures are not yet available to the majority of the world's population. Although therapeutic applications of radioisotopes are lagging somewhat behind, it is realized that radiotherapy sources are economical and easy to handle.

32. In most areas of the world the application of isotopes in agriculture is much less widely used. Since in most developing countries agriculture is of great importance there is considerable scope for development. While the use of tracers in the study of soil-plant relationships and the application of fertilizers could be initiated easily in many countries where a minimum of agricultural research is at present conducted, such large projects as grain disinfestation and insect eradication are likely to require an effort for which large-scale help from outside would have to be forthcoming.

33. Application of isotopes in hydrology, where little is being done at present, will have great economic significance in studying the availability of groundwater, or the silt transport in rivers.

34. While it may take some time for the industrial applications of isotopes to make their full impact in countries with small-scale industries it may be to the economic advantage of such countries to introduce these techniques in industry at an early stage.

35. The various applications of isotopes as tracers and as sources of radiation entail comparatively simple and inexpensive equipment. Moreoever, as more research reactors come into operation, many countries will start production of radioisotopes on a scale that will, in some way, meet domestic or regional requirements and make short-lived radio-isotopes available to many areas for the first time.

36. All these factors favour a rapid development of isotope applications especially in the developing countries the economy and welfare of which will derive prompt and significant benefits from the introduction of isotope techniques.

Summary of programme

37. The main emphasis in the Agency's activities should therefore be on the provision to the maximum number of countries of such fundamental and specialized knowledge, and as far as possible the supporting facilities, that are the prerequisites for the successful introduction of radioisotope techniques. Steps should be taken to encourage research for

the development of new techniques, or for the adaptation of existing techniques to the particular conditions of developing countries, as well as the dissemination of the results of such research.

38. It is desirable for the Agency to take the lead in promoting the use of isotopes and radiation sources in the less-developed countries; close and continuous collaboration with the specialized agencies and other intergovernmental and international non-governmental bodies would avoid duplication and would ensure efficient utilization of funds and manpower.

39. The order of priority which the Agency should observe in its work is indicated in Appendix B. Such priority has to a large extent been established in accordance with the needs of developing countries.

40. The promotion of isotope work will entail the initiation and support of an increasing number of relatively small individual projects of varying nature.

41. The steady growth of scientific activities in developing countries will result in a progressive increase in the need for research contracts designed to support practical rather than fundamental work. A further increase in expenditures for research contracts in the applications of radioisotopes is therefore to be expected.

42. There is in addition a need for the Agency's sponsoring during the coming years two or three large-scale research projects, such as the continuation of fertilizer up-take studies and regional studies of plant pest control. Since funds for such projects are not likely to be forthcoming from the Agency's budget, external aid will have to be sought for such work.

43. A sizeable expansion of isotope work in the Laboratory will be needed to bring it into closer relation with the Agency's isotope activities in Member States. The work should include the development of isotope techniques applicable to particular problems in developing countries, and should offer opportunities for the training of scientists therefrom.

44. The need for fellowships and basic training courses in applications of isotopes is not likely to increase very rapidly. Emphasis should, however, be placed on improving the quality, and in many cases increasing the duration, of training. On the other hand, it is expected that requests for isotope experts will increase steadily and that in a few years the number of such requests may be twice as big as it is now. In view of the difficulties in and the costs of recruiting experts, better use will have to be made of their time by organizing technical assistance on a regional basis.

45. Equipment for isotope applications is comparatively inexpensive; but institutions in less-developed countries are usually short of funds and foreign currency. Requests for such assistance will no doubt increase. Accordingly, the proposal made by a group of technically advanced Member States to provide a number of medical isotope laboratories to less-developed countries deserves careful consideration.

C. RADIOACTIVE WASTE MANAGEMENT

Foreseeable trends

46. The foreseeable trends in radioactive waste management can best be discussed from the point of view of the various categories of waste.

47. In this decade the high-level radioactive wastes from fuel reprocessing plants will be a problem mainly for the advanced countries now reprocessing fuel. However, due to improvements in reprocessing techniques the volume of waste will probably be decreased. Higher burn-up as a result of improved reactor technology will also contribute toward lesser waste volumes. The advanced countries may be expected to continue with a

considerable effort in research and development, and, in addition, new methods such as pyrometallurgical reprocessing will be tested in practice.

48. The techniques of treating high-level radioactive laboratory waste are being continuously improved, resulting in smaller volumes of waste to be stored. However, the trend to release less radioactive material to the environment will increase the amount of concentrated waste and makes it necessary even for small nuclear laboratories to concern themselves with the problems of treating radioactive solutions and storing relatively concentrated liquid as well as solid wastes.

49. Intermediate-level radioactive waste is in one sense a separable mixture of low-level and high-level waste, but some cases require special consideration. More experience with treatment processes for various kinds of intermediate-level waste will be gained in various nuclear establishments; such experience, if collected and made generally available, could be extremely valuable.

50. With regard to low-level radioactive waste the main problem is to establish methods for determining operating control levels of activity for wastes which could be dispersed in various environments without hazard. While at present dose monitoring seems an adequate method there is a need to relate discharge to exposure by assessing the pertinent parameters. The formulation of systematic methods for establishing codes and standards should be the ultimate goal.

51. The Agency's role in waste management should consist of collecting and disseminating information by means of meetings and publications, and stimulating new research and development related to wastes from small centres and radioactive waste problems that may have an international bearing. With regard to some waste problems particularly prevalent in developing States the Agency should encourage, promote and, to a limited extent, conduct technical development work and research.

52. When requested, the Agency should provide direct technical assistance.

Activities undertaken by the Agency on its own initiative

(a) Collection, analysis and dissemination of scientific and technical information

53. Among the topics which would deserve special attention are the following:

(i) Development of high-level waste treatment methods which are aimed at incorporation of waste fission products in inert solids, and the related development of appropriate long-term storage concepts;

(ii) Technical and economic evaluation techniques for application to waste treatment processes now being utilized;

(iii) Compilation of data and publication of an international registry of sea disposals of radioactive materials and complementary marine monitoring information; and

(iv) Radioactivity dispersal mechanisms in fluid environments, including diffusion and other dispersal mechanisms in the atmosphere and in fresh and marine waters.

(b) Stimulation of new research and development

54. The scope of development and research conducted by the Agency must be rather limited. On the other hand, through its work in collecting and analysing available information, the Agency should be in a favourable position to identify important gaps in the existing research programmes. Research subjects which are not covered by existing

programmes and which are of significance to the waste management activities in developing countries may become the concern of the Agency.

55. The Agency should also seek ways of stimulating new research and development on such topics through influencing research trends in national institutions, favouring applicable research contract requests, and conducting appropriate panels or other meetings of experts designed to develop interest in particular subjects. Among the topics which currently need emphasis are the following:

(i) Study of the effects of radioisotope materials in the hydrosphere, including demonstration of the accepted technique for establishing technical disposal limits for discharge of wastes into the sea. Fundamental studies of radioactivity in fresh and marine waters should continue to receive strong emphasis in the Agency's laboratories, especially in the Monaco laboratory;

(ii) Development of simple inexpensive waste treatment methods for small-scale applications. The design and application of such methods should be described in an appropriate manual of waste treatment procedures;

(iii) Methods for handling, processing, and disposing of radioactive solid wastes by inexpensive means appropriate for small installations located in densely populated areas;

(iv) Development of equipment and services for treatment of gaseous wastes for application to the requirements of small-scale users; and

(v) Methods for systematic assessment of waste management cost data from operating centres. This study would help new installations to formulate judgements concerning the direction to which their waste management activities should proceed.

56. While, in general, support of research in waste management by the Agency's research contract programme should play a subsidiary role, the award of such contracts should be utilized in the first instance to assist research in developing and developed countries on the problems pertaining to the management of wastes produced by small-scale reactors and centres. Other contracts could be granted in support of research which would have as an objective the solution of practical or specific operational problems in waste management.

(c) Special technical studies and projects

57. The information obtained from Member States as well as the results of research encouraged or conducted by the Agency should be analysed and studied by the staff of the Secretariat, and when appropriate with the help of panels of experts, with a view to establishing, as soon as feasible, a set of standards, regulations and codes of practice.

58. Other technical studies and projects should cover the preparation of a registry of disposal sites in the sea; the registry should include technical information regarding the quantities and form of waste disposed as well as information on possible effects, and the preparation of a study on the feasibility of establishing international burial grounds.

(d) Operational responsibilities

59. It is expected that the Agency's direct operational responsibility with respect to waste produced by its own laboratories and various reactor projects with which it may become actively associated will tend to increase. The Agency should, therefore, increase its efforts in solving the problems of waste management with which it might be faced directly.

Activities undertaken on request of Member States

60. The Agency should be prepared to assist in the training of specialists in waste management problems whenever the need for such specialists arises in developing countries, so that the lack of adequately trained personnel would not hinder the development of national nuclear power programmes. In addition to formal instruction training should also include practical work in an operating centre. In most cases a period of training up to two years may be required.

61. The services of experts for the selection, design and operation of waste management facilities may be needed on an increasing scale. The Agency should be prepared to provide increased assistance towards solving practical and specific problems of immediate significance for centres in the developing countries by the dispatch of missions, visits of its own staff or the provision of short-term experts.

D. HEALTH AND SAFETY

Foreseeable trends

62. As more nuclear projects are implemented in developing countries the need for assistance will increase. Therefore continuing health and safety guidance will be required either in the form of safety standards and technical manuals or in the form of technical advice on particular projects. Even with regard to advanced countries there are instances in which further development and exchange of information is necessary. Moreover, it would be advisable for the Agency to promote international co-operation in certain studies of health and safety problems.

Programme

(a) Work initiated by the Agency

63. In order to provide a sound scientific basis for its regulatory and advisory activities the Agency should continue to collect and digest information on development and research undertaken in the advanced countries. Whenever opportunity affords it may also endeavour to stimulate and co-ordinate research and development projects undertaken by national institutions. Visits by the Agency's scientists to important research and development centres and close co-operation with other international organizations working on the subject, such as the International Commission on Radiological Protection (ICRP) and the International Labour Organisation (ILO), are especially suitable methods of keeping abreast of progress.

64. The Agency should continue to provide advice with regard to the safety aspects of the simple uses of atomic energy, such as the application of radioisotopes, and with regard to problems common to all uses of atomic energy, such as monitoring practices. While keeping these subjects under continuous review, advice in matters of safety should be related to more advanced activities, such as mining and milling of nuclear ores, land-based or mobile power reactors and chemical processing plants. Symposia will often be useful prior to publication of data.

65. The problems relating to the design and testing of containers for the transport of radioactive materials and to the safety of shipments of fissile materials should be actively studied.

66. The Agency should not fail to attach high priority to studying the occasional incidents or accidents in nuclear establishments, as these provide a special opportunity for acquiring knowledge and experience.

67. Application of the Agency's health and safety standards and regulations to projects undertaken or assisted by it is a continuing task which may be expected to require a gradually increasing effort.

68. Co-ordination of certain health and safety work associated, for example, with work on whole-body counting, environmental study, methods of bio-assay and gamma radiography will be desirable.

(b) Assistance provided on request

69. The Agency's staff will probably be called upon increasingly for advice and assistance on the many special problems of health and safety which can arise in the operation of research centres in developing countries. It should be prepared to deal with most of these problems by correspondence, by special studies, by services performed in the Laboratory and by visits of experts to the countries concerned.

70. As the number of nuclear research centres grows, there will be a corresponding increase in requests for site and safety evaluations. The Agency should be prepared to respond to such requests by making available members on its staff or consultants, or by sending technical missions.

71. Co-ordination of international aid in the event of nuclear accidents must be regarded as still in the exploratory stage and the programme of aid should be expanded and adapted to experience.

E. WORK IN THE PHYSICAL AND LIFE SCIENCES IN RELATION TO ATOMIC ENERGY

General programme

72. In addition to its work in nuclear power and applications of radioisotopes, the Agency must maintain a lively interest in the developments of fundamental disciplines, especially physics, chemistry and the life sciences in so far as they are related to nuclear energy. Further progress will depend upon research in these sciences and the availability of trained scientists in the developing countries.

73. The Agency's activities in these sciences must be limited as regards both modes of work and the effort expended; since the scope and direction of the Agency's interest depend largely on unforeseeable circumstances it does not appear feasible at present to draw up a definite programme of future activities.

74. The main role of the Agency should be that of collecting, digesting and disseminating information, providing training and, to a lesser extent, stimulating research. Co-ordination with other international organizations will be of great importance.

75. The Agency should, however, also be alert to opportunities which may present themselves and participate actively in particular studies. It is, for example, vital to render assistance in the utilization of research reactors, as indicated below. Further examples of the kind of action the Agency may be called upon to take under this head are the establishment of a group of experts with the task of compiling and co-ordinating nuclear data, the encouragement and assistance of theoretical physicists from developing countries by the establishment of an international centre of theoretical physics or by other suitable means such as summer schools. Similarly, it has been suggested that the Agency might assist in bringing about future international projects, such as an accelerator of very high energy or a reactor of very high flux for research in solid state and nuclear physics.

76. So far the Agency has organized meetings and issued publications on work done in solid state physics, theoretical physics, plasma physics and thermodynamics. New topics which it may be desirable to take up include direct conversion, physics common to space and nuclear research, including radiological health and safety aspects of space exploration, interaction between radiation and matter, and radioactivity and radioresistance. The Agency's general aim in each should be to review the progress made and to assist in further promoting it on a broad basis throughout the world, especially as a result of exchange of information by means of symposia, expert meetings and publications.

77. The contribution which the Agency's laboratories will make to research under this head is described in section III.C below.

Assistance in utilizing research reactors

(a) General remarks

78. The simplest type of research reactor is expensive to build and operate, therefore its fullest possible use is of extreme importance. Used properly and intensively, research reactors do not only yield scientific information but also contribute to the development of national nuclear power programmes.

79. The Agency could render valuable service in encouraging the best possible use of research reactors, in co-ordinating Member States' research programmes and in exchanging information as to the results obtained. It should, therefore, be prepared to meet an increasing number of requests for such assistance and try to meet these requests, whenever possible, with an integrated programme of assistance covering a long period and as many subjects as possible.

80. With this in view, the Agency should maintain a keen interest in the following subjects:

(i) Nuclear physics particularly as regards the use of research reactors of small and medium power;

(ii) Physics of condensed state with particular emphasis on neutron diffraction methods, elastic and inelastic scattering experiments - including cold neutron techniques - and studies of radiation damage in solids;

(iii) Reactor physics and technology, including neutron thermalization and diffusion studies, lattice experiments and shielding studies;

(iv) Radiochemistry and radiation chemistry, including radioisotope production techniques and activation analysis methods;

(v) Radiobiological and medical studies connected with neutron and gamma-ray irradiation; and

(vi) Reactor operation problems.

(b) Work initiated by the Agency

81. In addition to assistance to newly-established research reactor centres the Agency should encourage co-operation and co-ordination between them and with older and advanced centres.

82. Regional study group and other meetings should be organized regularly to discuss the subjects mentioned above or particular aspects thereof. In addition, whenever necessary the Agency should convene panels of experts to assess progress in a particular part of research reactor work, with a view to suggesting further subjects of research, or co-ordinating parallel research carried out in different laboratories.

83. Whenever practicable, the Agency should encourage and support joint research ventures involving the use of research reactors and should in general seek to promote co-operation, including the co-ordination of research work and the exchange of scientists and information between neighbouring centres or centres engaged in similar work.

84. The award of research contracts can be an effective contribution to the programmes of a research reactor, and it is expected that a bigger proportion of the Agency's appropriation for research contracts will be assigned for that purpose. Such contracts may be particularly valuable in assisting small centres potentially capable of developing independent national programmes.

(c) Assistance provided on request

85. Simplified administrative procedures should be devised in order to speed up the provision by the Agency of small amounts of special materials and equipment needed in research projects.

86. Where experts are requested, the standard practice of sending one expert for a long period should not necessarily be continued. In order to develop a research programme it may often be more useful to send a scientist for short periods at longer intervals as the programme reaches the stage of independent work. The same purpose could be achieved by the use of regional experts and the establishment of close inter-laboratory collaboration.

87. The award of fellowships to several young scientists from the same laboratory for the study of closely related aspects of one subject would increase the possibility of it developing into an independent research programme. This method would help moreover to obviate a feeling of isolation from which scientists often suffer when they cannot exchange ideas with fellow workers in the same branch of science. Co-ordination of the fellowships programme with the provision of experts is also essential.

88. Research centres may need assistance in formulating their research programme or a specific part of it, and the Agency should be prepared to send upon request expert missions for this purpose.

III. FUNCTIONAL ASPECTS OF THE PROGRAMME

A. ACTIVITIES INITIATED BY THE AGENCY

Encouraging research

89. Though the scope of the Agency's research programme will of necessity be limited, it can, through proper planning and judicious use of modest resources, provide an invaluable stimulus to the advancement of research in nuclear energy. The Agency should however keep a proper balance between the following three main methods of encouraging research and, whenever appropriate, combine all three in integrated programmes:

(i) Stimulation and co-ordination of research in Member States without cost to the Agency;

(ii) Support of research by the grant of research contracts; and

(iii) Direct research activities conducted in the Agency's laboratories.

90. The Agency has an important role to play in stimulating fundamental and applied research projects which have a bearing on the development of peaceful uses of atomic energy to be undertaken by national or regional institutions from their own funds on individual or co-operative bases, but under the sponsorship of the Agency. Such projects should be carefully selected either directly by the Secretariat or with the assistance of panels of scientists from institutes likely to be interested in such ventures. The Agency's role should consist in initiating and, if possible, co-ordinating such research projects and subsequently publishing the results as part of its programme for the dissemination of information. For example, plans are under consideration for co-ordinated work in various countries on the radiotoxicity of incorporated radionuclides.

91. Research contracts have been used in the past for the financial support of research projects deemed to be of general value to Member States and specific interest to developing countries. The latter type of research contracts, which often served the incidental but important purpose of assisting scientific institutions or individual scientists in developing countries, should in the future be given higher priority. Among the wide variety of subjects deserving support, special attention should be paid to practical applications of isotopes and radiation sources in medicine, agriculture and hydrology as well as to research on local factors determining the siting of reactors and the type to be selected.

92. Research contracts in support of other projects should as a rule be part of an integrated research programme of general scientific or technological value. In some cases it might be appropriate to grant a contract so as to arouse interest in a particular research project, the funds for which would however have to be found subsequently from other sources.

93. While it is not possible to evaluate with any degree of accuracy future legitimate demands on funds for research contracts, it may be assumed that needs in respect of research conducted in, and for the benefit of, developing countries will increase. This tendency might be partially offset by a gradual decrease in awards of certain other types of research contracts, especially if the Agency succeeds in arranging for research to be carried out externally without cost to it. On the whole, however, an increase of expenditure for research contracts is to be expected.

94. Research in the Agency's laboratories should be devoted primarily to problems of an international character where the world-wide connections of the Agency can be brought into play (e.g. the international inter-comparison of analytical methods and the world-wide survey of tritium concentrations in water) or where work forms an integral part of a co-ordinated research programme also supported through research contracts, such as the

current rice research programme. The place of research activities within the over-all programme of work in the Agency's laboratories is described in section III. C below.

95. In furthering research the Agency must of course seek to ensure the necessary co-ordination with other interested research organizations with a view to avoid possible duplication of effort and obtaining the most fruitful results from the limited funds available.

96. The research programme sponsored by the Agency, whether supported by research contracts, undertaken in its own laboratories or conducted by outside institutions, will continue to require guidance and advice from panels of experts. Such panels have played, and will continue to play, an essential role in developing the Agency's activities in research, and particularly in helping to stimulate research projects undertaken outside the Agency and without its financial support. They have also proved to be the most effective means for the Agency's staff to keep abreast of recent scientific progress and of development plans in the more advanced countries. It may be assumed therefore that the need for panels of experts will increase gradually during the coming years.

Disseminating scientific and technical information

(a) General

97. The Agency's work in disseminating scientific and technical information must reflect the important developments which have taken place during the last decade, leading to an enormous expansion of scientific work, the proliferation of research centres and the transformation of research from an essentially academic endeavour into an undertaking actively sponsored and supported by governments and industry. The need for co-ordinated and organized exchange of such information has therefore become a major problem. A number of developed countries, having at their disposal considerable funds, have established large organizations for garnering and distributing scientific information.

98. An organized flow of scientific and technical information is of particular importance to developing countries, especially to those that have scientific potentialities the full use of which is hampered by organizational difficulties.

99. In general the role of the Agency is to foster the international exchange of scientific and technical information and supplement it when appropriate by its own activities with particular attention to the needs of the developing countries.

(b) Library collection

100. The Library is intended to have an international collection of scientific, technical, legal, administrative and economic publications relating directly to the peaceful applications of nuclear energy. In addition it must contain the main standard and general works on nuclear and natural sciences and technology. It has the twofold function of a research and reference library, serving the needs of Member States and of the Agency's staff.

101. The Library is in a favourable position to obtain research reports, documents, reprints and other unpublished material from Member States of which full advantage should be taken. The collection of references and abstract journals should be enlarged to cover not only nuclear sciences but also borderline subjects, such as theoretical physics, mathematical physics and applied mathematics. It might be useful to start also a repertory of information on scientists and educational and scientific activities in nuclear sciences, based initially on the information already available to the Agency.

(c) Information storage and retrieval

102. In the long run, the Agency may have to seek a satisfactory solution to the growing problem of information storage and retrieval in the use of special equipment and computers which may be utilized at the same time for other of its needs.

103. Increased use of microcards and microfilms, particularly for the collection of unpublished material, should be considered.

(d) Dissemination of information

104. The Agency should continue its work in the following activities:

(i) Publication of lists of material received for the Agency's collections;

(ii) Preparation and periodic up-dating of bibliographies based on a search of abstracting journals and of the original literature;

(iii) Co-operation with international organizations, particularly UNESCO, and other documentation centres, in co-ordinating abstracting activities and organizing the exchange of abstracts. The Agency should co-operate in drawing up exchange agreements and extending such agreements on a multilateral basis in accordance with the programme for "Exchange of Abstracts" approved by the Board of Governors; and

(iv) Participation in the development of a suitable multilingual system of classification, terminology and coding for studies covered by its activities.

105. Documentation on scientific and technical equipment and instruments should be further developed for the dual purpose of serving the internal requirements of the Agency in connection with the supply of equipment for technical assistance, research contracts, the Agency's laboratories, and as a source of information for Member States.

(e) Scientific meetings

106. In the Agency's programme of scientific meetings, emphasis should be accorded to certain topics of continuing interest on which it would be advisable to convene meetings at regular intervals. In particular, the Agency should study the advisability of convening a conference to review technological progress contributing to the economically competitive utilization of power reactors. Similar recurrent meetings should be envisaged on plasma physics, nuclear electronics, metrology of isotopes, dosimetry of radiation and application of isotopes. Priority may also have to be given to other specialized topics in the study of reactors, relating, for instance, to the development of fast and breeder reactors and the utilization of research reactors.

107. The list of subjects to be dealt with at Agency-sponsored meetings should be co-ordinated with other scientific organizations so as to ensure maximum coverage and avoid duplication. The number of meetings should be kept at the present level of about ten to twelve per year.

(f) Programme of publications

108. In its publications programme the Agency should accord priority to the proceedings of the Agency's scientific meetings in addition to panel reports, directories and scientific journals such as The Fusion Journal and The Atomic Energy Review. The over-all purpose of the programme should be to reflect the Agency's work and to give information on the latest developments in the nuclear sciences.

109. It is expected that the Agency will continue to rely on its internal reproduction facilities for the bulk of its publications programme. Production methods should therefore be continually reviewed so that maximum efficiency and economy may always be achieved.

(g) Assistance in documentation

110. On request, the Agency should be prepared to assist Member States in organizing their libraries and documentation centres in nuclear energy. The grant of fellowships and

training courses, the organization of library and documentation centres by Agency's experts and the provision, in special cases and to a limited extent, of auxiliary equipment, such as microreaders or document reproduction equipment, or subscriptions to periodicals will be the usual methods of rendering such assistance.

Regulatory activities

111. The sections on health and safety and on waste management contain an outline of research and scientific studies to be undertaken by the Agency in preparation for and support of its programme of safety standards. The purpose of this chapter is to give an over-all view of the programme of regulatory activities, comprising the establishment of international norms for direct application by Member States or international standards to be used as a basis or model for national laws and codes.

112. These norms and standards, which are issued under the authority of the Board of Governors and the General Conference and take the form of international instruments or of recommendations, which are however binding upon the Agency's own operations, and may, by agreement, become binding upon projects assisted by the Agency, should be clearly distinguished from other forms of advice such as that contained in manuals or other types of material compiled and published by the Agency which lack either the formal character of the norms and the standards or their legal purpose and content.

113. The preparation of regulatory norms and standards requires a solid scientific foundation based on knowledge and experience of the subject in question, and in many cases considerable legal knowledge often of an innovatory or a controversial nature. Panels of scientific and legal experts will therefore continue to be convened to assist in the evaluation of scientific data and in the clarification of legal issues.

114. In order to achieve a set of standards to cover all main aspects of radiation safety, it is proposed to supplement and complete the standards already established for application to the simplest and commonest uses of atomic energy. It is also proposed to develop the general outlines of standards relating to more elaborate and less widespread types of operations which in a later phase may be gradually expanded so as to provide detailed standards for them as well. Similar principles will guide the organization of work on international norms. The Agency is well situated to assume an increasingly important role in this subject.

(a) Health and safety

115. The revision of the Agency's basic safety standards adopted in 1962 will be a task for the immediate future. The study should be supplemented by standards concerning the permissible emergency doses to the public.

116. Codes of practice should be developed in consultation with ILO and other international organizations on the following subjects: basic tasks and requirements of radiation protection services in small nuclear establishments, and essential requirements for adequate personnel, area and environmental monitoring; safety standards in mining and milling operations and standards regarding certain problems arising in chemical processing plants (such as protection against plutonium hazards or criticality hazards).

(b) Waste management

117. The preparation of a code of practice for the safe disposal of radioactive wastes by users of radioisotopes will be a task for the immediate future.

118. Depending on the progress of supporting scientific work, and in some cases on the clarification of underlying legal issues, work should be pursued on the following subjects:

(i) Standards concerning the safe management of high-activity wastes;

(ii) Preparation of regulatory measures with regard to the disposal of radioactive waste into the seas, subject to consideration by the Board of Governors in June 1963;

(iii) Preparation of general standards for the safe disposal of radioactive wastes into fresh water; and

(iv) Elaboration of a legal framework for the establishment of international or regional burial sites for waste storage.

(c) Transport of radioactive materials

119. While a revision of the Agency's regulations for the safe transport of radioactive materials is expected to be approved in 1964, further work will be necessary with respect to testing and design specifications for transport containers.

120. There is an urgent need for co-ordinating the relevant provisions of the various international instruments dealing with the transport of dangerous goods. The Agency should initiate and should play a leading part in this work, taking particular care to ensure that the rules are applicable to all geographical areas and all modes of transport.

(d) Reactor safety

121. More scientific research is needed before it will be advisable to prepare detailed Agency standards in reactor safety. The Agency should strive nevertheless to issue in the coming years safety standards of at least a general nature on such subjects as site safety assessment, safe operation of research reactors, safe operation of power reactors and safe use of harbours and canals by nuclear merchant ships.

(e) Compensation for nuclear damage

122. Following the adoption of a Convention on Liability of Operators of Nuclear Ships, in May 1962, the Agency will participate in the work of a standing committee which has been set up to deal with a number of residual questions, such as the possibility of establishing an international jurisdiction to hear actions for compensation for nuclear damage and the possibility of establishing an international guarantee fund with a view to enabling financially poorer States to meet their indemnification obligations. The Agency will also take part in the preparatory work for the revision of the Convention, scheduled to take place five years after its entry into force.

123. Once the convention on minimum international standards regarding civil liability for nuclear damage has been adopted the Agency may be called upon to co-operate in drawing up the relevant national laws and regulations and in elaborating regional conventions to implement these standards.

124. The important but very complex problem of State responsibility for damage caused to the nationals, territory and rights of other States will also require attention.

Safeguards

(a) Foreseeable trends

125. Although it is not possible to predict accurately the rate of growth of the Agency's safeguards responsibilities, indications show that a gradual increase may be expected. It seems likely that most of this increase will be due to the Agency being made responsible for the administering of bilateral agreements between Member States, and to a much less extent due to the application of safeguards to the Agency projects.

126. So far the Agency has received no requests to assist Member States in establishing their internal systems for the control of nuclear material. However, with the expected gradual increase in the number of power and research reactors Member States may begin to request such assistance.

(b) Programme

127. General. The term "Agency safeguards" is at present related to safeguards against military diversion of nuclear facilities and nuclear material. The Agency's safeguards apply to Agency projects and to nuclear facilities and material to which such safeguards are applicable on a voluntary basis.

128. The implementation of the programme described below will depend on the number of facilities and projects actually brought under the Agency's safeguards during the coming years.

129. Safeguards provisions and procedures. The document setting forth the Agency's safeguards (INFCIRC/26) provides the basic guidance for the administration of safeguards by the Agency. The provisions of this document will have to be extended to cover reactors of more than 100 MW(t), plants for processing and fabricating nuclear fuel and scrap recovery, plants for reprocessing irradiated nuclear fuel and the storage and transportation of nuclear material.

130. In accordance with the decision adopted by the General Conference at its fourth regular session, the basic safeguards document should be reviewed in the light of experience obtained in its application and the technological developments. Such a review should be used to remove existing inconsistencies.

131. The Agency may have to undertake the preparation of additional provisions to cover such problems as the depositing of excess quantities of special fissionable material with the Agency in order to prevent its stockpiling [1]; providing security measures for storing special fissionable material; developing safeguards for the transportation of nuclear facilities and materials; developing safeguards of nuclear materials in possession of the Agency; and developing safeguards for merchant ships with nuclear propulsion.

132. Since the basic safeguards document lays down only general principles, additional detailed provisions and procedures may have to be developed, such as related to sampling of nuclear material, coverage of costs involved in the application of safeguards, production of small quantities of special fissionable material, and nuclear material losses.

133. General procedures, as well as detailed procedures for particular facilities, should be further developed for the accounting of nuclear material under safeguards. Production of special fissionable material in reactors requires supervision of the operation of the reactor by the Agency. In order to conduct additional and shake-up calculations access to a computer may have to be obtained.

134. General studies and development of technical methods. The preparation of basic data for the efficient application of safeguards may require various studies to be completed by the Agency, possibly with the assistance of other organizations.

135. In order to develop technical methods for the application of safeguards, various national nuclear centres may have to be awarded research contracts for studies such as:

(i) Methods of identification of fuel elements;

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[1] Article XII. A. 5 of the Statute.

(ii) Tamper-proof reactor instruments; and

(iii) Non-destructive analysis of non-irradiated and irradiated fuel elements.

136. Work on routine methods for analysis of nuclear material samples and for the determination of the characteristics of facilities should gradually be taken over by the Laboratory.

137. Following the development of methods for inspection measurements suitable equipment will have to be procured.

138. Initial review of facilities and inspections. Facilities brought under Agency safeguards will require initial review so as to ensure that they will not further military purposes and that they will permit effective application of safeguards. The assistance of Agency reactor experts as well as of external consultants may be required.

139. As more facilities come under Agency safeguards, there will be a corresponding increase in the number of routine inspections required involving audit of accounting and operating records, controlling of reactor operation and nuclear material, comparing of the completed facility with the design; and reviewing the experimental programme carried out at the facility.

140. In order to ensure effective performance of inspections, new procedures should be developed which will include both general and detailed instructions worked out for the particular facility.

B. ASSISTANCE RENDERED BY THE AGENCY ON REQUEST

Needs

141. In order to meet the task of estimating future needs of Member States for assistance in training, the provision of experts and equipment and other forms of technical assistance, the Agency should undertake a study of national development plans in the peaceful uses of atomic energy, where such plans exist, and of the resources available for the support of such plans.

142. In general, the type and scope of assistance required depends on technical, scientific as well as specific nuclear development in the requesting countries. A description of the type of assistance most frequently requested by various countries of the same category from the point of view of their degree of development may be a useful method to provide guidance as to their needs.

143. Countries can be divided into four categories between which, however, there are no rigid dividing lines:

(i) Countries that are taking the first steps towards technical, scientific as well as nuclear development. Approximately 20 per cent of the Member States belong to this category;

(ii) Countries that have made some progress in introducing nuclear science and the application of radioisotopes in agriculture and medicine, etc. Approximately 25 per cent of the Member States belong to this category;

(iii) Countries which have established, or have planned to establish in the near future, research reactors or sub-critical assemblies, or both, and already utilize the application of radioisotopes. Approximately 30 per cent of the Member States belong to this category; and

(iv) Countries that have nuclear reactors for power production either in operation, under construction or in an advanced stage of planning, or are undertaking the improvement of industrial processes, and devoting substantial funds for research and development. Approximately 25 per cent of the Member States belong to this category.

144. The availability of trained personnel is of course of prime importance at all stages of development corresponding to the categories described above, and is a pre-condition for passing from one stage to another. The needs in training, as indeed the needs in other types of assistance, will vary, however, from category to category.

145. First category. Scientific and technical education will be a predominant requirement for this group of countries. The establishment of a nucleus of scientists and technicians capable of laying the foundation for the development of the various peaceful uses of atomic energy is a main problem. In that connection it is difficult to emphasize the importance of creating facilities for the teaching of atomic energy sciences at institutes of higher education. This matter is of such vital interest for the development of atomic energy that the Agency cannot refuse to provide assistance especially if such assistance is not obtainable from other sources. Close co-operation with the United Nations Educational, Scientific and Cultural Organization (UNESCO) will be necessary, and in many cases the initiative will belong to that organization. However, whenever the assistance requested has a direct and close link with the development of atomic energy such as for instance in nuclear physics or radiochemistry, and no other aid can be substituted, it will be legitimate for the Agency to respond to the request. The most usual forms of assistance will consist of sending visiting professors.

146. Fellowships, especially for the training of future higher education instructors, and scientific equipment will play a complementary role. In addition, countries of the first category sometimes seek assistance in the application of radioisotopes in medical and agricultural work. Such projects are usually carried out in scientific facilities with a small staff and a modest amount of equipment.

147. Second category. Countries of this group include those that have made some progress in nuclear science and already have research institutions. Their requests for assistance are of a wider nature; their need for technical assistance is often characterized by a relationship to economic aspects such as increase of crop yields by proper use of fertilizers and in some cases development of new plant strains by induced mutations. The application of radioisotopes is mostly used as a new tool to assist them in scientific and technical work which has already been undertaken by conventional means. It is common for this group to request assistance in medicine, particularly in relation to diagnosis and therapy of diseases endemic in those countries. A further form of technical assistance commonly requested is in the prospection for and development of their nuclear mineral resources either for their value as an export commodity or as a provision for the anticipated future needs of the country in nuclear materials. Requests for assistance in water supply and irrigation projects in which tritium tracer methods are applied have been significant in recent years.

148. Requests for assistance in training from the second category of countries are expected to emphasize the training of specialists in various techniques in the application of radioisotopes, especially in agriculture, hydrology and medicine. Fellowships will play an increasing role. Training courses in the application of isotopes would also be of particular benefit for this group. Assistance will continue to be needed in fundamental nuclear education with emphasis veering gradually from visiting professors to fellowships for post-graduate studies.

149. Third category. This category consists of those countries that have established, or plan to establish in the near future, research reactors, sub-critical assemblies, or both, and make the widest use of the complete range of the Agency's possibilities for providing assistance. They usually have a comprehensive range of scientific institutions and possess

the main elements of technical knowledge necessary to enable them to obtain full benefits of nuclear technology. These conditions are not only desirable for the application of radioisotopes, but are necessary for the operation of a nuclear research reactor and the ancillary laboratory facilities. Such facilities can be most effectively operated in places where there is ready access to essential technical services, spare parts and supplies. This category of countries makes possibly the greatest volume of demands for technical assistance from the Agency. Their needs in training will become increasingly variegated and specialized. Requests received from them are often similar to those received from countries in the second group; in addition they also request assistance in health physics and radiological protection, and in some cases in metallurgical research, fuel elements fabrication, nuclear electronics and instrumentation, as well as in reactor construction, safety evaluation and research programming. Assistance in highly specialized applications of radioisotopes in industry, biology, entomology and in nuclear irradiation is often sought, while assistance in the raw materials field continues with the processing of uranium ores, production of uranium metal and fuel fabrication.

150. The need of countries in the third category for specialists in isotope applications, including applications in industry, will continue, and the training of reactor physicists and engineers, specialists in nuclear waste management, and health physicists will become of significance.

151. Fourth category. Even some of the highly advanced countries require outside assistance. Nuclear science is developing so fast that no country can be completely self-sufficient. Countries in this category, however, usually arrange for assistance through bilateral channels, and use the Agency's assistance only occasionally - in connection with highly specialized activities such as the evaluation of reactor hazards, fuel reprocessing and special metallurgical problems, and in some cases in connection with training in advanced or very specialized subjects.

Types of assistance

152. Fellowships. A larger number of requests for fellowships is to be expected due to the increasing membership of the Agency and also because some of the developing Member States are realizing the potentialities of the Agency's fellowships programme. This expected increase may be, however, to some extent compensated by the decrease in the number of requests from other countries. On the whole it is not anticipated that there will be any significant growth in the total number of requests. However, due to the need for long-term fellowships the resources required to meet such needs may nevertheless increase. In the first years of the programme, emphasis will continue on training of specialists in various applications of isotopes and on training in more fundamental disciplines, such as nuclear physics and radiochemistry. At a later stage it may be expected that a larger number of requests will be made for fellowships in special branches of applied sciences related to construction and operation of reactors, with special emphasis on the need for practical training in a reactor facility.

153. Visiting professors. A relatively large increase of requests for visiting professors is to be expected. With the development of national atomic energy programmes, interest will shift to the training of a larger number of specialists in the country itself. This need will be felt both in fundamental sciences related to atomic energy and in applied aspects of the use of isotopes and nuclear power. In some cases assignments of visiting professors for more than one year will have to be envisaged.

154. Training courses. The Agency, in consultation with its Member States and other international organizations, should be prepared to organize the following types of courses:

(i) Specialized training in the application of radioisotopes in agriculture, medicine, hydrology and industry;

(ii) Regional studies on the effective use of research reactors;

(iii) Training on such selected topics as nuclear physics, radiochemistry, radiation chemistry, radiobiology, human bio-assay, radiation health and safety, use of high energy radiation therapy, etc.; and

(iv) Refresher courses for members of the physics, chemistry and biology faculties of higher educational institutions.

Certain of these courses will have to be planned for a longer duration than was the practice in former years.

155. Regional radioisotope training centres. The Agency may be asked to assist in establishing regional training centres along the lines of the already existing Middle Eastern Regional Radioisotopes Training Centre for the Arab Countries.

156. The programme of research grants and scientific visits, though limited in scope, may prove to be a useful tool in assisting young scientists from developing countries in keeping abreast with scientific developments in advanced centres.

157. Mobile radioisotope laboratories. During the next few years, the laboratories will be used mostly in the countries that have become new Members of the Agency.

158. Experts. The fields in which the services of the Agency experts may be required in the next few years are described in the foregoing section on needs. A gradual increase in the number of requests for the services of experts is to be expected. Work in nuclear energy covers a wide number of subjects, and often an expert can only carry out his work successfully if he co-operates with other specialists on related subjects. In some cases it is therefore necessary for a country to receive assistance simultaneously in more than one branch of the nuclear sciences. Cases have been noted where a small group of experts working simultaneously in close co-operation would have been able to provide more effective assistance than the same number of experts visiting the country at different times. It is also believed that such a group of experts might successively serve several neighbouring countries and thereby effect savings in time and money. In some cases such savings could also be achieved if one expert serves as regional adviser a number of neighbouring countries, as for example in health physics and radiation protection.

159. Provision of equipment. There is no doubt that requests for scientific and technical equipment will increase considerably. The Agency, applying the principles governing EPTA, provides equipment only in conjunction with the dispatch of an expert. In view of the increasing demand for equipment and the lesser need for experts and because of the limited resources available to meet such requests the Agency should carefully study and formulate a policy on the conditions under which it would furnish requesting countries with equipment. Such a study should, among others, be directed to examining the question of whether under appropriate conditions it could supply equipment without sending an Agency expert.

160. Missions. The Agency cannot render effective assistance without remaining in close contact with the conditions prevailing in the requesting countries. While the number of preliminary technical assistance missions is going to decrease in the future, follow-up missions composed as a rule of a smaller number of participants will continue to play a very important and useful role. In addition the more frequent dispatch of members of the Secretariat must be envisaged. Such ad hoc missions may be required in any project of interest to the Agency, but it is expected that they will be particularly frequent with respect to projects in various applications of isotopes, including hydrology, surveys of economic feasibility of nuclear power, site and hazard evaluation, health, safety and waste management problems, utilization of research reactors, etc.

161. While each of the various methods of assistance enumerated above serves a separate purpose, it is expected that in the coming years emphasis will centre on such projects as will require a combination of various types and methods of assistance. As an example, the promotion of effective utilization of research reactors may involve missions and experts,

awards of fellowships and research grants, and in some cases provision of equipment. In addition, research contracts, although they are not primarily a means of technical assistance, may be utilized in that connection. Other activities which in themselves are not conceived as technical assistance projects, such as joint research projects, may have nevertheless an important training aspect and may require the award of fellowships, the sending of experts, etc.

162. The proposal first submitted to the sixth regular session of the General Conference by a number of Member States to include in the programme of technical assistance the provision of medical isotope centres and physics laboratories would also involve various other types of assistance, such as the provision of experts, granting of fellowships, etc. This proposal is being explored and, if approved, its implementation would be spread over the next few years as part of the Agency's long-term programme in technical assistance.

Programming procedures

163. With the expected growth of requests for assistance and the limitation of resources to meet these requests, the problems of co-ordination and priorities will gain in importance. The Agency should therefore study and adopt improved programming procedures based on the application of the fundamental principle that assistance is given in response to requests of Member States and that such Member States should have the maximum freedom in indicating priorities; it should also recognize that all types of technical assistance should as far as possible be combined to produce the maximum benefit to the requesting country. The programming procedures should also take into account the need for a closer co-ordination of assistance rendered by the Agency from its own resources with the assistance financed from other sources, such as EPTA or the Special Fund.

Resources

164. Since under the present system the resources of the Agency for rendering assistance are derived from voluntary contributions, it is not possible to forecast with any degree of certitude the funds that will be available in the coming years for that purpose. This constitutes a serious weakness of the Agency's assistance programme. A satisfactory solution to that problem is a necessary corollary to the establishment of a long-term programme of the Agency. It would be desirable if such a solution resulted in placing at the disposal of the Agency resources fulfilling the following conditions:

(i) The total amount of resources should be in some reasonable relation to the real needs for assistance as reflected in a well-prepared and integrated programme;

(ii) A certain, even if modest, annual rate of growth should be counted upon in the resources to correspond in some measure to the expected growth of needs;

(iii) A higher degree of predictability as to the actual volume of resources placed at the disposal of the Agency in any given period should be achieved by appropriate means; and

(iv) The resources should be contributed in a form which on the one hand would assure maximum flexibility, enabling the best use to be made of them for the benefit of developing countries and which, on the other hand, would not hamper the ability of Member States to make valuable and increasing contributions.

C. THE AGENCY'S LABORATORIES

165. The purpose of the work performed in the Agency's laboratories is threefold:

(i) To provide, on request, services to Member States. This should remain a primary task of the Agency's laboratories at Headquarters and at Seibersdorf. It entails also some development work in anticipation of future requests;

(ii) To undertake research work in support of the Agency's substantive programmes when it is deemed appropriate for such research to be carried out by an international team of scientists or when the research pursued is an integrated part of a wider research project supported by the Agency through other means, such as the grant of research contracts; and

(iii) To provide training facilities for young scientists from developing countries.

Services available to Member States

166. It is expected that requests for services will gradually increase as a consequence of the development of national atomic energy programmes. Some of the types of services which the Agency's laboratories should be prepared to provide are enumerated below:

(i) Distribution of calibrated radioisotopes, the demand for which will probably increase steadily. Methods of quality control should be studied to help in verifying the chemical and radiochemical purity of isotopes produced in Member States;

(ii) Environmental studies and collection, transmission and analysis of samples for the determination of strontium-90. The range of radioisotopes to be analysed is expected to be wider;

(iii) Supply of standards and test materials for bio-assay techniques;

(iv) Analysis of samples for tritium content;

(v) Routine analysis of samples for soil-plant relationship studies; and

(vi) Development of standard methods for analysis of reactor materials.

Preparatory work to meet future requests for services

167. The expected increase in the number and the widening of the range of requests for services from the Agency's laboratories will necessitate the development of new research methods and techniques. For example, it is planned to start a study on calibration of slow and fast neutron fluxes, with a view to providing standard foils for neutron dosimetry. Similarly, absolute measurements of gamma doses from cobalt-60 may have to be undertaken to provide calibration facilities for chemical dosimeters and cavity ionization chambers. The service for distribution of calibrated radioisotopes should also be improved by including control measurements of data which are not yet known, such as half-lives, branching ratio and fluorescence yields.

Research work in support of substantive programmes

168. The studies of radioactivity in marine and fresh water, including research on physical, chemical and biological mechanisms, will be continued and extended to more fundamental aspects in view of their importance for the Agency's work on health, safety and waste disposal. The studies of radioactivity in marine water will continue to be conducted at the Monaco laboratory. In the application of radioisotopes priority will be given to problems of significance to the developing countries. The Agency's laboratories should participate in integrated study projects organized along the lines of the present rice fertilizer up-take study but relating to other agricultural products and the use of iodine-125 in medicine and hydrology.

169. Methods for determining radioactivity, including bio-assay, may have to be developed and standardized. The whole-body counter should be used, both for studies of persons accidentally or occupationally contaminated with radioactivity and for studies supporting medical programmes or research contracts.

170. The Agency will continue to participate in various international comparison programmes including those conducted by the International Bureau of Weights and Measures with the aim of checking and improving standardization techniques the demand for which is expected to increase.

Training

171. Maximum use should be made of the Agency's laboratories as training facilities which at the same time provide practical experience adapted to special needs. In order to afford training facilities for a larger number of trainees, it may be necessary to seek closer collaboration with the Österreichische Studiengesellschaft für Atomenergie.

Expansion of premises

172. The expected increase in the number of requests for laboratory services and the growing role of research in support of substantive programmes may make it necessary to consider during the next few years the need for an expansion of Laboratory premises and equipment.

APPENDIX A

MONOGRAPH ON THE AGENCY'S ACTIVITIES IN RELATION TO THE DEVELOPMENT OF NUCLEAR POWER [1]

INTRODUCTION

1. A group of experts [2] met in August 1962 on the invitation of the Director General to assist him in the preparation of a long-term programme in nuclear power. This Appendix is based on the work of the group and also reflects the recommendations and the points of view which have been expressed by:

(i) Individual Governors during the discussions of the Board's series of meetings in March 1962;

(ii) Members of the Scientific Advisory Committee at its meetings in June and October 1962; and

(iii) Senior members of the Secretariat who are particularly conversant with past activities of the Agency in nuclear power.

Nuclear power and the Agency

2. The rapid development of nuclear power technically and economically indicates that it will soon play a bigger role in the production of electric power throughout the world. Assistance to the developing countries in planning and establishing nuclear plants, and integrating, when appropriate, nuclear technology into their industry, should therefore be regarded as an important future activity of the Agency. The Agency, together with the Governments concerned, has already made definite contributions to the preparation of Member States for the advent of economic nuclear power. The Agency should continue its efforts for furthering the progress of nuclear power in all areas. It is further recommended that the Agency give priority to activities which are designed to assist the developing countries.

3. Efforts should be made to ensure re-orientation of the Agency's future plans as well as of the utilization of its funds and, if possible, to enlarge its financial resources with a view to assisting in the development of nuclear power, especially for the benefit of the developing countries.

The Agency's functions

4. In the next few years the Agency's principal aim should be to assist requesting countries in promoting the development of nuclear power in connection with:

(i) Assessing the role which nuclear power can play in satisfying energy requirements;

(ii) Organizing and extending training of scientific and technical personnel in nuclear power engineering;

(iii) Furnishing Member States with systematic scientific and technical information on the important problems connected with nuclear power engineering;

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[1] In this Appendix "nuclear power" refers to electric power produced from fission energy in generating stations supplying industrial and domestic needs.

[2] Designated by the following Member States: Canada, Czechoslovak Socialist Republic, France, India, Japan, Pakistan, Union of Soviet Socialist Republics, United Arab Republic, United Kingdom of Great Britain and Northern Ireland, United States of America and Yugoslavia.

(iv) Finding methods for the optimum development of nuclear power in the existing circumstances; and

(v) Supplying materials, equipment, the services of experts, and information concerning the availability of nuclear materials and reactor components from commercial sources.

5. It is suggested that the Agency's most essential work should be the following:

(i) Research

(ii) General economic and technical studies

(iii) Assistance in nuclear power projects

(iv) Scientific meetings and publications

(v) Training

A programme for each of these activities is proposed below.

I. RESEARCH

Research contracts

6. Assistance on the utilization of research reactors is being dealt with in a separate paper. However, because the subject is related to a nuclear power programme it is important to outline the following aspects:

(i) Research reactors can be used effectively for the training of reactor operators and maintenance personnel;

(ii) Research reactors can be utilized to perform applied research of direct interest to a nuclear power programme, such as nuclear physics (measurements of cross-sections), materials studies (irradiation), reactor physics (lattice parameters); and

(iii) Research contracts could be awarded in the field of reactor safety, including meteorological aspects.

7. Because the funds available are very small the Agency's activities in research have been limited. Therefore, in order to allow more emphasis on research it is recommended that allocations in the budget for research should be substantially increased. And the Agency's activities could be:

(i) To encourage the research in countries that are building national programmes in nuclear energy;

(ii) To give active help to countries that are implementing their national programmes; and

(iii) To help all countries in establishing standards by making data and information available in the best form for the use of Member States.

Joint research projects

8. The initiative for a joint research project must come from a Member State, or a group of Member States, that is willing to finance such projects. The Agency can then try to plan and co-ordinate all efforts and combine all resources available to implement such projects by the following means:

(i) Programming with the aid of experts;

(ii) Staffing with the dual aim of training and getting the best possible staff;

(iii) Help in obtaining special materials and equipment; and

(iv) Awarding of research contracts.

9. Requests for well-conceived joint projects should be carefully considered and if possible encouraged.

10. In the long-term programme, such joint projects could consist, for instance, of both different types of reactors for research in safety, materials, plutonium utilization, etc., and non-reactor undertakings such as pilot plants of different kinds for chemical reprocessing, fuel fabrication, etc.

Research inside the Agency's laboratories

11. Experimental research inside the Agency in the field of nuclear power will stay on a very limited scale for a long time. This research should not compete with national programmes, but should aim at results of general use to Member States. One example of such work could be the establishment of standard analytical methods for reactor materials that could be universally adopted. It should be recalled that research in the Agency's laboratories will also be of use for training purposes.

II. GENERAL ECONOMIC AND TECHNICAL STUDIES

12. Whereas it will be essential for the Agency's economics and technical experts to have made assumptions of prices and values of special nuclear materials in putting forward their recommendations of a power project, considerable uncertainties are bound to remain in some of them during the next five years. It is recommended that the Agency should initiate joint studies which would include the views of advanced countries on a scientific basis for evaluating some of these uncertainties.

13. It is also recommended that the Agency should undertake general economic studies within the five-year period, without reference to particular countries, of methods of assessing the economic effect of installing a reactor within a generating system and of extrapolating costs in advanced nuclear countries to situations in developing countries. This would apply to a reactor purchased wholly or partially from another country. In addition, in the case of a country relying largely on its own efforts in nuclear energy it would be useful to study methods of assessing the effect of a major reactor programme on the financial resources of the developing countries, including the capital cost of providing ancillary fuel handling facilities.

14. A suggested detailed programme could be as follows:

(i) Continued study of methods of analysis of the power-engineering conditions prevailing in definite geographical regions of various countries. Similarly, continued study of economic conditions including preparation of regional charts showing power production costs and giving examples of specific capital investments in conventional power stations. Establishment of economic criteria governing choice of sites for nuclear power stations;

(ii) Study of unified methods of calculating the economic parameters of nuclear power stations as a function of the main reactor and fuel cycle, including power rating, burn-up, conversion ratio, power on-load factor, efficiency and turnover time of fuel in the fuel cycle;

(iii) Study of the relationship between the technical and economic characteristics of nuclear power stations depending on unit power size and specialized equipment;

(iv) Study of plutonium and uranium-233 as power equivalent of uranium-235 and of the most effective methods of employing them in power engineering;

(v) Analysis of the effect of expenditure in associated branches of the industry (different arrangements of fuel cycle, waste disposal and utilization, safety techniques) on the economics of nuclear power stations;

(vi) Study of a common denominator reactor of a moderate size of 10 - 20 MW(e) useful for the developing countries. If a number of identical units were built the economic picture would change considerably; and

(vii) Study of the possible use of very big reactors for water desalination projects.

15. Similarly, effort should be devoted to the methodological studies, surveying and assessing practices in reactor safety and siting problems. Caution should, however, be taken against premature standardization and code formulation, which should await the maturing of the technology in each case. The programme could include:

(i) Systematic study of reactor accidents and incidents;

(ii) Survey of practices in safe operation of research reactors and power plants; scientific approach to the safety standards of particular reactors;

(iii) Survey of approaches to the problems of siting of research reactors and power plants; and

(iv) Survey of approaches to the problem of transporting irradiated fuel elements.

III. ASSISTANCE IN NUCLEAR POWER PROJECTS

16. Special attention should be given to joint projects involving regional or international participation.

17. Over the next few years an increasing number of requests for power surveys should be expected from Member States and such requests should be given the best possible attention by the Agency.

18. It is extremely important that the Agency should recognize the emphasis on the development of nuclear power in the developing countries and consequently it should expand and improve its assistance. The Agency should expect to receive requests from one or a number of countries for:

(i) Assistance in some phases of power plant development; or

(ii) Programmed assistance in a project as a whole.

19. In both cases, the Agency should continue to provide any type of technical assistance within its capabilities.

Feasibility studies

20. At the same time special attention should be paid to requests from Member States for a study of the economics of nuclear power generation and its distribution within the national system. The study should be especially directed to find answers to the following questions:

(i) The economical advisability to develop nuclear power;

(ii) The areas of the country and the types of reactor suitable; and

(iii) The scale of development of nuclear power called for, and the financial and material resources required.

21. The Agency's activities in this respect should be concentrated on surveying the available data on the subject and developing unified methods of approach to the solution of the problems at issue, with a view to arriving at optimum answers to the questions indicated above.

22. In the case of a request by one or a number of countries for an evaluation of the feasibility of a project, the Agency should support and encourage such a request.

23. Some feasibility studies may be so comprehensive that they are beyond the resources of the Agency. In such cases the Agency should make a preliminary study and an estimate of the costs involved in completing the study; this information should be transmitted to the requesting country.

Safety

24. The Agency is already able to assist developing countries in the assessment of the safe design and operation and proper siting of new reactors. It would be desirable to increase the amount of effort at present expended on this work, but it is emphasized that safety research and indeed most of the safety expertise must reside in the countries which have developed reactors.

Fuel supply

25. The Agency should take the necessary steps, to the extent relevant, to help Member States with practical organizational problems of fuel supply and for the reprocessing of irradiated fuel elements and recycling of fissile material content. The Agency should also be prepared to assist developing countries with problems of fuel element specifications and performance guarantees.

26. There is one important problem associated with fuel supply in which the Agency should take the initiative. This relates to the transport of irradiated fuel. The Agency should study all economic and legal questions related with this problem and try, by the means at its disposal, to obtain a more favourable attitude on the part of shipping and other transport interests.

A proposal for the Agency to influence work in advanced countries

27. The Agency may, in the course of its studies of the role of nuclear power in developing States, discover technical or economic problems which they feel should be brought to the attention of the advanced countries for their assistance. The Agency is encouraged to do so.

IV. SCIENTIFIC MEETINGS AND PUBLICATIONS

Scientific meetings

28. The Agency should organize regularly every three years a major conference covering all aspects of power reactor technology.

29. In those years in which no major conference would take place, the Agency should continue to sponsor three or four small conferences or symposia on more restricted subjects. The most convenient specific subjects will in general become apparent as time passes. But as a guidance for the preparation of biennial programmes, the following general areas can be stated:

(i) Construction and operating experience;

(ii) Reactor physics;

(iii) Fuel element technology;

(iv) Special topics in reactor design; and

(v) Reactor safety.

Panels

30. Although it is expected that the general economic and technical studies mentioned in section II will be carried out mostly by members of the staff of the Agency, some panels may be convened to advise the staff on some difficult or controversial points dealing with those studies.

31. Other panels should also be organized to deal with topics which are too specialized to be the subject of symposia.

Publications

32. The range of subjects of the Agency's publications should be extended where possible and the publications should be kept up to date.

33. The Directory of Nuclear Reactors has proved to be very useful and should therefore be continued. Efforts should be made to provide more complete information on more reactors and forward plans as far as the Agency considers it useful.

34. As a general rule, publications must be issued in the same field as those proposed for conferences and symposia.

35. The periodic review of selected power reactor projects in Member States [3], covering experience gained in design, construction and operation, should be continued and extended to more countries. The Agency should also continue to issue regular reports on available data on nuclear power costs and have them distributed to Member States.

V. TRAINING

36. Assistance to Member States in training of staff is one of the main tasks of the Agency. The question of staff training must always be regarded in the context of the country's nuclear power programme, of the long construction time for reactor stations and of the need to advise an appropriate body of trained staff at the right time.

37. There is a need for expanding training in all aspects of nuclear power especially to meet the growing needs of the developing countries. Special attention should be placed on arranging for practical training, including on-the-job training in design, construction and operation, not only for engineers and scientists, but also for technicians and skilled personnel who are needed in national nuclear power programmes.

38. The Agency should help organize courses in special fields, possibly at existing reactor facilities and on a regional basis.

39. Within the Agency's programme of exchange of scientists and visiting professors, nuclear power experts should be included.

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[3] GC(V)/INF/41 and GC(VI)/INF/54.

APPENDIX B

MONOGRAPH ON THE AGENCY'S ACTIVITIES IN RELATION TO THE APPLICATION OF ISOTOPES AND RADIATION SOURCES [1]

I. PRESENT WORLD SITUATION AND FORESEEABLE DEVELOPMENTS

Application of isotopes and radiation sources

1. There are four main groups of applications of isotopes and radiation sources:

(i) They are used in small quantities as tracers to follow the course of a process, such as the flow of blood in the body or of water in a river, the up-take of nutrients by a plant or the wear of a piece of machinery, and for detecting and localizing an abnormal condition such as a tumour in the body or a leak in a water pipe;

(ii) They are also used in larger quantities as sources of radiation (external or internal) for bringing about a biological, chemical or physical change in the irradiated object. The purpose of the irradiation may be, for example, to kill cancer cells, to improve the storage properties of foodstuffs, to combat insect pests, to produce new varieties of plants or to sterilize medical appliances. Secondly, smaller sources may also be used for examining the structure or properties of materials by radiography or of determining the thickness of a layer or structure by measurement of the transmitted or back-scattered radiation. Thirdly, some sources are frequently used for ionizing the air in operating theatres or textile factories to dissipate static electricity;

(iii) Another application of radioisotopes, the technical feasibility of which has been demonstrated only recently, is as sources of energy, as for example in isolated weather stations, in satellites and for the production of "cold" light. This group of applications is unlikely to be of major relevance to the Agency's programme in the next five years and will not be further discussed in the present document; and

(iv) Stable isotopes are used in some research institutions which have the necessary analytical equipment. Certain stable isotopes, particularly those of hydrogen, carbon, nitrogen and oxygen, will play an increasing role in research and are expected to find an increasing number of practical applications to medical, agricultural and hydrological problems.

2. The application of isotopes both as tracers and as sources of radiation are distinguished by the fact that they are usually of great practical importance, whether in industry, medicine or agriculture. The two groups differ somewhat in their financial requirements in that most of the tracer applications and some of the source applications such as gauging can be carried out with less than $10 000 worth of equipment whereas isotope therapy machines and accelerators for, say, grain disinfestation will cost on the average about $30 000 and in many instances will require an additional outlay of about $20 000 to house them. However, even the latter is a comparatively small financial investment and the results of radioisotope applications are frequently spectacular. Radioisotope techniques can often displace other methods of investigation with a manifold saving both in time and money and the use of large radiation sources has already begun to have an impact on some industries. The importance of such techniques for the development of the economy and general well-being of developing countries can hardly be overstated.

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[1] Prepared by the Secretariat and discussed, amended and agreed by a group of Government experts.

Isotope production and availability

3. At present only five countries produce radioactive isotopes in large quantities and export them to a significant extent. Many other countries, including several developing countries, produce isotopes commonly used as tracers in medicine and agriculture, but on a limited scale, and this production may be sufficient for the country's own requirements of the isotope concerned with perhaps a little over for export to neighbouring countries. The number of countries in this position is likely to increase substantially in the next decade as more and more research reactors come into operation. As a result radioisotopes will become much cheaper in many parts of the world, since transport over long distances at present accounts for a high proportion (up to 80 per cent) of the cost of isotopes to the purchaser. This lowering of the cost will be associated with, and will tend to accelerate, the increasing demand for radioisotopes in every field of application. Furthermore, as a result of local production, short-lived radioisotopes will become available for the first time in many areas. Labelling of compounds is also likely to be undertaken more and more in local laboratories. On the other hand, the number of major isotope-producing countries, from which supplies of virtually any radioisotope or labelled compound can be obtained, is unlikely to increase by more than two or three at most. The few major producers will therefore retain their responsibility for developing the production of new isotopes and for supplying the world with many less common isotopes and labelled compounds and with multi-curie sources of radiation for medicine, agriculture and industry.

4. Whilst the production of many stable isotopes in some of the advanced countries can be expected to satisfy foreseeable demands, there are some pure stable isotopes (particularly C^{13}, N^{15}, and O^{18}) which should be made available in larger quantities and at a low price. The production of tritium-free D_2O should also be encouraged.

5. Parallel to the increased demand for, and supply of, isotopes there will be an increased demand for equipment associated with isotope applications. Broadly speaking, this equipment is of two types: measuring instruments for tracer studies (and to a lesser extent, for radiation dosimetry), and housings for large radiation sources (e.g. cobalt units). At present, such equipment is manufactured in about 12 countries and it seems unlikely that this number will increase appreciably in the next decade since its commercial production requires advanced electronics and heavy engineering industries. In instrumentation for tracer studies the trend will be towards small transistorized units. The assembled equipment into which these units are built will tend, however, to become more rather than less complex since techniques such as automatic scanning and coincidence counting will become more widespread. The priority task of developing countries in the instrumentation sector will therefore be to develop maintenance facilities and personnel but it should not be overlooked that a fair number of less complex instruments can be made locally if a few well-trained technicians and good workshop facilities are available.

Conditions required for isotope work

6. Isotope work is the application of an advanced tool and therefore it is obvious that the fundamental knowledge as well as supporting facilities must be available if such specialized techniques should have success if introduced. The Agency should assist receiving institutions in the attainment of a scientific level sufficiently high to ensure that maximum benefit will be derived from the introduction of these new tools since the application of isotopes will be most fruitful where the necessary background knowledge and supporting facilities exist.

Isotope work in medicine, agriculture, hydrology and industry

7. The most widespread application of isotopes is in medicine. At present there are only a few countries where some use is not made of isotopes in this field, however small. In many countries the effort is confined to a comparatively small area even within medicine

(usually the study of thyroid disorder) and there is much scope for expansion into other branches of medicine and for making routine diagnostic procedures available to the great majority of the world's population. Steady progress is being made in this direction and it does not seem an unattainable goal. The therapeutic applications of radioisotopes are somewhat lagging behind in this development although the increase by more than 50 per cent in the number of radiocobalt units which has occurred in the past three years would indicate that it is increasingly realized all over the world that they are economic and easy to handle.

8. The potentialities of isotope applications in agriculture are probably as great as those in medicine and their socio-economic significance is probably even greater. However, agricultural isotope applications are much less practised in many areas of the world. Since in most developing countries agriculture is a major industry, any means of improving the efficiency of a country's agriculture should be adopted without delay. While the use of tracers in the study of soil-plant relationships and the application of fertilizers could be initiated in many countries where a minimum of agricultural research is at present conducted, such large projects as grain disinfestation, insect eradication and food irradiation or plant genetics are likely to require a massive effort for which large-scale help from outside would have to be forthcoming.

9. Very little is at present done in hydrological isotope applications and even that mostly in countries where there is no chronic water shortage. Water is perhaps the most important commodity in human life and data of great economic significance concerning such problems as the availability of groundwater or the silt transport in rivers could be obtained with a comparatively small effort.

10. The use of isotopes in industry is also an important one since a small financial investment may result in considerable economic savings. Whilst it may take some time before the full impact of industrial isotope applications can be felt in countries with small-scale industries, there is no doubt that by introducing isotope techniques right at the beginning these countries will get some benefit and in some cases even produce better products. Although the impact as such might appear small, it is nevertheless an important one and may during the next five to ten years develop to a worth-while contribution to these countries' economy.

11. There is another important aspect. Most of the isotope techniques at present in use in the developing countries have been worked out in the more advanced countries, and the task is to transfer these techniques, sometimes with small adaptations, to the developing countries where they can be applied to the solution of special local problems. However, the results achieved need not be of local interest only. For example, research on the life cycle of a parasite which only exists in one particular country or region might contribute significantly to our medical knowledge as a whole; likewise, the results of research with isotopes on the most efficient way to place fertilizer in the rice fields of a particular country will be of great interest to other rice-growing countries. Moreover, there will always be room for the development of new isotope techniques and there is no doubt that such original research (in contrast to the application of already established techniques) should be encouraged by all means in developing countries.

The place of isotopes and radiation sources in the Agency's work

12. The two main products of nuclear reactors - nuclear power and radioactive isotopes - present entirely different problems to the Agency in that the promotion of isotope work entails the initiation and support of many individual and small projects of greatly varying nature, whereas the promotion of nuclear power requires a concerted effort on perhaps one project in one country or even only in a group of countries. Consequently, when promoting isotope work the Agency often deals with a great number of institutions in a particular country such as hospitals, agricultural research stations or water resources boards,

whereas in the field of nuclear power it has usually only one main contact, i.e. the atomic energy commission or its equivalent.

13. It is likely that this situation will continue to exist during the period covered by the present programme, although it will gradually change as more and more countries acquire the means of nuclear power once it has become economically competitive. Even then, however, isotopes and radiation sources will continue to play a major role in each country's atomic energy programme and hence in the Agency's activities.

II. PRESENT AND PAST WORK BY THE AGENCY

General

14. The various methods used by the Agency to promote the use of isotopes might conveniently be divided into five categories. The first two are specifically concerned with training and are therefore exclusively designed to meet the needs of developing countries. The other three are of interest to both advanced and less advanced parts of the world.

(i) Fellowships and training courses. This may be considered as a first step in an over-all training programme. Young scientists from a less-developed country are sent to an advanced country, normally for one year, to receive basic training. Sometimes they are brought together in groups of twenty to receive instruction in the form of a course of several months' duration organized by the Agency in a fairly advanced institution.

(ii) Technical assistance. The second basic training method differs from the fellowship programme in that here an expert from an advanced country is sent to an institute in a less-developed country. Usually the scientists in the host country with whom he works have already received some basic training abroad and are now taught more sophisticated techniques. When necessary, the expert is provided with a limited amount of equipment which remains in the country after his departure.

(iii) Research contracts. The award of a research contract to an institute in a developing country may be considered as the "third stage" of an over-all programme of assistance. Once a research worker has an interesting research project in hand and is able to carry it out without outside advice, he may be awarded a research contract under the terms of which salaries, expendable supplies and equipment necessary for the successful execution of the project are provided by the Agency. A research contract may also be awarded to an institute in an advanced country to facilitate work the results of which are expected to be of special interest to the Agency and its membership as a whole.

(iv) Dissemination of information including conferences. The Agency organized scientific meetings both on subjects of general interest with a fairly large attendance and on highly specialized topics with not more than 50 to 100 participants. These meetings fulfil a triple function: they provide an opportunity for experts to meet and exchange information; they further the training of the less advanced participants; and, through the publication of the proceedings of the conferences, they facilitate the rapid dissemination of information in a convenient form.

(v) Technical work at Headquarters. Much of the time of the scientific staff of the Secretariat is devoted to the evaluation of requests for the provision of training, technical assistance and research contracts and the technical supervision of their execution, and to the preparation and servicing of scientific conferences and symposia. The staff further participates in various Agency missions to Member States to provide advice on technical matters whenever required. Furthermore, some time is spent on writing manuals on isotope procedures, on collecting, collating and distributing information relating to isotope applications,

on developing new research programmes and on promoting a certain measure of international collaboration and co-ordination. Finally, a small amount of research is done in the laboratory on projects the results of which may be expected to have a bearing on the Agency's over-all programme in a particular field.

Co-operation with other international bodies

15. The very nature of the problems to which isotope techniques are applied makes close co-operation and co-ordination between the Agency and other organizations of the United Nations family imperative. The World Health Organization (WHO) is interested in the medical aspects and the Food and Agriculture Organization of the United Nations (FAO) in the agricultural aspects of atomic energy, and the World Meteorological Organization (WMO), FAO and UNESCO, although to a lesser extent, in the use of isotopes in hydrology. Thus, in order to avoid duplication of work as far as possible, joint working groups have been set up between the Agency and WHO, and the Agency and FAO, which review their respective programmes twice a year. In addition, close contact is maintained between technical units in the Agency Secretariat and corresponding units in the Secretariats of the sister organizations. Thus there are frequent consultations between the medical isotope section of the Agency with those units at WHO Headquarters which are concerned with parasitology, entomology, nutrition, etc.; likewise, close contact is maintained between the agricultural isotope section of the Agency and the scientists in FAO who are experts in such fields as animal nutrition, fertilizers, entomology, etc. This close co-operation finds expression, for example, in the joint organization of conferences and symposia and in the participation of one organization's scientists in panel and scientific group discussions organized by the other organization. In general, it may be said that jurisdictional controversies between the various members of the United Nations family have almost ceased to occur due to increased recognition that both finances and manpower of each organization concerned are extremely limited compared to the task at hand.

16. Special mention must be made of the role the Agency has begun to play as an executive organization in Special Fund projects which involve partly or wholly the use of isotopes. In such cases, the Agency may be either the main contractor with the Special Fund or may be a subcontractor to another specialized agency, such as FAO, which does the bulk of work for the Fund with the Agency responsible for that part which involves the use of isotopes.

17. Finally, close technical co-operation exists with certain non-governmental bodies such as the International Commission on Radiological Units and Measurements (ICRU), the International Council of Scientific Unions and its Commissions, and others.

Promotion of isotope applications according to subject matter

18. In order to obtain a proper perspective of the five-year plan described later in this document it is necessary to give some indication of the work completed by the Agency during the first five years. The following statistical table illustrates the isotope activities of the Agency during that period. [2]

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[2] The statistical data describe the isotope activities by the Agency as a whole and not just those of the Division of Isotopes in the Secretariat. For example, the award of fellowships, the organization of training courses and the dispatch of visiting professors are the responsibility of the Division of Exchange and Training, whereas the organization of conferences, symposia and seminars is the responsibility of the Division of Scientific and Technical Information; likewise, the Division of Economic and Technical Assistance is responsible for the administration of the technical assistance programme and the Division of Research and Laboratories for the administration of the research contract programme. In these activities the specialists of the Division of Isotopes act in an advisory capacity only.

Subject matter	1958	1959	1960	1961	1962
Fellowships[a/]	39	75	102	92	95
Training courses	-	2	1	4	3
Technical assistance experts (man-months)	-	8	81	91	125
Visiting professors	-	2	3	1	1
Advisory missions	1	4	8	3	9
Conferences, symposia and seminars	-	3	4	4	2
Panels and consultants' meetings	1	2	2	7	11
Research contracts[b/]	-	5	8+5R	11+10R	31+11R
Expenditure for above activities (US$)	162 500	401 800	731 500	747 700	1 084 240

a/ The figures are for fellowships for which funds were obligated by 31 December 1961, i.e. those selected for awards minus withdrawals before taking up the fellowship. The years are programme years. The 1962 figure is an estimate.

b/ The figures indicate the number of contracts for which financial support has been provided during the financial year. The first figure is for new contracts, the second for renewed contracts as indicated by (R).

III. PAST EXPERIENCE AS A GUIDE IN FUTURE PLANNING

General

19. Any plan for the second five-year period of the Agency's work must be based on a critical assessment of the results which have been achieved during the first five-year period. In particular, it is necessary to examine those areas in which there is room for improvement.

Scientific staff

20. Over the past five years Member States have become increasingly aware of the benefit they might derive from the use of isotopes and radiation sources in medicine, agriculture, hydrology and industry. The number of requests to the Agency for assistance has been steadily increasing. The expenditure for the promotion of isotope work has increased from $162 500 in 1958 to about $1 085 000 in 1962. This rapid increase in the isotope activities of the Agency was, however, not accompanied by a corresponding increase in the scientific staff.

21. As has already been stated [3] a high proportion of the time of the scientific staff of the technical divisions is devoted to the evaluation and supervision of requests for Agency support. This is an essential part of the Secretariat's work and, in any particular area of work, can be undertaken only by scientists who are themselves experts on the subject and are in close contact with current work and personnel in the area concerned. Indeed, only by substantive servicing of each project can it be assured that fellowships, experts and research contracts are correctly assigned and that maximum benefit is derived from the assistance rendered. In many cases a simple project has to be followed up in detail over a period of months or years and it is felt acutely at present that the scientific staff does not have sufficient time to service each project as thoroughly as it should be.

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[3] See para. 14(v) above.

Assistance provided on a regional basis

22. While the great variety of isotope activities will always necessitate a considerable spreading of the Agency's efforts, it must be realized that concentration of efforts on one particularly promising project, perhaps at the expense of other worth-while projects, might have its merits. In the field of training, part of the available funds is already used to organize training courses on a regional basis and a further step in this direction is the establishment, under the Agency's auspices, of a regional isotope training centre. It is felt that similar steps should be taken in the field of technical assistance by the establishment of groups or "task forces" of technical assistance experts who would provide advice and assistance to a number of countries in one region. This, no doubt, would result in great economies, particularly through a more efficient utilization of the time of experts who, in any case, are often difficult to enlist. Similarly, experience in the past has shown that it might be advantageous to use part of the funds available for support of research activities to establish, under the auspices of the Agency, isotope research units attached to a large hospital or agricultural research station which would carry out research on problems of interest to a number of countries in a particular region.

23. On the other hand, the support of many small projects, particularly of those of a research nature, in many countries is the basis of the Agency's important role as an international research co-ordinating body. The considerable success of the two co-ordinated projects which the Agency has supported in the past (the Ca^{47} project and the rice fertilization project) indicate that in future the Agency should give more emphasis to the support of research in which a number of participating institutes work on related aspects of the same problem.

24. At the present stage the lack of rapid communications between Headquarters and scientific workers in countries far away from Vienna greatly impairs effective and efficient execution of the Agency's programme of assistance to these countries. Many small but nevertheless acute problems arising unexpectedly and at short notice could be more effectively solved through advice and assistance given on the spot by technical staff available in the region. Requests for technical assistance and research contracts could be drawn up with the help of that regional staff and could be evaluated at Headquarters in the light of an assessment made on the spot. Fellowship candidates could be interviewed personally and a great deal of preparatory work for technical assistance experts could be done before the expert takes up his duty.

25. Other specialized agencies such as WHO and FAO have experienced similar difficulties at an early stage of their activities and have met them by appointing regional and later on country representatives. While the volume of work by the Agency cannot be expected to reach at the end of the second five-year period a level similar to the present volume of work of WHO or FAO, it is believed that it will grow sufficiently to justify, towards the end of the second five-year period, serious consideration of the desirability of establishing regional technical offices. If such offices were to be established at e. g. the United Nations Regional Economic Commissions and would comprise not more than two or three professional scientific staff, their costs would be small compared with savings which are likely to be achieved through greater efficiency in the execution of Agency projects.

The role of the Agency's laboratory

26. The rice fertilization project has also demonstrated the important part which the Agency's laboratory can play in co-ordinating efforts of this type. While at the time of the establishment of the Agency's laboratory it was foreseen that its activities would be restricted to certain branches of physics and chemistry, it has already become necessary to include a small amount of isotope work in medicine (including health physics), agriculture and hydrology. A considerable expansion will be needed in this direction during the next five years in order to bring the laboratory into closer relation with the Agency's isotope activities in its Member States. Its work will then not only include the development

of isotope techniques to be applied to problems of significance to developing countries but will also offer an opportunity for scientists from these countries to be trained in such techniques.

IV. FIVE-YEAR PLAN

General

27. The Agency's methods of promoting the use of radioisotopes are essentially identical, whether they are used in the medical, agricultural or hydrological field. Thus many aspects are common to all and a discussion of these aspects is organized most conveniently according to the methods used. In each case the proposals for improvement made in the preceding paragraphs have been borne in mind.

(a) Fellowships and training courses

28. About one third of all fellowships which the Agency has so far provided were awarded in the field of isotope applications and it is likely that the pattern of requests received from Member States will remain unchanged. Increased funds for the fellowship programme are necessary during the next five years and they should be used to increase the quality rather than the quantity of the fellowships awarded. Whilst short-term fellowships are frequently useful, the experience of the Agency indicates that many trainees need more than one year to derive maximum benefit.

29. In the past the Agency has organized, on the average, one training course in medical and one in agricultural applications of isotopes per year. At present these courses last only two months and this is not sufficient to enable the students to apply their newly-acquired knowledge immediately to the solution of practical problems. In many instances these courses will be considered as a preparatory phase to long-term training and it is hoped to co-ordinate the training programme on isotopes in such a way that the attendance at an Agency basic training course will be a prerequisite to the award of a more advanced fellowship of one or two years' duration.

30. Some time during the second five-year period, perhaps in 1966, the Agency will be able to assess and evaluate the achievements of its first isotope training course which will start operation in the UAR in 1963. The Agency will consider on a continuous basis and in the light of experience gained with this programme the desirability of creating similar isotope centres in other parts of the world.

(b) Technical assistance

31. It is expected that the number of technical assistance requests for the dispatch of isotope experts in 1968 will be at least twice the number received in 1963. Even if funds needed for meeting all these requests should be forthcoming, the difficulties in the recruitment of experts already encountered by the Agency suggests that it will be impossible to find a sufficient number of experts in the more advanced countries. Thus the time of those experts that can be enlisted will have to be utilized more efficiently. In 1963/64 the Agency will appoint its first two regional advisers to several countries located in the same region. It is planned to use the method of providing expert advice on a regional basis more frequently in the ensuing years.

(c) Research contracts

32. The view has been expressed [4] that one function of the research contract programme is to act as the "third stage" of an over-all technical support programme; this would particularly apply to contracts on isotope applications which are, in their

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[4] See para. 14(iii) above.

majority, designed to support practical rather than fundamental work. If this view is accepted, then the steady rise in the level of scientific activities in developing countries, including that of research with isotopes, will result in a progressive increase in the relative importance of the research contract programme among the Agency's methods of promoting the use of radioisotopes. At the present time more than 50 per cent of the research contracts on radioisotope applications are placed in developing countries and it is expected that, over the next five-year period, this proportion will rise to 75 per cent.

33. The various panels convened by the Agency to discuss different aspects of its research programme on isotope applications have invariably expressed the view that the funds set aside by the Agency for this programme are extremely limited compared to the task at hand. Mainly as a result of the recommendations made by the Agency's Scientific Advisory Committee, the volume of the Agency's isotope research contract programme has gone up, from $67 000 in 1959 to about $395 000 in 1962, i.e. by a factor of six during a period of four years. It is anticipated that a further increase over the period 1964-1969 will be required to meet demands for this type of support likely to be made by research institutions in Member States.

34. This increase, however, will be just sufficient to cover expenses for small contracts of the order of $5000 to $10 000 each. As will be shown below, there is, however, a case for the Agency sponsoring, during the next five-year period, two or three rather large research projects which will be concerned with such subjects as eradication of insect pests or disinfestation of grain by irradiation. The cost of these projects is likely to exceed the one-million-dollar mark and there is no doubt that funds from outside the Agency's budget will have to be secured to finance these large-scale projects.

35. The establishment in Member States of isotope research units attached to large hospitals or agricultural research stations would also require a large financial investment.

36. In any case, whatever increased funds the Agency will have available during its second five-year period for the support of research, these will always be small compared to national efforts of research support. It will therefore be necessary to make an appeal to individual scientists and institutes as well as national research authorities, particularly in the more advanced countries, to carry out work for the Agency at symbolic cost or no cost at all.

(d) Dissemination of information

37. In the past, the Agency has organized on the average three symposia on isotope work per year, one in the agricultural, one in the medical field and one on either industrial or hydrological isotope applications. It is planned to continue in the next few years this pattern of meetings with no increase in the number of events per year. Preference will be given to specialized subjects with an attendance of not more than 100 participants. Discussions will centre around isotope techniques and the co-operation of other United Nations agencies will be invited where appropriate, as has been done in the past.

38. On the other hand, there will be some increase in the number of small meetings of a few consultants and of expert groups to discuss specific aspects of the Agency's isotope programme. Wherever possible, the discussions and recommendations of these groups will be published since experience has shown that this is an effective way of bringing the most recent results of scientific work to the notice of scientists in Member States.

(e) Technical work at Headquarters

39. The Agency has made a modest start with medical and agricultural isotope work at the Agency's laboratory; this work is already proving to be a valuable and important part of the Agency's over-all programme of promoting the use of isotopes.

40. The Secretariat's scientific staff will continue to service technically such projects as technical assistance missions, the research contract programme, scientific conferences, symposia and panels, at a steadily increasing rate during the five years to come.

Promotion of isotope applications according to subject matter

41. The application of isotopes and radiation sources is a field which is expanding so rapidly that it was possible to draw up only general principles for the Agency's activities indicating the main long-range trends of development in the various branches of isotope research and isotope applications. Certain more precise trends for the next two years are, however, already discernible, and these will be discussed in the following paragraphs.

(a) Medicine

42. Within the field of medical applications, the Agency has in the past been concerned with both tracer work and the use of isotope sources in radiotherapy.

43. A comparatively small part of the Agency's effort to promote the use of radioisotopes in medicine has been concerned with the support of the development of techniques for the production and application of new isotopes. After having successfully completed its Ca^{47} project, the Agency will devote its attention to other isotopes and labelled compounds which are likely to be of practical importance. At present several research contracts are under way to further the use of I^{125} which has recently become commercially available, and thought is being given to the development of a gamma-emitting red-cell label which would be better suited to life span measurements than Cr^{51} or DFP^{32} which are used at present. It is expected that efforts of this type will continue at their present modest scale, with the Agency's laboratory playing a small but vital part in the co-ordination of efforts.

44. The major part of the Agency's activities in this area will continue to be devoted to the support of the application of isotope techniques in problems in tropical medicine. The Agency will continue to concentrate on the physical aspects of this field [5], leaving the medical side to WHO with which close co-operation has been established and is likely to be intensified in the future. Priority will continue to be given to projects which are concerned with disorders affecting a high percentage of the population and therefore having a high socio-economic significance. Projects of this type are at present being carried out in twelve countries in tropical and subtropical areas and it is envisaged that there will be a substantial increase in both the number of projects and their geographical distribution over the next five years.

45. Some support will also be given to experimental biological research with isotopes and radiation sources designed to improve and elaborate the most efficient methods of radiotherapy, particularly the radiotherapy of cancer (plans for this work are described in more detail in the chapter on "Health and Safety").

46. It is expected that the Agency's project initiated in 1961 on the international standardization and calibration of thyroid radioiodine up-take measurements will be completed towards the end of 1964, having covered by that time the majority of the Agency's Member States. It is anticipated that this project will be followed by at least one more of a similar nature, the details of which are to be worked out in close co-operation with ICRU.

47. In the area of the use of isotopes as radiation sources, up to now the Agency has concentrated its efforts on the provision of information and data designed to improve the knowledge and application of physics in radiotherapy, particularly in the developing

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[5] This policy is exemplified by the dispatch of technical assistance experts who, in the majority, are hospital physicists rather than physicians.

countries. It is intended that the Agency will play a much more active part in organizing training and the direction of local effort in the therapeutic use of radiation sources. The topics concerned are:

(i) Radiation beam therapy; and

(ii) Use of interstitial isotope sources.

48. In collaboration with WHO, it is intended to devote a larger effort to the establishment of adequate working conditions within radiotherapy institutes in developing countries. This may involve advice and assistance relating to the design of isotope installations, basic calibrations and protection measurements, staffing and auxiliary equipment through field work either by Secretariat staff or by regional advisers in different parts of the world. In addition, special courses in radiation physics for the training of physicists to work within radiotherapy institutes are planned.

49. In relation to the use of large sources for beam therapy, the work hitherto has involved the collection of technical data from institutions all over the world, processing the data and finally re-distributing the material either in collected and edited form or as individual items. It is expected that this effort will continue in future at about the same over-all scale. The emphasis will, however, shift from the collection and collation of data to its effective distribution, and to this end it is intended to establish within the framework of the Agency an "international clearing house" for physical data in radiotherapy.

50. It is also planned to promote the use of interstitial isotope sources in radiotherapy by providing technical details of equipment and preparing recommendations concerning its use. This again will be done in close co-operation with WHO, with the Agency concentrating on the physical aspects of the problem.

51. While in the past technical assistance in the medical isotope field has been provided by the Agency mainly in the form of expert advice and only to a limited extent in the form of equipment, it has become apparent that increasing the equipment proportion in the form of the provision of integrated medical isotope centres, including equipment for both diagnostic tracer and therapeutic radiation source equipment, would be a very effective form of meeting the needs of developing countries in this field. Discussions at the sixth regular session of the General Conference have indicated that this view is shared also by advanced countries and a specific proposal was made to establish six such medical centres in various developing countries. The Agency is at present studying this proposal and in the event of its implementation close co-operation with WHO will be needed.

(b) Agriculture

52. The use of isotopes and radiation sources in agriculture can be conveniently divided into six technical areas: soil-plant relationships, entomology, plant breeding, animal science, plant pathology and radiation treatment of agricultural products. As in the past, training and dissemination of information will in general be a joint effort of the Agency and FAO with a close association in many other phases of the programme.

53. It is anticipated that demands by Member States will expand appreciably in the area of soil-plant relations, improvement in the understanding of which is a prerequisite to the enhancement of agricultural productivity in developing countries. Not only will the rice fertilization programme be continued, but other crops important to large agricultural regions will be included. Moisture measurements in soil, an essential of proper irrigation practices, can be easily carried out with a neutron moisture meter. The production of this instrument has reached the commercial stage and expansion of the training of scientists in its use and provision of these instruments will be undertaken.

54. The largest sector in which an increased effort is planned is entomology. Work in this field will include the collection and dissemination of information and the implementation

of a research programme on grain disinfestation, an area in which the Agency is already taking the lead. It is further planned to establish a co-ordinated programme for the use of radiation in population control of the Mediterranean fruit fly and related species (including control of the tsetse fly). A laboratory training manual on plant pest control will be produced jointly with FAO. Finally, insofar as possible, projects will be initiated concerned with the residues and mode of action of insecticides, fungicides and herbicides.

55. The application of radiation to plant breeding to improve the possibilities of selection has initially received greater attention by the Agency than the other agricultural applications. It is planned to continue the present modest level of support through technical assistance and research contracts and to provide information on the latest progress in this field through symposia, panels and publications.

56. It is also planned to support work on the effects of irradiation of seeds to further plant growth.

57. Although up to now animal science has not been included to any appreciable extent in the Agency's programme of work, this subject will receive more attention in the future with particular emphasis on animal nutrition and on metabolic studies to elaborate better methods of animal feeding. The effort will be channelled particularly through the provision of information and the publication of a laboratory training manual, jointly with FAO. A recent development of great practical importance is the production of vaccines of irradiated larvae, which offer the only practical method of immunizing animals against nematode diseases. Information on this method will be collected and disseminated and support will be given to further research on this subject.

58. Applications in plant pathology are anticipated only insofar as they are concerned with specific problems where technical assistance may be requested from Member States.

59. Radiation treatment of agricultural products, which includes food preservation, will be maintained at its present level of effort, primarily because food irradiation, with the exception of potato sprouting, has not yet reached the stage where practical applicability has been demonstrated. Hence technical assistance and training of scientists from developing countries in this area will not be encouraged to the detriment of training and technical assistance in other areas of agriculture. There will be a shift of emphasis to the radiation treatment of agricultural products moving in international trade in order to prevent the transmission of diseases or insect pests of importance to plants, animals, or man.

(c) Hydrology

60. The Agency's work on radioisotope applications in hydrology has in the past involved the dating and tracing of groundwater. Tritium dating of groundwater is a most promising tool for estimating recharge rates of groundwater bodies. Such dating is very cheap compared with the exploration and exploitation of the groundwater itself. Consequently, it is planned to extend the Agency's advisory service especially to developing, water-deficient countries which are exploring and exploiting, or plan to explore and exploit, their groundwater resources. To facilitate expedient analysis of such samples the existing facilities in the Agency's laboratory for the measurement of tritium concentrations will need to be expanded correspondingly. As UNESCO is at present embarking on an elaborate hydrological programme, it will be important to arrange for the closest co-operation with that organization.

61. The Agency's primary interest in groundwater tracing concerns karstic regions and it can be expected that, as the potentialities of radioisotopes will be increasingly realized, further requests will be received to carry out groundwater experiments, perhaps in connection with Special Fund projects. A particular advantage of the latter is the possibility of working together with hydrologists and geologists on a common project. By

convening panels the Agency has already attempted to bridge the gap between hydrologists on the one hand and isotope specialists on the other.

62. At present several national organizations are examining the possibility of using various isotope techniques to measure the water discharge of streams and rivers. Such work is of direct interest to the Agency and these methods will be recommended for use if they should prove to offer some advantages over conventional methods. Likewise, it is expected that the Agency will be active during the later part of the second five-year period in the area of isotope applications to the measurement of bedload transportation in rivers. Reliable conventional methods are at present lacking although this is a process of immense importance in connection with the construction of dams and the upkeep of navigation channels in rivers.

(d) Industry

63. In the light of what has been said in paragraph 10, it can be assumed that during the second five-year period of the Agency's activities demands from Member States for assistance in the development of industrial isotope applications will be small in number compared with medical and agricultural applications. However, the Agency will during this period of time keep abreast of the newest developments in this field and will follow closely any possibility of applying techniques developed in more advanced countries to the needs of industries in the lesser developed areas of the world. Since, however, even in the more advanced countries the potentialities of isotope techniques in industry do not appear to be fully realized, the Agency will continue to facilitate the exchange of information by arranging for scientific conferences and panel meetings on various specialized subjects, prepare literature surveys and bring up to date the results of the economic survey started in 1962.

64. Attention will be mainly directed to the development of geophysical methods of prospecting for minerals, to the automatic control of industrial processes and to the radiation treatment of materials with a view to obtaining new materials with improved properties.

65. In the research programme, which will ensure the rapid development of work along these lines, it is the intention to support theoretical and experimental research with a view to acquiring a better understanding of the effects of interaction between radiation and matter. The research programme will also extend to the development of radiation techniques for obtaining new materials with improved properties and the design of improved types of equipment for recording ionizing radiation as well as of equipment for measuring the concentration of stable isotopes.

66. The research programme will also include questions of the development, standardization and calibration of the isotopic radiation sources required for radioisotope equipment used in the control of industrial processes, for the radiation treatment of materials or for geological survey work.

V. SUMMARY AND CONCLUSIONS

67. On the basis of evaluation of the trends of development of isotope work, particularly in the developing countries, which is likely to take place during the second five-year period of the Agency's activities and a careful assessment of the experience gained during the first five-year period, the following conclusions may be drawn with regard to the policy the Agency should adopt to promote the use of isotopes and radiation sources in medicine, agriculture, hydrology and industry during the period 1964-69.

68. The major part of the Agency's activities in this area will continue to be determined by the extent and nature of the demands for assistance made by its Member States and the following developments can be foreseen:

(i) Requests to the Agency to assist the development of isotope work in its Member States are likely to increase substantially as a consequence of increased realization by Member States of the great practical benefits which will result from the use of isotopes and radiation sources; and

(ii) Ever-growing resources will be needed to meet requests in connection with the programme and the pattern of expenditure of funds will have to be adapted to the changing character of requests. It may be expected that in the forthcoming years the need for installations involving equipment, experts and research contracts will grow relatively faster than for other types of assistance.

69. Some of the Agency's activities in the area of isotope and radiation source applications will continue to be determined largely by the Secretariat's own initiative; among these activities are the organization of conferences, symposia and panel meetings, the provision and exchange of information, the co-ordination of research and the selection of suitable research projects for support, and the work done at Headquarters and the Agency's laboratory. The potentialities of isotope and radiation source applications are great and the possibilities for Agency action numerous, but a selection between such possibilities must be made to ensure that the limited funds available are used for projects likely to have practical effects within a comparatively short time on economic progress in its Member States. Technical development in this area is, however, rapid and the Agency must preserve a certain measure of flexibility; the order of priorities given below will therefore need to be kept under continuous review:

(i) The most effective way of promoting the use of isotopes and radiation sources is likely to be the transfer of established isotope and irradiation techniques to the developing countries where they can be applied to special local problems. To this, first priority should be given. However, there will always be room for the development of new techniques and there is no doubt that such "fundamental" research should be encouraged; and

(ii) With the above general principle in mind, the following order of priority should be given to projects within each of the large areas of isotope and radiation source applications to medicine, agriculture, hydrology and industry, beyond and above any promotion of routine uses of these tools through the regular provision of training and technical assistance:

A. Medicine:

(a) the promotion of research with radioisotopes into diseases prevalent in developing countries, particularly tropical diseases;

(b) the improvement of the knowledge and the application of physics to radiotherapy in the developing countries, particularly as applied to the treatment of cancer;

(c) the development of new isotope techniques and the standardization of established techniques already widely used, especially for the diagnosis of various diseases;

(d) the promotion of research into the basis of the biological effects of radiation necessary to further the progress of radiotherapy.

B. Agriculture:

(a) the integration of nuclear methods into the study of soil-plant relationships with the objective of improving over-all agricultural productivity;

(b) the promotion of the use of isotopes and radiation sources in the control of insect pests of importance to plants, animals and man;

(c) radiation genetics for plant improvement;

(d) the promotion of the use of isotope tracers in studies on animal nutrition;

(e) the development of methods of controlling disease organisms by radiation treatment of agricultural products.

C. Hydrology:

(a) the promotion of the use of tritium and other isotopes for the tracing of groundwater in water-deficient countries;

(b) the development of the use of isotope techniques to determine the water discharge of, and the bedload transport in, streams and rivers.

D. Industry:

(a) the examination of the possibilities of, and the provision of information on, the use of isotopes and radiation sources in industrial processes, and the encouragement of their application in those of the lesser developed countries which have already reached a stage of industrialization which would make their application an economic proposition;

(b) to co-ordinate and promote research on improvements of established, and the development of new, techniques of using isotopes and radiation sources in industry and the improvement of instrumentation for the recording of ionizing radiation and for the measurement of concentrations of stable isotopes.

70. The methods at present used by the Agency to promote the use of isotopes and radiation sources are adequate for work on the present scale; however, with the envisaged expansion of the Agency's activities there will be considerable room for improvement in the application of these methods to achieve efficient utilization of funds and manpower and to correlate the total Agency effort in this area with simultaneous national efforts; to this end it will be necessary to:

(i) Intensify the promotion of technical assistance on a regional basis by making increased use of regional advisers, regional expert groups and regional training courses;

(ii) Make increased use of the willingness of advanced Member States to carry out research for the Agency at symbolic or no cost and seek outside financing of research projects too expensive for the Agency's limited resources; and

(iii) Increase co-operation with national or other international agencies and organizations, in particular with WHO and FAO.