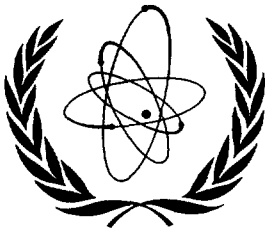

International Atomic Energy Agency

THE AGENCY'S PROGRAMME FOR 1967 - 68

GC(X)/332

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LIST OF ABBREVIATIONS

AGENCY	International Atomic Energy Agency
CERN	European Organization for Nuclear Research
ECOSOC	Economic and Social Council of the United Nations
ENEA	European Nuclear Energy Agency of the Organisation for Economic Co-operation and Development
FAO	Food and Agriculture Organization of the United Nations
GeV	Giga-electron-volt (1000 MeV)
GS	General Service (staff)
IAEA	International Atomic Energy Agency
IBWM	International Bureau of Weights and Measures
ICRP	International Commission on Radiological Protection
ICRU	International Commission on Radiological Units and Measurements
ICSU	International Council of Scientific Unions
IHD	International Hydrological Decade
ILO	International Labour Organisation
IMCO	Inter-Governmental Maritime Consultative Organization
ISO	International Organization for Standardization
IUPAC	International Union of Pure and Applied Chemistry
M&O	Maintenance and Operatives Service (staff)
MeV	Mega-electron-volt
MW	Megawatt
NORA	Joint Norway/Agency research programme in reactor physics with the zero power reactor "NORA"
OECD	Organisation for Economic Co-operation and Development
SAC	Scientific Advisory Committee of the Agency
THIRD GENEVA CONFERENCE	Third International Conference on the Peaceful Uses of Atomic Energy
UNDP	United Nations Development Programme
UNDP/EPTA	Technical Assistance Sector of the United Nations Development Programme
UNDP/SF	Special Fund Sector of the United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WHO	World Health Organization
WMO	World Meteorological Organization

NOTE

All sums of money are expressed in United States dollars.

I. INTRODUCTION

1. In the preparation of this programme for the Agency for the two-year period 1967-68, the Board of Governors has taken account both of the experience gained in past years and also of the long-term programme for the Agency's activities [1] which was endorsed by the General Conference in 1963 [2].

2. In terms of ECOSOC Resolution 984 (XXXVI), the Director General has consulted the Directors General of other international organizations on certain aspects of the programme; that part of the programme which covers work on the applications of radio-isotopes in agricultural and related subjects (food) has been prepared by the joint FAO/IAEA Division of Atomic Energy in Agriculture, and work relating to the uses of nuclear energy in medicine is being undertaken, as far as is possible and appropriate, in collaboration with WHO.

3. Although under the Statute the General Conference is required to approve annual budget estimates, the Board wishes to inform it that the execution of the biennial programme set forth in this document is estimated to require funds totalling approximately $25 million under the combined Regular and Operational Budgets. It is estimated that, over the two years, approximately $5 million will be provided from operational funds, and a balance of less than $20 million from the Regular Budget. For the first year, 1967, the Board will submit estimates which amount to slightly less than half this sum.

4. Within the budgetary limits approved by the General Conference for the first year of the two-year programme, the Board and the Director General will need some flexibility in its execution; particularly, if circumstances and the development of the work make it necessary, they will be able to bring activities now planned for 1968 forward for execution in 1967 and to defer others from 1967 to 1968.

5. Some of the activities referred to in this programme, particularly training courses and regional projects, have been included on the understanding that they will be financed under UNDP/EPTA. Since the United Nations Development Programme for the period 1967-68 will not be approved until late in 1966, their inclusion must, of course, be regarded as tentative.

6. The Board believes that the General Conference would not require to be informed of detailed programme plans for 1968 at its eleventh regular session when it will be asked to approve the budget estimates for that year; the Board proposes at that time to report to the General Conference on the programme for 1967-68 only insofar as major modifications have occurred or are expected to occur or if new activities require attention. Such refinements as are found to be necessary with regard to research, scientific meetings etc., after consultation with SAC, will be reflected in the budget estimates for 1968.

7. Certain new activities and the expansion of existing ones, such as those relating to the various applications of isotopes and radiation sources and to reactors and safeguards, will necessitate some increases in Professional staff in 1967, to which reference is made in each case in the relevant part of the programme. In addition to six new Professional staff members, there will be seven new Professional posts to cover the reclassification of staff members who are already engaged in work concerned with interpretation and

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[1] INFCIRC/50.

[2] By Resolution GC(VII)/RES/151.

editing. This makes a total of 13 new Professional posts. In the General Service category, there will be an increase of four posts. The draft budget estimates for 1967 will provide for these changes under appropriate units of the Secretariat. No definite forecast regarding staff can now be made for 1968, but in order to arrive at a tentative estimate for the total cost of the programme for the two years, it has been assumed that approximately 11 additional Professional posts, six GS and six M&O posts will be added in 1968. On this basis, and with some allowance for cost increases in other sectors, the summary of estimated costs of the various parts of the programme for 1967 and 1968 under the Regular and Operational Budgets, as shown in the table below, has been prepared. The estimate for 1968 is, of course, tentative.

Part of the programme	Expenditure				
	1965 Actual $	1966 Budget[a] $	1967 Estimate[a] $	Increase or (decrease) 1966:1967 $	1968 Tentative Estimate $
REGULAR BUDGET					
Technical assistance and training	585 129	581 320	627 315	45 995	650 000
Nuclear power and reactors	590 135	627 940	717 525	89 585	800 000
Isotopes and radiation sources	1 004 659	959 620	1 148 670	189 050	1 260 000
Health, safety and waste management	744 452	891 160	916 575	25 415	950 000
Research and services in physical sciences	1 109 547	1 205 250	1 407 560	202 310	1 600 000
Information and technical services	927 285	1 263 830	1 271 440	7 610	1 380 000
Safeguards	290 928	417 130	555 815	138 685	635 000
Sub-total	5 252 135	5 946 250	6 644 900	698 650	7 275 000
OPERATIONAL BUDGET					
Technical assistance and training	1 405 353	1 777 000	1 876 000	99 000	1 850 000
Isotopes and radiation sources	142 010	202 000	-	(202 000)	-
Health, safety and waste management	44 408	40 000	45 000	5 000	45 000
Research and services in physical sciences	584 408	459 000	487 000	28 000	513 000[b]
Sub-total	2 176 179	2 478 000	2 408 000	(70 000)	2 408 000
TOTAL[c]	7 428 314	8 424 250	9 052 900	628 650	9 683 000

a/ For details, see Annexes II and III to document GC(X)/333.

b/ Includes $278 000 from Operating Fund I for the International Centre for Theoretical Physics, although no decision regarding its future financing has yet been made.

c/ Excludes expenditures for the General Conference, the Board of Governors and general direction and administrative services.

II. TECHNICAL ASSISTANCE

(a) General

8. The Agency's programme of technical assistance, to be financed from the Operational Budget, is drawn up on the basis of requests which Member States submit in an order of priority. These requests cover all forms of technical assistance - experts, equipment, fellowships and training. The magnitude of the assistance that can be provided depends on the resources available to the Agency. It is expected that in 1967 and 1968 the financial resources will be approximately of the same order as in the previous five years; however, in view of the increased costs of salaries, equipment, stipends etc., equal financial resources will in fact entail a reduction in the effective programme. The programme for 1967 and 1968 as outlined below takes into account the need to make the optimum use of diminishing resources.

(b) Programming and the provision of experts and equipment

9. The increased need for assistance in the form of experts and equipment is reflected in the growing number of requests received from Member States; excluding projects to be financed under UNDP/EPTA, requests for assistance from the Agency have risen from $690 000 in 1959 to an estimated $3½ million in 1967. Funds approved to meet these requests have increased from $620 000 in 1959 to an estimated $900 000 in 1967 and experience shows, unfortunately, that of this sum only about 60%, or $540 000, is likely to be available. Every effort will be made to meet the requests for which Member States have indicated their own priority, but at the same time it is planned:

(a) To identify projects of a similar nature within a region which could be serviced by the same expert, because it would be better that one expert on an annual assignment should spend three months in each of four countries than that four experts should perform the same duties on shorter separate contracts involving higher costs for travel and overheads; and

(b) To identify projects for which a small group of experts collaborating simultaneously would provide more effective assistance than the same number of experts visiting the country at different times. It is expected that some assistance, for example in subjects like waste disposal and reactor utilization, could be provided by Agency staff but there may be occasions when a group of experts will be required.

10. As national atomic energy programmes develop, many Governments request expert advice for relatively short periods of up to one month. Wherever possible, such assistance will be provided by utilizing the Agency's technical staff, whose salaries and allowances will continue to be met from the Regular Budget; only their travel costs and expenses in the country will be financed from the Operational Budget. Apart from providing the required assistance, this procedure will help establish a closer relationship between the Agency and its Member States, and the experience gained will be useful in the development of future programmes.

11. It is expected that the services of regional advisers may be required in such fields as hydrology (Africa), hospital physics (Latin America), rice production (the Far East) and industrial applications of isotopes (Europe and the Middle East, the Far East and Latin America). Their functions would differ from those of the experts mentioned above and also from those of the Agency's Regional Officers. They would be expected to advise Governments in the region on requests etc., to organize, where appropriate, regional training courses and to lecture at national training courses.

12. Without additional resources it will be impossible to meet the increasing demands for equipment; equipment will, however, continue to be made available, as appropriate, to experts for demonstration purposes.

13. The effectiveness of the Agency's assistance and its impact on the economic and social development of Member States are increased by regular visits of small missions, usually composed of one or two staff members, who discuss with responsible officials current technical assistance requests, long-range programmes and the manner in which the Agency can best assist in preparing further requests for aid, both under UNDP/EPTA and the Agency's own programme. It is planned to send three such missions annually in 1967 and 1968 to regions in which the greatest need exists, as demonstrated by the requests received and indicated by the progress made in the implementation of current programmes.

14. The Agency is now acting as Executing Agency for four projects under UNDP/SF and expects to do so in 1967 and 1968 in respect of one or two more projects which are now under consideration. It will also continue to act as a sub-contractor in UNDP/SF projects for which other United Nations organizations are Executing Agencies. Assistance will be given to Member States in the study and preparation of additional projects suitable for execution under UNDP/SF.

(c) Bilateral assistance

15. Since multilateral aid is complementary to bilateral assistance and likely to remain so for some time to come, Governments are asked when submitting requests to provide information on any aid which they receive under bilateral arrangements or from sources other than the United Nations. Increased emphasis will be placed on ensuring that this information is provided, on its analysis and its bearing on Agency-assisted projects. It is foreseen that, in accordance with Article XI.B of the Statute, increased attention will be given to assisting Member States or groups of Member States to secure financing from outside sources to carry out projects which may require considerable capital investment.

(d) Training and exchange

16. Over 2500 fellowships have now been awarded by the Agency. A careful analysis has been made of replies to questionnaires sent to fellows who had completed their training abroad by 30 June 1965, with a view to ascertaining whether their services were effectively utilized on return to their home country. A summary of the results of this analysis appears in the Board's report on the technical assistance provided by the Agency in 1965. [3]

17. In carrying out its statutory obligation to advance the peaceful uses of atomic energy, the Agency is called upon to provide various forms of training. It is evident that the development of nuclear science in many areas of the world must proceed in co-operation with other United Nations organizations and institutes concerned with the application of science and technology in developing countries. It is therefore proposed to follow up, in close collaboration with UNESCO, one of the recommendations of the panel on the training of scientists in the developing countries which was held in 1965, by holding a joint meeting with UNESCO in 1967 to study the feasibility of introducing nuclear science into the curriculum of educational institutions. The programme submitted below is based largely on the panel's recommendations.

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[3] GC(X)/INF/87, paras. 92-96.

18. Emphasis will be placed on the provision of assistance for training courses and fellowships associated with Agency-assisted projects in Member States. It is expected that an increased number of requests will be made for training in food technology, power reactors and nuclear desalting. Inventories of available facilities for training in these subjects will be prepared. In conjunction with UNESCO or other agencies, increasing emphasis will be given to the training of technicians, laboratory assistants and middle-grade technical staff in skills specifically required in atomic energy laboratories. Appropriate training manuals will be prepared.

19. The role of the Agency in providing assistance for training in fundamental science, bearing in mind the training given to date and the requests made for such training in recent years, will be discussed with UNESCO with a view to transferring future requests for training and facilities in fundamental science to that organization.

20. Assistance will continue to be given for the purpose of establishing contacts between laboratories in developing and more advanced countries; so far such contacts have been successfully established between four laboratories.

21. Note has been taken of the views expressed by Member States on the increased need for training in power reactor operations. The main problem is the inadequate number of facilities provided by Member States for this purpose and an effort will be made to solve this problem.

22. The demand upon the Agency's funds for the support of training programmes at centres or institutes which directly or indirectly receive other forms of assistance from the Agency is expected to continue, but it is proposed gradually to reduce direct contributions from the Agency's own resources to individual centres or institutes. About 20 visiting professors will, however, continue to be provided each year to nuclear institutes and universities engaged in teaching nuclear science and in nuclear research programmes.

23. The Agency's two mobile laboratories have provided training for 1500 students and technicians in 16 countries in Africa, Asia, Europe and Latin America. [4] One is now stationed at the Seibersdorf Laboratory and the other has been assigned to the UNDP/SF project in Central America for the eradication of the Mediterranean fruit fly. They will continue to be used for training and research but no financial provision will be made from the Agency's technical assistance funds.

24. The Agency has received many requests and suggestions for the organization of training courses and seminars in 1967-68. It is unlikely that funds will be available for more than ten such courses in each year.

(e) Staffing

25. As a result of the recent reorganization of the Department of Technical Assistance, one further Professional post can be abolished in 1967.

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[4] See also document INFCIRC/81.

III. NUCLEAR POWER AND REACTORS

(a) General

26. Now that reactor systems can compete with fossil-fuelled systems, nuclear energy will play an expanding role in the power economies of both developed and developing countries. Installed nuclear capacity is expected to increase from 8500 MW at the end of 1965 to 24 000 MW by 1970. The years 1967-68 will witness an accelerated growth in nuclear power activities throughout the world, and some of the Agency's services will consequently be in greater demand.

27. In view of these developments it is proposed that the Agency should hold a greater number of meetings to provide more frequent exchange of technical information and experience with regard to power reactor technology, plant operation, fuel fabrication and reprocessing, reactor materials, nuclear power economics and reactor safety. The number of reviews and publications dealing with nuclear power will have to be increased, and the Agency must be prepared to meet more requests for advice on technical and economic evaluation of specific nuclear power reactor and desalting projects, for missions to conduct nuclear power and desalination surveys, and for detailed pre-investment studies.

(b) Nuclear power

28. Through nuclear power survey missions, the Agency has already assisted developing countries that are considering using nuclear power to meet their growing energy requirements. It is expected that two such missions per year will be sent in 1967 and 1968 in response to requests from Member States.

29. In mid-1966 the Agency completed a pre-investment study on power, including nuclear power, in Luzon, a UNDP/SF project in the Philippines. It is expected that in 1967 and 1968 the Agency will be the Executing Agency for more projects of this nature. If such studies lead to the construction of nuclear power stations, it is likely that Agency advice and assistance will be sought for a review of specifications, evaluation of bids, site selection and safety analysis, construction, training of staff, and procurement of fuel. Where a country initiates a nuclear power study on its own, the Agency may, upon request, provide expert advice in reviewing its results.

30. A number of developing countries have initiated construction of heavy-water reactors for power production. By 1967 valuable operating data will be available from commercial and experimental heavy-water reactors in Canada, Sweden, the United States of America and other countries. It is therefore appropriate that an international symposium on heavy-water reactors should be held in 1967 to discuss not only experience with existing plants, but also the technical and economic problems of advanced heavy-water-moderated systems, cooled by boiling light water, organic liquids, or gas, including their use for desalination.

31. One of the disadvantages of the present generation of light-water and heavy-water reactors is that they produce low-temperature saturated steam which requires specially built large turbines of relatively low efficiency. The introduction of nuclear superheat to obtain high-temperature steam comparable to that in modern steam plants would overcome this drawback; it would improve efficiency and permit the use of standard low-cost turbogenerators. A symposium in 1968 may deal with the special problems connected with the physics of two-region cores, control of power split, design and fabrication of superheat fuel elements, design of large nuclear superheat stations and the economics of nuclear superheat reactors.

32. It is estimated that between 1964, when the Third Geneva Conference reviewed the operating experience with nuclear power plants, and 1967, installed nuclear capacity will have increased from 5000 to 10 000 MW, mainly due to the advent of improved second-generation plants. These and the earlier ones will yield valuable operating, technical and economic data. It is proposed to convene a conference in 1968 to review and exchange information on the performance of commercial nuclear power reactors.

33. To assist developing countries in planning and implementing their nuclear power programmes, it is proposed to hold two regional study group meetings - one in Latin America in 1967 and another in the area of Africa and the Middle East in 1968. Previous meetings have been extremely useful. They serve to review the present status of nuclear power, latest data on cost and operating experience, extrapolation of cost data from advanced to developing countries, planning of nuclear power programmes, training of staff, and nuclear power programmes and projects in the area.

34. The Agency will continue to publish a review of selected power reactors and reactor projects in Member States, their basic design, construction, operation, safety and fuel cycle, and the cost of power production. As a result of offers by certain Member States, the scope of this review will be broadened to include power reactors in countries other than Canada, the United Kingdom and the United States.

35. In 1967-68, the Agency will give due attention to advanced converters and breeders, which are of great potential significance as they could lead to lower generating costs and better utilization of available low-cost nuclear fuel resources. Gas-cooled reactors were the first to generate commercial nuclear power. The Magnox reactors have led to the development of more efficient advanced gas-cooled reactors (AGR), which produce high-temperature steam. A new generation of the latter type of reactors has now emerged; these include the high-temperature gas-cooled reactor (HTGR) and the Arbeitsgemeinschaft Versuchs-Reaktor (AVR). Under the INCA (incorporé combustible annulaire) project, advanced fuel is being developed. An AGR demonstration plant has been in operation since 1963; HTGR and AVR prototypes are expected to begin producing power in 1966. It is proposed to hold a symposium on advanced gas-cooled reactors in 1968, by which time sufficient experience with these and other experimental gas-cooled reactors will be available. The symposium will also discuss problems relating to design and development including heat transfer, coolant properties, on-load fuelling, and other aspects.

36. Fast reactors are still in an early stage of development; major problems relating to physics and safety remain largely unsolved. The Third Geneva Conference drew attention to the need for a frequent review of information on these questions. A symposium on the physics and related safety problems of fast reactors is proposed for 1967.

37. A number of reactor systems are reaching the stage of commercial application, but work is continuing on the development of others which are either advanced versions of existing types or radically new ones. The first category includes reactors with super-critical steam in direct cycle and reactors using the seed and blanket or the mixed spectrum concepts. The second category embraces a variety of systems, including fluid-fuel, pebble-bed, paste-blanket and experimental beryllium oxide reactors as well as the ultra-high-temperature reactor experiment. It is proposed that a symposium be held in 1968 to review and exchange information on the latest developments in advanced power reactor systems and concepts.

38. The important problems in the development of advanced reactor system which have yet to be solved include heat transfer, fluid flow, coolant behaviour, reactor control, in-core instrumentation, and detection of fuel failures. The progress that had been made with regard to certain heat transfer and fluid flow problems covering burnout flux, dynamic stability, etc. was briefly discussed at the Third Geneva Conference. The time available

was too short to cover them in depth, but the necessity for a special meeting devoted to these problems was evident. The Agency proposes to organize a conference on heat transfer and fluid flow problems in 1967 or 1968 to cover such reactor coolants as water, gases, and organics.

39. The Agency plans to hold, probably in 1968, a symposium on the design, technological characteristics and economics of reactor power plant equipment such as pumps, heat exchangers, pressure vessels, refuelling machines, control rod drive mechanisms, valves, etc. which are an important and sometimes decisive factor in achieving competitive nuclear power. Equally important are new types of control systems and instrumentation, particularly in-core instrumentation, which could lead to savings without compromising safety. A symposium on power reactor controls engineering, including the use of computers, is planned for 1968.

40. Since reliable and safe operation of nuclear power plants depends to a great extent on the integrity and performance of their fuel elements, it is necessary to have a reliable system for immediately detecting any failure in a fuel element and precisely locating it. It is therefore proposed to review, in 1967, with the help of specialists, various aspects of the design, installation and operating experience with various failed fuel element detection systems and to discuss possible improvements.

41. With regard to nuclear ship propulsion, the Agency's programme will be based on the recommendations of a panel scheduled for the end of 1966. The Agency is in touch with IMCO and other appropriate organizations. It may be desirable to hold a symposium on nuclear ship propulsion in 1968 to review the design, construction, operation, and safety problems of ship propulsion reactors.

42. In view of the attention given to the development of reactors for special applications, such as mobile or package units for use in remote stations and in space, a symposium in 1968 on such applications might serve a useful purpose.

(c) Nuclear desalination

43. The importance of water desalination is increasing as supplies of fresh water fail to meet the growing domestic, industrial and agricultural demands. The First International Symposium on Water Desalination, held at Washington in October 1965, emphasized the potential contribution of desalination plants to industrial and economic development.

44. The Agency's programme in nuclear desalination has evolved in response to requests from Member States. In 1965, a panel of experts recommended that the Agency should serve as the focal point in matters relating to the use of nuclear energy for desalting, provide assistance, advice and co-ordination services to Member States, and foster the study of practical applications of nuclear energy in desalting. The Agency will therefore continue to study reactor types and their potential use in meeting various desalting requirements. The Agency will continue to convene panels of experts regularly to review all developments relating to nuclear desalination.

45. The organizers of the First International Symposium on Water Desalination plan to convene an international Water for Peace Conference in 1966 or 1967, in which the Agency expects to participate, at least as far as nuclear desalination is concerned. In view of the importance of this subject and as a follow-up to this conference, the Agency plans to hold a meeting on nuclear desalination in 1968.

46. There may be a need for two survey missions per year in 1967 and 1968 to deal with desalination; where possible, these will be combined with the power survey missions mentioned in paragraph 28 above.

47. By a tripartite agreement signed in 1965 [5], the Agency, Mexico and the United States, established a joint study group to make a preliminary assessment of the technical and economic practicability of a dual-purpose nuclear power plant for the arid regions in the States of California and Arizona in the United States, and the States of Baja California and Sonora in Mexico. The group is expected to complete its report by the end of 1966. The project may continue through 1967 and 1968 in the form of a detailed engineering study of an appropriate dual-purpose plant. The Agency has also participated in a similar United States-Israeli project, and if it is decided to go ahead with a nuclear desalination plant, the Agency may be further involved.

48. The agreement of co-operation between the Union of Soviet Socialist Republics and the United States of America in desalination, including the use of atomic energy, [6] provides that the Agency receive copies of accounts, reports and other documents exchanged between the two countries. It is expected that the Agency will be invited to send observers to meetings held as a result of this agreement.

49. The Agency took part in the United Nations Inter-regional Seminar on the Economic Applications of Water Desalination, held in New York in 1965, and has invited United Nations experts to its panel meetings. Similar co-operation with the United Nations and its specialized agencies will continue.

(d) Research reactors and their utilization

50. The design and development of advanced research reactor systems were also reviewed during the Third Geneva Conference. By 1968, it is expected that considerable experience in their operation will have been accumulated, and it is planned to hold a symposium to review the important operational and experimental aspects of the work being done with these reactors (including those operating in the pulsed mode) and to discuss future trends.

51. The Agency's study group meetings on research reactor utilization have been fruitful, and in 1967 and 1968 such meetings will be held in the Far East, Eastern Europe and Latin America. In order to meet the changing needs of the developing regions, it is planned to hold a panel in 1967 to review past activities, assess requirements, and advise on the future course for these study groups.

(e) Economics of nuclear power

52. The Agency intends to continue its analysis of nuclear power costs, concentrating on two topics of particular importance. The first is the international extrapolation and comparison of nuclear power costs, which is of recurring interest to power survey missions and most industrialized and developing countries; a symposium on this topic is planned for 1967. The second topic is the economics of nuclear fuels, and a symposium is planned for the same year to deal with the present and future supply of, and demand for, different fuels, and possible trends in costs.

(f) Reactor research

53. Fruitful international collaboration in reactor research has been achieved in the joint Norway-Poland-Yugoslavia project, the India-Philippine neutron crystal spectrometer project and the NORA reactor physics project. The extent to which the Agency is now required to participate in the latter project is decreasing. It is hoped to promote similar co-operative programmes for research and training, particularly among laboratories in developing Member States.

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[5] INFCIRC/75.

[6] INFCIRC/60.

54. While a wide variety of experimental and analytical studies in light-water reactor physics has been carried out, there is a continuing need for new or improved solutions of problems arising from the theoretical difficulties inherent in the treatment of the mixed spectral heterogeneities in multi-region hydrogenous systems. Important results have been obtained in studies of simple and complex lattices of different fuels, including plutonium/uranium, uranium-233/thorium and slightly enriched uranium oxide. A panel to discuss these and related topics will be convened in 1967. Similar problems arise in the case of graphite-moderated, gas-cooled systems, and accordingly a panel on graphite lattices is planned for 1968.

55. In recent years increased attention has been paid to the more accurate predictions of reactivity and isotopic changes in thermal reactors as the core burns up. This is also of relevance to the Agency's safeguards programme. In 1967, a panel of experts will make a detailed examination of current burn-up predictions and new codes for use with the more advanced computers which will then be available. The importance of such a panel was stressed by the European-American Committee on Reactor Physics in October 1965. This committee is at present preparing a document specifying the requirements of such new burn-up codes; the objective of the Agency's panel would be to provide a consistent follow-up on a broader international basis.

56. The methods now employed to obtain long-term reactivity control in power reactors include the use of burnable poison, control by spectral shift, refuelling and shuffling of fuel under load, and the use of plutonium-240. All these have proved successful but, since their comparative effectiveness has not been evaluated, it is proposed to hold a panel in 1967 to discuss their engineering, operational and economic merits.

57. In view of the importance of reactor kinetics to the operation and safety of research and nuclear power reactors, the Agency plans to hold a symposium in 1968 to review advances in the knowledge of transient and instability phenomena in various reactor types. It would cover theoretical and experimental aspects of fast transient behaviour in closely-coupled systems, space-time reactor dynamics in large thermal power reactors, reactivity shut-down mechanisms, and fuel element destructive effects under transient conditions.

58. Since the International Seminar on Codes for Reactor Computations, held in 1960, important advances in reactor physics analysis have been made. In view of the importance of new calculation techniques in the design of power reactors and advanced research reactor systems, the Agency will hold a symposium in 1968 on methods of using computers in reactor physics. It will deal with such topics as multi-dimensional, multi-group diffusion codes, methods for calculating few-group constants and self-shielding factors, depletion codes, Monte Carlo methods, neutron thermalization and transport theory codes.

59. As part of its programme to improve research reactor utilization the Agency will convene a panel on in-pile dosimetry measurements in 1968, to review developments in techniques for measuring radiation dosage. The discussions will bear on the experimental and theoretical problems of determining the separate energy in test samples as a result of gamma-ray absorption radiation, fast neutron scattering, or nuclear reactions occurring in the sample, and related subjects.

(g) Nuclear fuels and materials

60. It is important to reduce fuel cycle costs, which form part of the total generating costs in a nuclear power plant, by improving techniques. In collaboration with ENEA, the Agency is paying special attention to nuclear fuels and materials technology and will continue to assist Member States to secure information on different aspects of the production, treatment, utilization of source, special fissionable and other nuclear materials, and on the fabrication of nuclear fuels and their reprocessing.

61. With the expansion of national nuclear power programmes, large quantities of plutonium will accumulate. Extensive programmes for the development of plutonium technology are under way in Member States so that this by-product can be recycled and subsequently utilized in both thermal and fast reactors. SAC has emphasized the importance of the Agency's work relating to plutonium and recommended that the Agency "organize technical meetings concerning the utilization of plutonium in reactors". Accordingly, the Agency is organizing meetings at frequent intervals on this subject. As a follow-up to a panel convened in 1964, a symposium will be held in 1967 and in 1968 a further panel will review the latest developments and possibly prepare an Agency publication on the subject.

62. Thorium is an important fertile material for providing power reactor fuel. Since reserves of low-cost thorium are more abundant than those of uranium, several developing countries are anxious to utilize their deposits. In 1965, a panel recommended that the Agency should follow closely the rapid progress in the development of thorium reactor systems and organize suitable technical meetings. By 1968 there may be sufficient new information on thorium technology and on the operating experience of reactors using thorium fuel to justify a panel to review progress.

63. Non-aqueous reprocessing of nuclear fuels is advancing rapidly, the fluoride volatilization process having reached the stage where a commercial-scale plant is being designed. Encouraging developments are taking place with pyrometallurgical and pyrochemical processes. The advantages offered by non-aqueous processes include ability to process irradiated fuels cooled for a short time, avoidance or simplification of chemical conversion and direct production of solid wastes. A symposium on this subject is planned for 1968 to discuss the considerable amount of information which is expected to be accumulated by that time.

64. Following the Conference on New Nuclear Materials held at Prague in July 1963, a symposium on advanced techniques for fuel fabrication will be held in 1968 to deal with vibratory compaction, the sol-gel process and various schemes for remote control fabrication. It is expected that advanced techniques may lower the cost of fabrication and thereby help to reduce power generating costs.

(h) Information

65. The collection and dissemination of technical data and information on research and power reactors and nuclear power programmes constitutes an important part of the Agency's work. It is planned to extend this work to cover reprocessing plants when data are available. The seventh volume of the Directory of Nuclear Reactors is expected to be issued early in 1967. The first reactor index cards issued, covering 800 reactors, have been well received. These cards will be brought up to date and supplemented at suitable intervals during 1967 and 1968.

66. Following the installation of the computer, steps are being taken to store bibliographical and technical information on magnetic tapes. The Agency will thus keep a comprehensive and systematic record of pertinent information on nuclear reactor installations, which can be retrieved quickly, and made available to Member States upon request.

(i) Staffing

67. The increasing volume of work requires that the Division of Nuclear Power and Reactors be strengthened by the addition in 1967 of two Professional posts to deal with research reactors, reactor safety, power reactors and the Directory of Nuclear Reactors.

IV. ISOTOPES AND RADIATION SOURCES

(a) Food and agriculture

(i) General

68. The Joint FAO/IAEA Division of Atomic Energy in Agriculture was established at the Agency's Headquarters on 1 October 1964. The Joint Division prepares a single joint programme on the use of isotopes and radiation in food and agriculture on behalf of both FAO and the Agency. Emphasis is placed on activities which can be of early practical benefit to agriculture and increase food supplies, and the assistance provided is related to the specific needs of countries and to their stage of development. The Division concentrates on those activities which are not being dealt with by other international or national organizations, particularly on projects of importance to developing countries. In carrying out the programme, the scientific staff of the Division not only arranges meetings of experts, gives advice to Governments and prepares technical publications, but assumes responsibility for all activities involving the use of radiation and isotopes in food and agriculture, including technical assistance projects, training courses, fellowships, research contracts, symposia and the Agency's Laboratory programme. Programmes are developed and carried out in consultation, as appropriate, with the relevant divisions in both organizations.

69. In the programme on the use of isotopes and radiation in work on soil fertility, irrigation and crop production emphasis is laid on the most efficient use of fertilizers, in particular with rice and maize. The successful rice fertilization programme, in Asia and the Far East, which involves 14 contractors in 12 countries and has already resulted in practical recommendations, will be continued, while a new programme on the efficient use of fertilizers in tree crops will be developed. The problem of irrigation is being approached with a view to achieving a more efficient use of water in arid areas. In insect eradication and pest control, stress is laid on the development and application of the sterile male technique, through co-operative research work and demonstration projects under UNDP. Achievements to date include development of a cheap rearing medium for the Mediterranean fruit fly, mechanization for the production of several million flies a week and methods of aerial release and dispersal. Similar work has been started, and will be expanded, on the tsetse fly and other animal insect pests. Work on pesticide residues will be carried out in collaboration with FAO and WHO and the compilation of world-wide data on dietary levels of natural and artificial radionuclides for the United Nations Scientific Committee on the Effects of Atomic Radiation will be continued. The very successful three-year UNDP/SF project for the application of nuclear energy in agriculture, veterinary medicine and forestry at Zemun, Yugoslavia, was completed in April 1966. The main purpose of the work relating to plant breeding and genetics is to facilitate the application of induced mutations to plant breeding by developing improved methods of mutation induction, including standardization of neutron seed irradiation. With regard to animal production and health, attention is primarily devoted to the use of labelled materials for investigating protein metabolism in the ruminant and the etiology and treatment of parasitic diseases. The food preservation programme concentrates on microbiological, entomological and technological problems, for the solution of which the irradiation technique offers unique advantages over existing methods. A UNDP/SF project for a grain irradiation pilot plant in Turkey is being initiated.

(ii) Soil fertility, irrigation and crop production

70. The existing co-ordinated programmes on the use of isotopes and radiation in rice and maize cultivation and in water-use of efficiency studies will be continued as priority contributions to the United Nations Development Decade. A new programme on the use of labelled material in investigating the nutrition of tree crops important in the economy of tropical countries will be initiated. The work will be co-ordinated by meetings of research contractors, as appropriate, in both 1967 and 1968, with such changes in direction and

emphasis as may be dictated by the progress achieved. The Agency's Laboratory will continue to support these programmes by carrying out routine analysis of about 4000 samples of phosphorus-32 and nitrogen-15 per year as well as by associated field and greenhouse work.

71. In 1967 a panel will evaluate the results of the programme on the use of isotopes and radiation in studies of plant nutrient supply and movement. In 1968 a planning meeting will consider broadening this into a programme on the use of isotopes and radiation in studies of the physical-chemical relationship of soils and plants. The Laboratory will concentrate on the study of movement and supply of plant nutrients in rice soils and will also contribute to the research contract programme on water-use efficiency studies by carrying out soil and water analyses.

72. In 1967, a symposium on the use of isotopes and radiation in soil physics and irrigation studies will be held, to be followed in 1968 by a symposium on the use of isotopes and radiation in soil organic matter studies. Panels on radiation and isotope techniques in soil, water and irrigation investigations and in studies of soil microbiology are planned for 1968. Subject to the availability of funds, training courses on the use of isotope and radiation techniques in soil physical investigations and in horticultural investigations may be held. The Joint Division will co-operate with other technical divisions in FAO and the Agency in studies involving the use of desalted sea water for crop irrigation.

(iii) Insect eradication and pest control

73. The co-ordinated programme on the use of the sterile male technique to control or eradicate species of insects which are harmful to crops and livestock is a priority contribution to the Development Decade. Planning meetings of contractors will be convened in 1967 and 1968 in conjunction with a panel on the use of radiation and radioisotopes in the control of insect pests.

74. The Special Fund project for a large-scale demonstration of the control and eradication of the Mediterranean fruit fly (Ceratitis capitata), initiated in 1965 in Central America, will continue through 1967; it is expected that, on its completion in 1968, other countries will be interested in eradicating this species on a practical scale, and this should result in further UNDP/SF projects. The progress made by 1967-68 should permit the initiation of a large-scale demonstration of the control or eradication of the olive fly (Dacus oleae) and the oriental fruit fly (Dacus orientalis). In 1968 a panel on principles and guidelines to be followed in fruit-fly eradication programmes will be held. Support will also be given to research on the application of the sterile male technique to the control or eradication of the tropical ox warble (Dermatobia hominis) and to the solution of the extremely complex but challenging problem of the tsetse fly (Glossina spp.). Work on the application of the sterile male technique to rice insect control will be expanded, and close contact will be maintained with the work of the FAO International Rice Commission Working Party on Rice Production and Protection.

75. A symposium on the use of radiation and radioisotopes in entomology will be held in 1967, and the distribution of the information circular on Radiation Techniques and their Application to Insect Pests will continue.

76. The Agency's Laboratory will continue to assist in working out methods of irradiation, economical mass rearing and selection of vigorous strains of insects for use in campaigns for the control or eradication of the above-mentioned species by the sterile male technique. A specialist in the control of insect pests of livestock will assist in expanding work in these and related subjects. In 1967, a panel will be convened to review progress in research on tsetse fly and insect pests in livestock and to advise on further developments.

77. In 1967 a symposium on radioisotope applications in plant pathology will be held.

(iv) Pesticide residues and food protection

78. Work on pesticide residues will be developed in association with the FAO Committee on Pesticides and WHO will be invited to co-operate. A further panel on the use of radioisotopes and radiation in studies of pesticides and residue problems will be convened in 1968. The Laboratory will participate in a project for the distribution of standardized samples for inter-laboratory checking of analytical methods for the determination of pesticide residues.

79. A panel on the assessment of maximum permissible concentrations of radionuclides in foods will be convened in 1967 to consider and recommend the principles in accordance with which competent authorities should establish maximum doses of radiation acceptable to man in normal and emergency situations which may arise from the operation of nuclear reactors and associated installations. WHO will be invited to participate. The possible immediate and long-term injury to farm livestock in the event of radioactive contamination of the agricultural environment will be considered by consultants.

80. Jointly with WHO, a seminar on agricultural and public health aspects of environmental contamination will be held in 1968 to review the relevant problems and determine whether modification or simplification of plans for the protection of the public are required in the light of the experience gained since this subject was first reviewed internationally at a joint seminar in 1961. A training course on radionuclide surveys in foods will be held, in co-operation with WHO.

(v) Plant breeding and genetics

81. The need to produce increased variability by the use of induced mutations is growing. A number of improved crop varieties now in use has been produced through nuclear techniques. The use of radiation for specific genetic and cytological studies has also greatly assisted the plant breeder.

82. The co-ordinated programme on the use of induced mutations for rice improvement will be continued, in association with the FAO International Rice Commission Working Party on Rice Production and Protection, while a project dealing with aspects of efficient mutagen treatment of rice will be carried out in the Laboratory; planning meetings will be held in 1967 and 1968, and a regional training course is planned for 1968.

83. The use of the induced-mutation method, which was introduced into the FAO Near East Regional Wheat and Barley Improvement and Production Project in 1965 by testing mutant lines of durum wheat, will be extended through the provision of mutagenic treatment services, and technical advice and laboratory services will be supplemented by sending specialists to the region in 1967 and 1968. Panels will be convened in 1967 and 1968 in conjunction with the FAO meetings of participants in the region.

84. The International Group of Mutation Workers engaged in studies on the production and use of induced mutations in plant breeding will, in 1967 and 1968, consider the effects of small doses of radiation on crop plants if developments so warrant. Consultants will prepare bibliographical lists to assist this group and the Section of Mutation and Polyploidy of the European Association for Research in Plant Breeding (Eucarpia).

85. Panel meetings of participants in a co-ordinated research programme on the use of neutrons in seed irradiation and the use of germinating seedlings for the standardization of measurements of neutron absorbed dose will be convened in 1967 and 1968. The Laboratory participates in this programme.

86. A Manual on Mutation Breeding will be published in 1967; a list of workers engaged in mutation investigations and a list of radiation sources will be prepared. The Laboratory will work on the improvement of methods of inducing mutations by gamma and neutron irradiation and their comparison with other mutagen treatments.

87. International standardization of the recording and processing of mutant data by using computers will continue and a panel on this subject is planned for 1968. A symposium on the use of induced mutations in plant breeding is expected to be held in connection with the Twelfth International Congress of Genetics in Tokyo in 1968.

(vi) Animal production and health

88. Radioisotopes have proved valuable in studies of the physiology, metabolism and nutrition of farm livestock, whilst ionizing radiation has important potential applications in the control of certain animal diseases.

89. One of the main problems in animal nutrition is the utilization of nitrogen by ruminants; this involves the use of urea and other cheap sources of nitrogen in the feeding of cattle. The increasing use of nitrogen fertilizers has created an interest in the economic and physiological aspects of the soil-plant-animal relationship. A symposium on the subject will be held in 1967; in 1968 a meeting may be organized to discuss the use of isotopes in the study of reproduction physiology. Special emphasis will be given to nutritional factors.

90. In accordance with the recommendations of the panel on the production and utilization of radiation vaccines against helminthic diseases, held in 1963, support will be given to studies on the use of different sources of radiation and to the development of techniques for labelling the infective forms of certain parasites that cause animal diseases. A panel on the radiation inactivation of viruses and the radiation attenuation of larvae for vaccine production will be held in 1967.

91. Subject to availability of funds, a further advanced training course on the use of radioisotopes and radiation in animal science and veterinary medicine may be held in 1967.

(vii) Food preservation

92. Intensive research in various countries over the past two decades has clearly demonstrated the feasibility of using ionizing radiation to increase the storage life of certain perishable foods, to disinfest stored grain and dried or packaged foods and to destroy food-borne parasites or pathogenic micro-organisms which cause food poisoning.

93. The grain disinfestation pilot plant, established under a UNDP/SF project in Turkey, will provide by 1967 the first opportunity for a technical and economic evaluation of the use of this process on a commercial scale; international demonstrations of its technical and economic feasibility are expected to be held.

94. Further investigation is needed on means of increasing the radiosensitivity of micro-organisms that cause food spoilage or poisoning, so that lower radiation doses can be employed, and panels on the microbiological aspects of this subject will be held in 1967 and 1968. A panel on microbiological standards and testing methods for irradiated foods will also be held in 1967. A panel on the use of radiation for the elimination of harmful organisms, especially Salmonella and others causing intestinal infections and parasitic diseases, from food and animal feeds will be held in 1967; in 1968 an effort will be made to determine a suitable location for a pilot irradiation plant to demonstrate and evaluate Salmonella decontamination of food items which do not lend themselves to other methods of treatment.

95. Panels will be convened in 1967 and 1968 to advise on means of minimizing undesirable changes induced by radiation in fruits and vegetables and on means of controlling the maturation of fruits and vegetables by radiation. In 1968, the possibility of establishing a regional irradiation centre for tropical fruits and vegetables will be explored. Panels will be held in 1968 to consider problems of control of undesirable changes in irradiated foods of animal origin and the packaging and handling of irradiated food. An international training course on food irradiation techniques is also planned for 1968.

96. The primary aim of the Laboratory's work on food irradiation is to determine in detail the mechanism of enzyme protection against radiation, with a view to developing means of eliminating the protector so that enzyme action can be inhibited by low-dose irradiation.

97. The Agency will continue to take part in the work of the planning and evaluating committee of the project on the preservation of fruit and fruit juices by irradiation which is carried out at the Austrian Reactor Centre under the tripartite agreement between the Agency, the Oesterreichische Studiengesellschaft für Atomenergie, and ENEA [7]. The Agency will participate in a symposium on the preservation of fishery products which will be organized by FAO in 1967.

(b) Nuclear medicine and radiation biology

(i) General

98. The Agency will continue to contribute to the development of nuclear medicine and radiation biology by providing technical assistance, training facilities and information services, promoting research and by evaluating new instruments and techniques. In view of the constant increase in the number of medical radioisotope departments and radiation biology laboratories, a corresponding increase in requests for advice and assistance is expected during 1967-68. This is exemplified by the Agency's technical assistance programme for 1966. Of all projects approved, 15% relate to nuclear medicine, and in the implementation stage this fraction will probably increase to as much as 20%; 25% of research contract funds available in 1965 was spent on support of medical isotope research.

99. As a result of the Agency's training, technical assistance and research activities over the past six years, medical isotope work has expanded and improved throughout the world. Through its annual symposia on different methods of in vivo and in vitro radioisotope measurements, its atlases, directories and bibliographies its scientific work in the Laboratory and its standardization projects (such as the international calibration of thyroid radioiodine uptake measurements which has now been completed), the Agency has become a focal point for the exchange of information and the provision of advice and assistance on the physical aspects of nuclear medicine and radiation biology. On the advice of SAC, this work will be concentrated on the physical aspects to an even greater extent during 1967-68, with diminishing emphasis on purely medical problems. Nevertheless, close contact will be maintained with WHO, through the Liaison Officers, on all medical and biological aspects of the Agency's work in order to integrate the programmes of the two organizations.

100. The work on radiation biology has been mainly directed towards the support of research, training and scientific meetings which are intended to serve as a foundation for, or have a direct bearing on, other activities in the Agency, particularly agriculture, medicine and health protection. For example, research in radiation biology has led to recognition of the difference in sensitivity of tissues under varying conditions. It has been found that tissues are much more sensitive to radiation in an environment of increased oxygen tension than in normal atmospheric concentrations but much less sensitive in an atmosphere of nitrogen. Such experimental results have found application in new methods of radiation therapy. Basic genetic mutation studies have led to the use of radiation in agriculture, specifically for the improvement of crops. A case in point is the rice mutation programme which is being actively pursued by the Joint FAO/IAEA Division. Recent investigations have shown that chromosome changes in the peripheral blood cells of mammals may serve as indicators of radiation exposure. Although further work is needed in radiation haematology and genetics before the technique can be adopted, it shows considerable promise for large-scale monitoring of individuals engaged in the nuclear industry. Thus,

[7] INFCIRC/64.

the programme in radiation biology will continue to be closely related to the Agency's medical, agricultural and radiation protection programmes. In addition, such practical applications as radiation sterilization of medical supplies and bioproducts will receive increased attention during 1967-68.

(ii) Radiation sensitivity

101. The Agency's programme in radiation biology, which since 1964 has largely aimed at gaining an understanding of the radiation sensitivity of organisms at the molecular, cellular organ and total-body level, will continue to be pursued through the organization of co-ordinated research and a series of panels or symposia with emphasis upon the effects of radiation on the metabolic mechanisms and genetic properties of the cell.

102. Work at the molecular level will concentrate on the effects of ionizing radiation on the deoxyribonucleic acid molecule and the associated relationship to genetic effects, alterations of the "code" or biological information. A group of experts on the effects of radiation on the biological information system will be convened in 1968, and the fourth training course in molecular biology is tentatively scheduled for the same year.

103. Studies of radiation sensitivity at the organ and total-body level are of interest in relation to radiotherapy, modification of radiation injury and radiation protection. A knowledge of the immune response of the body to foreign tissue and its possible modifications by radiation is extremely important. An understanding of this response and its suppression by radiation is invaluable for the successful transplantation of tissues such as the kidney in the therapy of renal disorders or bone marrow cells in the treatment of persons exposed to radiation. As a follow-up to the panel on radiation immunology held in 1965, a panel on co-ordinated contractual research in immunology will be held in 1967 and a symposium on radiation immunology is planned for 1968. In addition, two training courses are planned, one dealing with radiation effects on the haematopoietic system in 1967 and the other with radiation recovery and immunology in 1968.

104. An important part of modern radiobiological research is concerned with the true understanding of the relative biological effectiveness, or radiation quality, and its dependence on radiation energy. In recent years significant progress in both biology and physics has been made. In particular, a great deal of information on linear energy transfer (LET) spectra of different kinds of radiation has been reported, and investigations have been started on the relative contribution of different LETs to the total dose. This is important for the evaluation of radiation hazards in mixed radiation fields, in the vicinity of high-energy accelerators, and in space. A panel on the subject, held in 1965, agreed on some general directions for future research. It is therefore planned to hold a second meeting on biophysical aspects of radiation quality in 1967 at which results of current research will be discussed.

(iii) Radiation toxicology

105. The co-ordinated research on the metabolism and toxic effects of radium and strontium-90 in humans will be continued in the light of the recommendations made by the Panel on Dosimetry and Toxicity of Strontium-90 and Radium held in 1966. Support will be given to laboratories capable of collecting useful data on human beings, particularly groups of people occupationally contaminated with these isotopes during luminous-dial painting. The data on about 150 such cases will be kept up to date; emphasis will be laid on the recording of dosimetric and toxicological data which facilitate pooling of the information.

106. The laboratory work on human subjects carrying appreciable burdens of thorotrast which has for several years received financial support from a Member State will be continued. Its aim is to acquire a better understanding of certain aspects of the hazards of internally deposited radioisotopes. As a result of recommendations made by the joint Agency/WHO panel on the dosimetry and toxicity of thorotrast held in 1965, this work will be integrated into international activities designed to collect epidemiological information

available from the world pool of thorotrast cases, which is estimated at about 10 000. So far, the Agency has collected data, including, where appropriate, the cause of death, on about 300 cases and on an equal number of control cases; about 60 cases still living were measured for body burdens by whole-body counting. Whole-body spectrometric analysis and profile scanning will be required for newly discovered cases or as special checks on those previously measured. More samples are needed in order to obtain more refined information on dose rates at the organ or cellular level. Gamma-spectrometric, chemical, and possibly autoradiographic techniques will be employed. Training in whole-body counting techniques, which up to the end of 1965 was provided for ten physicists for periods of up to six months, will be continued in 1967-68.

107. The toxicological investigation has been greatly stimulated by the recent finding, through the joint efforts of the University of Vienna and the Agency's Laboratory, that chromosome aberrations are identifiable in the peripheral blood cells of nearly all thorotrast cases, and that their frequency increases with body burden. For the first time a quantifiable dose-effect relationship in living thorotrast cases has been established, and an increased effort will be made to clarify the dose, the effect, and to correlate these findings with similar findings in humans subjected to other types of irradiation.

(iv) Diagnostic and research applications of tracers

108. With the rapid development of medical radioisotope techniques, there is an increasing need for advanced training facilities for persons already working in medical radioisotope laboratories. It is planned to organize in 1967-68 two advanced regional training schools on medical applications of radioisotopes similar to that held in 1966 in Bangkok. As a result of offers received from Member States, the possibility of establishing an international centre for nuclear medicine under the Agency's auspices will be further examined.

109. In its research contract programme on medical applications of radioisotopes the Agency will continue to stress its interest in their applications in the study of endemic and tropical diseases which were accorded high priority by a joint Agency/WHO meeting in 1962. Emphasis will be given to the co-ordinated research programme on the use of radioisotopes in the study of malnutrition in tropical and subtropical regions as one of the Agency's contributions to the United Nations Development Decade. In 1967, a consultants' meeting will evaluate the progress made and advise on future work. The Laboratory prepares labelled proteins for distribution to collaborating research groups - at present eight - to enable them to check locally-made preparations.

110. Automatic computing methods are being increasingly used in medicine, especially in studies involving radioisotopes. A symposium on data storage and computer analysis in medical applications of radioisotopes is therefore planned for 1968. The Agency's computer is being used for producing the nuclear medicine bibliography which is sent at three-monthly intervals to about 1100 medical isotope laboratories. It is also used for analysing data obtained with the whole-body counter and the double-crystal spectrometer.

111. Scanning techniques for the localization of radioisotopes in the human body or its organs are rapidly expanding. The Agency will hold its third symposium on medical radioisotope scanning in 1968. In 1965-66 eight medical radioisotope laboratories in Member States were supplied with scanning machines under technical assistance projects or research contracts; this entailed an expenditure of well over $100 000 on equipment alone. The Laboratory conducted a series of tests on a scanner and a gamma-camera, loaned by commercial companies, in order to establish criteria for assessing the suitability of commercial equipment and to develop calibration equipment for inter-laboratory comparisons to be carried out in 1967-68. Since it is only possible to borrow such equipment for short and unpredictable periods, the purchase of a scanning machine will soon be necessary.

112. The estimation of the radiation dose received by patients during diagnosis involves many problems, and the dose considered to be acceptable varies widely from country to country. The work of ICRP on occupational exposure offers no guidance for the assessment of the radiation hazard resulting from either routine or research applications of isotopes in medicine. Use was made of the professional officer's post, which became available on completion of the thyroid uptake calibration project, to make a modest effort, in conjunction with ICRU, to collate data on the physical and mathematical aspects of the dose computations. In 1967, it is intended to broaden this work by including metabolic data, which are not only inadequately known and poorly evaluated but are widely scattered in the literature. The systematic collection and evaluation of these data is a major problem which can probably be satisfactorily solved only by an international organization. A panel on the estimation of radiation dose in diagnostic radioisotope applications will be held in 1967 to review the results of work done by that time.

113. Activation analysis techniques and their biological applications are advancing rapidly as a result of developments in spectrometry, computer reduction of data, automated ion-exchange column separation of elements and solid-state detectors. These permit considerable improvements in the analysis of trace elements in biological materials. A symposium on the use of nuclear activation techniques in the life sciences will be held in 1967. Its results will have a bearing on the Laboratory's activities, which are designed to meet the needs of Member States for technical assistance and to provide training and advice and will, in addition, permit the conduct of research concerned with the nutritional and medical role of trace elements in diverse environments and diseases.

114. Full advantage will be taken of techniques and skills already available at the Laboratory, the Austrian reactor, the computing facilities now accessible to the Agency, and the two parameter pulse-height analyser donated by a Member State. Current technical developments in automated chemical separation procedures and especially in high-resolution solid-state lithium-drifted germanium gamma-ray detectors promise a dramatic increase in the potential of this analytical technique. The standardization of neutron activation methods of determining iodine concentration in blood will be continued.

(v) Applications of radiation sources

115. The principal application of radiation sources in medicine is in radiotherapy, and the physical aspects of radiotherapy will continue to play an important part in the Agency's programme. Several Member States have offered radiotherapy equipment for delivery to hospitals in developing countries. It is expected that this equipment will be in full use during the period 1967-68. The third advanced training course on the physics of radiotherapy is planned for 1967.

116. Up to the present the Agency's activities have been concerned only with facilities needed for teletherapy and the use of small sealed radiation sources. In order to cover also other modes of radiotherapy, it is proposed to seek the advice of experts in 1967 on the physical aspects of the use of unsealed radioisotopes for systemic, intracavitary and interstitial therapy.

117. The panel on the use of computers in radiotherapy dosimetry, which met in Vienna in 1965, suggested a number of projects which could be undertaken by advanced radiological institutes, with Agency co-ordination, to provide physical data for radiotherapy in a form that could be utilized by small radiotherapy centres. The second meeting of the panel will be held in 1968 to review the progress made and make further recommendations.

118. A Radiation Data for Medical Use service was set up by the Agency in 1964 and over 1000 individual requests for such data had been met by January 1966. The service provides copies, at low cost, of graphs, charts and other radiation data which have been measured or calculated in other centres. At present the service provides only unpublished

data which happen to be available, but no attempt has been made to evaluate them, to correlate data from various sources and to fill in gaps. It is proposed to convert the catalogue [8] into a comprehensive source-book in which the best data, whether published or not, will be quoted and annotated.

119. For several years experimental work related to radiotherapy and other applications of radiation sources has been conducted in the Agency's Laboratory. The development and testing of the absorbed-dose microcalorimeter have been completed. The programme for measuring the absorbed dose by the calorimetric and other suitable methods will be carried out through the calibration of chemical and solid-state dosimeters by comparison with the calorimetric method and the distribution of chemical and solid-state dosimeters to interested laboratories. In order to review the progress of this work and to decide on further measures for providing help and advice, the Agency will convene a panel in 1968 on the dosimetry requirements of small radiotherapy centres. Some of the information now missing in the data used by the Radiation Data for Medical Use service will be obtained by making gamma-spectrometric measurements on a simulated irradiation unit, using microcurie quantities of cobalt-60 and caesium-137.

120. The recruitment and training of medical physicists for work in the various branches of medical physics pose many problems. It is proposed to convene, jointly with WHO, a group of experts in 1967 to examine these problems and to determine the extent to which the two organizations can assist in their solution.

121. Concurrent with the industrial use of radiation sterilization of food, the sterilization of various items of medical interest, (e.g. medical devices, pharmaceuticals, bioproducts and tissues), has found increasing application. The need for international co-ordination and technical advice is evident. The Agency's role will centre on the co-ordination of research to improve existing techniques, the establishment of codes of practice and the provision of technical advice on radiation sources and doses. As a follow-up to the Panel on Radiation Sterilization of Medical Devices, Pharmaceuticals and Bioproducts, a symposium on the same subject will be held in 1967. In 1968, a panel will be convened to discuss the use of radiation sterilization for the preservation of cartilage, bone and vessels, and to review the co-ordinated research work which is under way.

(c) Hydrology

(i) General

122. The Agency's programme in hydrology is aimed at the development and promotion of isotope techniques, which may well constitute a major weapon in the attack on the world shortage of water. The Agency's activities form an integral part of the programme of the International Hydrological Decade (IHD) which has been drawn up by the world's leading hydrologists.

123. Among the Agency's past achievements in hydrology are the successful completion of isotope studies in three UNDP/SF projects (Greece, Jordan and Turkey). In Turkey, for example, it was demonstrated that springs important for water supply in the Antalaya region are not significantly fed by major lakes in the area. It has also been possible to estimate water losses from these lakes, and this is of great importance to irrigation engineers. Similar information has been obtained in the case of Lake Chala in Kenya. At present the Agency is acting as a sub-contractor to FAO for isotope investigation in UNDP/SF projects in Jamaica, Jordan and the Niger and is active by negotiating with a view to participating in projects in six other countries.

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[8] Radiation Data for Medical Use - Catalogue No. 1, IAEA, MDS/CAT/1964.

124. At present the Agency's main concern is to encourage the acceptance and use of isotope techniques in studies carried out over large areas; in such work the Agency has become the prime mover.

125. The main emphasis in the Laboratory's programme will continue to be placed on the provision of tritium and carbon-14 analyses. In view of the increased interest in the use of carbon-14 and stable isotopes for ground-water studies some extension of the present facilities is foreseen together with the provision of equipment for isotopic analysis of deuterium and oxygen-18. This is necessary not only because of the more widespread use of these techniques, but also to enable the Agency to discharge its responsibilities in IHD.

126. The Agency will continue to carry out short-term field experiments in collaboration with national hydrologists, and this will necessitate the acquisition of the field equipment required for techniques as they become available for general use. Work on instrumentation will continue with the aim of developing simple, rugged equipment for field use.

(ii) International Hydrological Decade

127. The Agency's activities in the application of isotope techniques to hydrology will contribute to the programme of IHD in the following areas:

i. Collection of hydrological isotope data

128. The world survey of the concentration of tritium, deuterium and oxygen-18 in precipitation has, after four years, resulted in a greatly improved understanding of the distribution of these isotopes in nature. The basic data obtained permit the computation of the tritium input function for most areas in the world, a knowledge of which is of great importance to hydrologists. This work is now being reduced to sampling at a network of key stations in order to obtain data on the rate of decay of tritium in the atmosphere. The survey is at the same time being expanded to include the major rivers of the world and also surface ocean water. The latter data will be of use in studying mixing processes at the surface of the oceans.

ii. Inventories and water balances

129. Although IHD is in its initial phase, the Agency is already collaborating in two projects where different aspects of isotopic hydrology will be examined in detail. The first is the Vienna Basin Project, a study of the hydrology of a large basin with special reference to ground-water movement, and the second project, which is being carried out in the small Modry Dul Basin in Czechoslovakia, is essentially a study relating to snow hydrology.

130. The global survey of tritium and stable isotopes in precipitation and in major rivers also yields data of considerable value in hydrological studies of inventories and water balances.

131. The Agency is also participating in working groups on the hydrology of the carbonate rocks of the Mediterranean basins and on representative and experimental basins and will provide technical guidance, possibly through publications, in isotope techniques in the planning and operation of such basins.

iii. Research

132. With the IHD research programme the following subjects have been recognized as important for isotope investigations: geochronology; water content of the unsaturated and saturated zones; ground-water movement; stable isotopes in hydrology; and nuclear techniques in snow hydrology and glaciology.

133. The Co-ordinating Council of IHD has invited the Agency to participate actively in the geochronological studies, using its own facilities, and to provide the technical secretariat and facilities for a working group on nuclear techniques in the determination of water content in the unsaturated and saturated zones.

(iii) UNDP/SF projects

134. Although the Agency is directing its main effort to support the IHD programme, hydrological studies, which are not necessarily included in that programme, will also be carried out. Some of these will arise out of Agency co-operation in Special Fund projects, with FAO for example. It is hoped that similar projects may be carried out in co-operation with other organizations, such as the United Nations and UNESCO. Such projects will provide an opportunity to apply isotope techniques on a large scale, to evaluate them and to make demonstration studies which will induce those hydrologists who are still reluctant to use such techniques, to do so.

135. The Agency will hold a symposium on radioactive dating and methods of low-level counting in 1967; methods of background reduction, choice of shield materials, counter design, and the results of dating investigations will be considered. This symposium would be a follow-up to earlier ones held in Athens (1963) and Pullman, United States (1965).

(iv) Publications

136. Since hydrologists have been slow in accepting isotope techniques, one of the most important functions of the Agency is to break down their reluctance through education and advice. As techniques become ready for application, manuals and reviews will be prepared. Lecture notes will be prepared for the use of the students attending regional training courses in the use of isotope techniques.

(v) Staffing

137. No increase in the staff of the Hydrology Section of the Division of Research and Laboratories is proposed for 1967; however, an additional Professional post is required in the Laboratory to support the hydrology programme [9].

(d) Industry

138. The United Nations has placed great emphasis on industrial development and the Agency must contribute to this effort through its programme of industrial applications of isotopes. The purpose of this programme is to publicize and promote the many well-proven uses and advantages of radioisotopes in industry, and to assist in the development of new techniques needed by industrial establishments in Member States.

139. During the past year two panels and one symposium dealt with different aspects of industrial uses of radioisotopes. The Agency prepared a 500-page bibliography, containing 2000 references, as well as three review and two original articles, and provided an information service which successfully processed over 20 requests from Member States. This was achieved with a staff consisting of one Professional officer.

140. In 1967 and 1968 a number of study group and panel meetings will be convened to discuss specific applications of radioisotopes in the basic metals, pulp and paper, construction, petroleum and coal industries as well as in the development of natural resources. In addition, publication of the bi-monthly bibliography The Industrial Uses of Radioisotopes - which will begin on a trial basis in 1966 - may continue through 1967 and 1968.

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[9] See para. 224 below.

141. The increasing interest in industrial uses is already leading to an increased demand for training. A study tour, in which industrial experts and senior staff from radioisotope centres in developing countries would visit appropriate laboratories or industrial undertakings in the developed countries, would be an excellent method of instruction. The first study tour concerned with industrial uses of radioisotopes is planned for 1966; additional tours may be arranged in succeeding years. Regional training courses will start in 1967.

142. There is only one staff member engaged in work on the applications of isotopes in industry at present; an additional Professional post will be required in 1967 in the Division of Research and Laboratories.

V. HEALTH, SAFETY AND WASTE MANAGEMENT

(a) General

143. The Agency's health, safety and waste management programme covers the collection and dissemination of information through studies, scientific meetings, panels and co-ordinated research, which deal in detail with specific topics. An essential task is, however, to help developing countries to put that information into practice by increased field activities: training, advisory services, study groups and assistance to regional projects. This, together with regular visiting missions, will also keep the Agency's scientists thoroughly acquainted with the particular problems of those countries.

144. Ad hoc advisory services to Member States are being provided, as a joint service with ILO and FAO. This involved work by Agency staff amounting to about 75 man-days in 1964 and 125 man-days in 1965. Advice was requested and given on the organization of radiation protection, protection measures for certain specific operations, for example reactor safety, and on waste treatment and disposal. The demand for such services is expected to continue to rise in 1967 and 1968 as a result of closer contacts with developing countries and a wider interest owing to the collaboration of ILO and FAO.

(b) Health and safety

145. By 1967 the Agency will have established a number of essential standards. Except for a few subjects referred to below, the framework thus to be provided is at this stage considered to be sufficient. However, some of the standards will have to be brought up to date during 1967-1968 and much work will have to be done with regard to the transport of radioactive materials as a result of the wide recognition of the Agency's standards.

146. A major effort will therefore be devoted to the dissemination of information on operational safety practices to assist Member States in applying the standards. In that connection, appropriate publications will provide full information on monitoring and the engineering aspects of radiation protection, and the most essential guidance on emergency procedures. The training programme as well as advisory services by visiting experts will be expanded.

147. Certain studies and research work will continue to be necessary, and it is expected that assistance in the co-ordination of research programmes in different countries and the promotion of regional co-operation will produce very useful results.

(i) Safety standards

148. As a follow-up to the study of hazardous radioactive consumer goods, which was carried out in 1965 and 1966 in collaboration with WHO and ENEA, the Agency will try in 1967 and 1968 to establish, jointly with these organizations, safety standards for some of these goods.

149. The Agency's Basic Safety Standards for Radiation Protection [10] will be kept under review in accordance with the procedure the Board has authorized, particularly in the light of any further work by ICRP. In 1967 a joint Agency/FAO/WHO panel is expected to provide practical guidance on the computation of permissible levels of contamination in food, in normal and emergency conditions.

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[10] STI/PUB/26 - Safety Series No. 9.

150. The 1964 revised edition of the Agency's Regulations for the Safe Transport of Radioactive Materials [11] is intended to provide a lasting framework and no major revision is foreseen in the coming years. By 1967 it is expected that the regulations will have been put into force by international transport organizations and by a number of Member States. With the assistance of consultants, the Regulations will be kept technically up to date in accordance with the procedure authorized by the Board; in collaboration with ISO, further technical data on the design and testing of packages will be incorporated. The transport of wastes in ready-for-disposal containers will be studied by a panel in 1968; in that year also, it may be possible to convene a panel to consider the experience of radioisotope producers and users in applying the Regulations.

151. Detailed packaging designs which Member States are expected to submit for incorporation or reference in Annex V to the Regulations will be reviewed by a panel of experts in 1967; another meeting of experts may be necessary in 1968. The development of adequate methods of calculation to ensure that packagings for large radioactive sources meet the requirements of the Regulations is essential for economic and practical reasons; a meeting on this subject may be held in 1968. The incorporation of testing specifications in revised Regulations provides a basis for the international acceptance of models of packages; the proper testing of packages, however, requires special skills, experience and facilities. In 1966 the Agency will try to ascertain whether it would be desirable and feasible that certain existing testing facilities in Member States be used as internationally acceptable testing centres under the auspices of the Agency. Such centres would also be in a good position to develop data on the testing and packaging specifications of the Regulations. Further developments in this matter may take place in 1967 and 1968.

152. The advisory service for the technical safety review of proposed irradiated-fuel movements will be continued.

(ii) Operational health and safety technology

153. Proper monitoring techniques are an essential part of radiation protection. The Agency has already devoted considerable attention to that subject. In 1967 and 1968, guidebooks will be prepared on neutron monitoring, area monitoring, air monitoring techniques and instruments, monitoring of radiation of low penetrating power and of high energy particles, and - if necessary, to complement the work of ICRP - on the measurement of internal doses in radiation workers, including warning and action levels. These publications will complete the coverage of the whole subject of monitoring and thereafter will need to be brought up to date only periodically.

154. In 1967 a symposium will be organized on techniques and instruments for assessing airborne radioactivity in nuclear operations; a panel will be held on the establishment and keeping of monitoring records. In 1968 a symposium on environmental surveillance programmes for nuclear installations may be held.

155. With regard to training, it is expected that the following may be organized in 1967:

(a) A short course in Latin America on the organization, techniques, and interpretation of results of personnel, area and environmental monitoring;

(b) A visiting seminar in South East Asia on the electronics, calibration, standardization and maintenance of monitoring instruments; and

(c) A course in the Laboratory on bio-assay methods.

156. A training film on environmental monitoring will be produced in 1968.

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[11] STI/PUB/97 - Safety Series No. 6.

157. A service initiated in 1966 by the Laboratory for assisting Member States in the calibration of monitoring instruments, e.g. through the provision of appropriate calibrated sources, will be continued.

158. The information concerning the assistance that Member States may make available within the Agency's mutual emergency assistance scheme will be kept up to date in collaboration with FAO and WHO. A second and final meeting of the joint Agency/FAO/WHO panel to prepare a detailed manual of guidance on emergency planning will be held in 1967. The Agency will assist Member States on an ad hoc basis in the preparation or review of their emergency plans and procedures for particular installations or operations in collaboration with other organizations as appropriate.

159. With the help of consultants, it is planned to publish, in 1967, selected data for use in controlling radiation emergencies; regional training courses on emergency procedures, followed by drills if possible, may be organized for South East Asia in 1967 and for certain countries in Europe and the Middle East in 1968.

(iii) Studies and research

160. The behaviour of strontium-90 in man and in the food chain is a subject of controversy in the establishment of maximum permissible intakes and the evaluation of hazards in normal and emergency conditions. A panel will be convened in 1968 to review the data on that subject, with a view to bringing up to date, as necessary, the Agency's Basic Safety Standards and the 1965 report on "Risk evaluation for the protection of the public in radiation accidents".

161. In 1967 a panel will study inhalation risks, that is those arising out of the characteristics and behaviour of inhaled radioactive contaminants, and the intepretation of monitoring results.

162. Since the Agency must be able to advise its Member States, upon request, on the safety aspects of the peaceful utilization of nuclear explosives, it is closely following developments in the subject.

163. Very significant progress is being made on biological dosimeters for radiation protection purposes, and according to a number of highly qualified scientists, it may be appropriate in 1968 to convene a panel to consider practical applications.

164. In connection with a scheme for co-ordinating national research programmes in health and safety in the same way as programmes in waste management, it is expected that two cost-free co-ordination meetings on selected topics will be held each year. As a complement to this scheme, research contracts will continue to be awarded for work which has an immediate bearing on the Agency's activities in radiation protection.

165. Regional study groups will be convened in the Middle East in 1967 and in South East Asia in 1968 to review radiation protection problems in these regions, to examine the possibility of developing certain services on a regional basis, e.g. film-badge services, or of establishing other regional projects, to review the Agency's programme in relation to regional needs and to discuss the most recent advances in radiation protection. A radiation protection study tour may be arranged in 1967 or 1968.

(c) Waste management

(i) General

166. When nuclear activities were on a relatively small scale, waste involving very low specific activities was discharged into the environment without significantly raising the radiation background level. With the increasing production of radioactive wastes it is essential to remember that the amount of waste that can safely be discharged is strictly

limited by the capacity of the biota to absorb radioactivity with safety, though this varies with local conditions and it still requires further study. Considerable work has therefore been done on the decontamination of the sometimes large volumes of liquids or gases which have to be released into the environment and on the techniques which, apart from temporary controlled storage, allow the disposal of the resulting concentrated wastes, or other wastes, in a manner that considerably reduces or prevents the transfer of radioactivity to the biota.

167. Thus, development of waste management has progressed more than is often believed. The problem nowadays is to choose, according to the amount and nature of the wastes and the site conditions, the most economic from among fairly well established techniques. However, the enormous production of wastes, particularly high-level wastes, which will result from the expected development of nuclear power plants calls for a better understanding of the environment, improved waste treatment and disposal technology (possibly including the re-utilization of wastes for useful purposes) and the promotion of international co-operation. It is proposed to review, in 1967, the Agency's past and current waste management programmes and to seek expert advice on developments and future work.

(ii) Operational technology

168. There is a considerable difference of opinion within and between countries as to what the terms low, intermediate and high-level waste really mean. A panel will be held in 1967 with a view to standardizing the definitions of the categories of wastes.

169. As appropriate, further material will be published on such subjects as the solidification/cementation of radioactive wastes, preliminary and absolute air-cleaning filters, and the design and construction of tanks for short-term and long-term storage of liquid wastes.

170. Publications in the Safety Series [12] and several Agency meetings have dealt with the problems of waste disposal into the seas, oceans and fresh waters. A revision of the manual on Disposal of Radioactive Wastes into Fresh Water [13] may be made by consultants in 1968.

171. Disposal into the ground is recognized as a most promising and safe method of waste disposal and an Agency document was published in 1965 on the factors to be considered in choosing ground-disposal sites. Much operational experience is being gained in shallow disposal of certain solid wastes and the disposal of certain liquid wastes in adsorbing soils. It is expected that the disposal of gaseous wastes into the ground will also have been developed operationally in certain countries by 1967. Disposal into underground salt deposits or deep geological formations is considered a very promising possibility for the ultimate disposal of high-level solid wastes. A symposium on the disposal and storage of radioactive wastes in the ground, including deep formations, may be held in 1967 in collaboration with other international organizations.

172. A symposium on the design and operational experience in the treatment of airborne radioactive wastes will be held in 1968. This will be an important part of a programme on the control of airborne wastes which will also include the production of manuals of guidance on the techniques for controlling air pollution and on air-cleaning filters, and a research co-ordination panel on the air-cleaning of radioactive volatile compounds. This programme is expected to be practically concluded by the end of 1968.

173. Following a panel meeting in late 1966, it is expected that in 1967 a report will be published on the factors to be considered in selecting waste treatment and disposal processes. This is closely connected with the study of the methods of analysis of the economics of waste management operations initiated in 1965. That study is a particularly complex one; it is likely that the panel which considered it in 1965 and 1966 will not complete its report until 1967.

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[12] STI/PUB/14 - Safety Series No. 5; STI/PUB/44 - Safety Series No. 10.

[13] STI/PUB/44 - Safety Series No. 44.

(iii) Research co-ordination

174. The funds which the Agency can use in support of research and development are very limited in comparison with the resources available in some of the advanced countries. In order to make the results of this research and development available and to promote co-ordination of national research projects, the Agency arranges meetings of persons responsible for research in particular branches of waste management in the national programmes of a number of advanced countries, the travel and other costs of participants being borne by their respective Governments. These meetings discuss the results of work which has been and is being done in order to decide what problems should be given priority or require further study and to co-ordinate the programmes to the maximum extent possible. The information and abstracts dealing with national waste management research programmes in a number of countries are collected and distributed, and this work will be continued in 1967-68.

175. The Agency's research contract programme will continue to support studies of the fundamental processes of dispersal and release of radioactive materials into various environments and studies leading towards economically sound treatment and fixation processes. Preference will be given to studies particularly adaptable to small-scale operations and to studies on topics recommended by the research co-ordination meetings.

176. Research and development in management of high-level wastes is particularly important. In 1968 a panel will consider the technology of high-level-waste fixation and another panel will consider the storage of high-level wastes in the lithosphere if that subject is not considered sufficiently covered in the symposium referred to above.

(iv) Training

177. In 1967 an advanced training seminar on waste management is expected to be organized in Europe, principally for participants from developing countries, to be followed in 1968 by a waste management training course in Latin America, if necessary.

178. In 1968 a training film on different aspects of waste management will be produced.

(v) International co-operation

179. In 1967 a project for the co-ordination of waste management research and development in South East Asia and the Far East may be organized. It would involve exchange visits of waste management operators in the countries of the region and the provision of outside experts, as appropriate.

180. The study of the technical, economical and legal aspects of establishing international burial grounds will be pursued. Co-operation between Member States on problems arising from radioactive waste disposal into international rivers or the marine environment will continue to be encouraged in collaboration with other responsible international organizations.

(d) Reactor safety and criticality control

181. The Agency will continue to assist and advise Member States regarding the safe design, operation, siting and containment of reactors and any installations with criticality hazards. Advisory panels will be convened as appropriate; panels may also be called upon to make hazard evaluations of nuclear merchant ships in harbours or narrow waters. The Agency will also provide advisory safety assessments and criticality evaluations of particular installations and operations upon request.

182. A second meeting of the panel on the safety aspects of operating nuclear power plants may be called in 1967 to review the comments of Member States on its first draft of the code of practice on the safe operation of nuclear power plants prepared in 1966. The original suggestion for a panel to prepare a manual as a code of practice for research reactors and critical assemblies has proved to be impracticable for a number of technical reasons. There is, however, considerable support for the convening of a panel in 1967 to review and bring up to date the manual on Safe Operation of Critical Assemblies and Research Reactors [14], and it is therefore proposed to do so.

183. The role played by meteorology is important in the evaluation of the possible effects on the public in the area surrounding nuclear establishments following a release of radioactivity. It is proposed to hold a panel on the subject in 1967; co-operation by WMO will be sought.

184. At the symposium on the siting of reactors, held in Bombay in 1963, and also at the Third Geneva Conference, the view was expressed that the Agency should again sponsor a symposium on this topic, since it relates to an important subject which is in a continual state of change. Accordingly, the Agency is planning a symposium on siting and containment of nuclear power plants in 1967.

185. As a result of informal discussions with the heads of four national safety organizations, it is proposed to hold a symposium on reactor safety research in 1968.

186. It was suggested at the symposium on criticality control of fissile materials that the Agency should write a manual of guidance on the safe handling of fissile materials and it is proposed to hold consultants' meetings for this purpose in 1967. Collaboration with ISO will continue.

187. Following consultations with interested countries in 1966, a cost-free meeting of experts may be held in 1968 on problems encountered in the safe design and operation of irradiated fuel storage facilities.

188. Some years ago the Agency started to compile information on nuclear accidents and incidents which was recorded on punched cards under the headings of: reactor status prior to incident, cause of incident, point of failure, how incident was first noted, how incident was stopped, consequence of incident. This project has been in abeyance for two years. Recently there have been expressions of renewed interest in a compilation of this kind from a number of Member States. In 1967, this work will be reviewed and advice will be sought on its future development.

189. Appropriate criteria and specifications for reactor control systems are essential for the safety of nuclear reactors. It is not possible - nor desirable at this stage - to lay down rigid standards. However, it would be very useful to have a thorough discussion of the criteria and specifications for control systems in various types of reactors, and a panel on this topic is proposed for 1968. The discussion would cover the collection and evaluation of information, the relation between equipment failure and working conditions, application of the fail-safe principle, the testing, reliability, and design of control equipment.

(e) Staffing

190. One additional Professional post will be required in the Division of Health, Safety and Waste Disposal in 1967.

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[14] STI/PUB/29 - Safety Series No. 4.

VI. RESEARCH AND SERVICES IN PHYSICAL SCIENCES

(a) General

191. The aim of the Agency's programme in the physical sciences is twofold: to review and disseminate scientific knowledge to Member States by means of study groups, panels, symposia and the publication of proceedings; and to provide, principally on the basis of recommendations made by these scientific meetings, certain laboratory services.

192. At present these aims are pursued under the broad headings of analytical chemistry and radiochemistry, nuclear data, neutron and theoretical physics, standardization of radionuclides and of methods of measuring radiation and oceanography. Training of fellows is provided in most of these subjects either in the Laboratory or in the International Centre for Theoretical Physics at Trieste.

193. The assessment and dissemination of thermodynamic and other physico-chemical data for nuclear materials will be continued. A symposium on the thermodynamics of nuclear materials will be held in the summer of 1967 so as to coincide with a symposium on thermochemistry organized by IUPAC. A panel will be held in 1967 to assess data on the thermodynamic properties of uranium and plutonium carbides. Another panel is planned for 1968 to assess thermodynamic data on systems important in nuclear technology. Further monographs in a series dealing with the assessment of thermodynamic and other physico-chemical properties of elements of interest in nuclear technology will be published.

194. Radiochemistry based on reactors affords one of the best means of promoting research in developing reactor centres. The following activities are planned for 1967-68:

(a) Two or three regional study groups on research reactor utilization each year;

(b) Two missions per year to advise on isotope production, activation analysis, hot-atom chemistry and radiation chemistry at developing reactor centres;

(c) The establishment of joint research projects as a means of promoting research at developing centres;

(d) The collection and dissemination of data on the design and operation of hot laboratories, which are becoming increasingly important as many newly established centres now plan to develop their isotope production, activation analysis, or other activities involving the processing of highly radioactive targets; two regional seminars on facilities and techniques for the production of radioisotopes may be held;

(e) The manual on methods of isotope production published in 1966 will be revised in 1967-68; and

(f) As a follow-up to previous regional study group meetings, panels will be held in 1968 on the reactor as a source of radiation, and on safety aspects of sample irradiation in reactors.

195. The activities of the Nuclear Data Unit continue to develop and it is intended to hold, as in the past, two panels each year, to advise the Agency on its programme. The meetings of the International Nuclear Data Scientific Working Group will continue to be held at approximately 10-month intervals. In recognition of the fact that the international exchange of nuclear data has now been successfully initiated, it has been proposed that its name should be changed to International Nuclear Data Committee (INDC) and that its work should continue on a more permanent basis. The two years 1966 and 1967 will be regarded as a transitional period during which the scope of these exchanges should be defined, and towards the end of this period it is intended to draw up formal terms of reference for the work of INDC.

196. The work of the unit comprises both exchange of bibliographic information, using the Computer Index of Nuclear Data (CINDA), and exchange and analysis of numerical data. This work will continue with the aid of the IBM 7040 computer at the Vienna Technische Hochschule and, for some incidental operations, with the Agency's own computer. For CINDA, specialists in, for example, Australia, India and Poland supply information to supplement that obtained from Soviet Union, United States and ENEA nuclear data centres. The scope of the numerical data exchange has not yet been so clearly defined, but it is considered essential that it should be determined before mid-1967. As in the past, limited studies of a critical review type will be undertaken in Vienna as a service to Member States and the scientific community.

197. Neutron and reactor physics research with pulsed neutron techniques will be continued through the research contract programme in 1967-68; a versatile pulsed neutron generator is available to Member States. In 1967 a panel on pulsed accelerators as high intensity neutron sources will be convened.

198. The symposium on neutron thermalization and reactor spectra, originally planned for 1966, will be held in 1967 to discuss significant advances made since the Brookhaven conference in 1962.

199. A time-of-flight technique in neutron diffraction studies of crystal and solid-state structure has been developed through research contracts and it promises to become an inexpensive solid-state research tool for use with low-power research reactors. In accordance with the recommendation of the Bombay Symposium on Inelastic Scattering of Neutrons it is planned to hold another meeting on the subject in 1968.

200. The symposium on chemistry and physics of fission in 1965 revealed a lack of data on the energy spectra of the delayed neutrons emitted in the fission process. Significant progress on a novel time-of-flight coincidence method having been made through Agency research contracts, it is proposed to convene a panel in 1967 to review new fundamental data on delayed neutron yields as a function of incident neutron energy.

201. Low-energy (less than 15-20 MeV) nuclear physics research has been supported by the Agency through fellowships, technical assistance experts and equipment, and research contracts. A list of particle accelerators in the world will be compiled in 1966. If it then seems desirable, regional study group meetings on the utilization of such accelerators may be organized in 1967 and 1968 in order to obtain a better co-ordination of research.

202. A meeting of representatives of CERN, the Soviet Union and the United States at the Agency's Headquarters in July 1964 considered international co-operation in the design, construction and operation of an ultra-high-energy accelerator, nominally in the 1000 GeV range. At present machines are being operated at the 30-GeV level, constructed at the 70-GeV level and designed at levels above 200 GeV. A new generation of machines of still higher energy is under intensive discussion, but the cost would be so high that an international co-operative effort must be considered. To explore the possibility of such co-operation, the Agency will contact appropriate authorities in interested Member States.

203. At the Second Conference on Plasma Physics and Controlled Nuclear Fusion Research in 1965 it was recommended that the next conference be held in three years, and thus it is planned to hold another conference in 1968. It will be necessary to convene, in 1967, a small preparatory panel of experts.

204. Because of the increasing use of nuclear energy in space, the Agency may be required to perform some standardization and regulatory functions which would entail world-wide co-ordination and co-operation. If necessary, the Agency will convene in 1967 or 1968 a panel or a symposium on those aspects of space research which have a direct bearing on the Agency's interests in nuclear energy. Among these are the radiation environment in space, shielding problems, nuclear, ionic and plasma propulsion systems and space contamination.

205. It is well known that radiation damage affects reactor design. Since 1962, radiation damage studies have been extended to higher integrated fluxes and very high and low temperatures. A symposium on radiation damage, fundamentals, fuel elements and reactor materials is proposed for 1968.

(b) Laboratory work in physical sciences

206. The number of calibrated samples distributed in 1965 exceeded 1500; the number of different radionuclides was 20. This distribution service will be continued and expanded. Some of the radionuclides to be added are: carbon-14, calcium-45, calcium-47, cobalt-58, silver-110m, europium-152, iridium-192 and radium-228. Solid calibrated gamma-emitting sources with activities in the millicurie range, for use in the calibration of dosimeters will be prepared. The preparation of standard solid beta-emitting sources will also be developed.

207. The Laboratory will continue to participate in the international comparison programme of IBWM. Since only one or two radionuclides are involved per year, an effort will be made to obtain interlaboratory comparisons for other radionuclides for which calibration techniques are not yet well established, namely hydrogen-3, carbon-14, caesium-137, cobalt-57, cobalt-58, barium-133 and iridium-192. Research on methods of preparing highly stable solutions of common radionuclides will be pursued.

208. In 1966 the Laboratory will acquire experience in the measurement of in-pile neutron fluence by means of activation detectors. A practical guidebook for such measurements, useful in both recent and long-established reactor centres, will be published as a result of the recommendations of the Panel on In-Pile Neutron Fluence Measurements. Standards for calibration of activity measurements in connection with fluence determination will be developed. A collection of recommended types of activation detectors will be made for the purpose of intercomparisons with specialized centres. It is planned to offer a calibration and training service to Member States.

209. In support of the Agency's safeguards work, the Laboratory is developing methods for assaying the tritium content of heavy water (to be used as an indicator of integrated reactor power).

210. The microcalorimetric method will continue to be used for determining nuclear constants and measuring the chemical effects of radiation damage in irradiated materials. Openings will be available for one or two fellows at a time for training in radiation flux measurements and the determination of nuclear constants.

211. Activities concerned with the development of general schemes for separating trace elements from blood, after radioactivation analysis, and from soil samples, and the labelling of sand and mud for stream bedload transport studies, have now been terminated.

212. The preparation of reference standards will continue in conjunction with international comparisons of analytical techniques for nuclear materials. By the end of 1966, analysed samples of three low-grade uranium ores, of pure uranium oxide and of uranium oxide containing trace impurities will be available for the purpose of checking analytical methods for uranium and for trace elements in uranium.

213. Work started in 1964 on analytical methods for the determination of uranium in unirradiated fuel rod samples (and possibly in process solutions) will continue in the light of experience gained from samples obtained in work on safeguards. It is foreseen that methods for determining elements other than uranium will have to be investigated.

214. The mass spectrometer will continue to be used for the determination of trace elements by isotope dilution techniques, and for measuring nitrogen-15 samples. A service for the determination of isotopic ratios of hydrogen and oxygen in water, previously done elsewhere through research contracts, will be established. More than 4000 samples were done in 1965.

215. The recently developed method of "substoichiometric analysis" considerably extends the range of the isotope dilution method, in some cases to limits not attainable by activation analysis. Where appropriate, this will be applied to problems of interest to the Agency.

216. Some commercially available radioactive preparations, particularly some in medical use, are not well-defined substances and may contain radioactive impurities. In 1965, a study of analytical methods for testing such preparations was started. It is intended to draw up recommendations, in collaboration with suitable medical specialists, on the required purity of such preparations. This work, the need for which has been strongly emphasized by the Joint Commission on Applied Radioactivity, will be continued in 1967-68 and extended to other radioactive preparations, as appropriate.

217. Measurement of carbon-14 content will be used to date natural waters, as part of the programme in hydrology. Enrichment of the carbon-14 content of isolated carbonaceous material will permit the extension of this method to older waters which contain amounts of carbon-14 that are difficult to measure. Methods of concentration will be considered, particularly gas chromatography which was used successfully for the concentration of tritium in hydrogen.

218. One of the problems involved in the irradiation of substances in reactors is the lack of information on the extent of decomposition. One danger is the production of gases which could cause the sample container to explode. Such information as is available on this subject will be collected and, if necessary, checked by experimental investigation and amplified.

219. The work of measuring, at the request of about 15 Member States, low-level radioactivity in environmental materials, which was carried out on a large scale during 1960-63, has now practically ended as the various States have acquired their own trained personnel, many of whom were taught in the Agency's Laboratory. The equipment and manpower are now employed in carrying out a programme of intercomparison of strontium-90, caesium-137 and radium-226 determinations in samples of environmental and biological materials; about 80 laboratories in 26 Member States participate in this programme, which will continue in 1967-68. In addition, environmental and biological materials, spiked with known amounts of radionuclides, and low-level radionuclide standard solutions will again be provided. The interest shown by Member States in this and in similar analytical intercomparisons suggests that the Agency may be asked to expand the programme to include non-radioactive trace elements in different matrices.

220. Two symposia, on assessment of radioactivity in man and on diagnosis and treatment of radioactive poisoning, have stressed the importance of a knowledge of bone structure in the evaluation of mechanism uptake and removal of radionuclides. In 1967-68 X-ray diffraction studies will be made of the structure of apatites, which are constituents of bone, as a contribution to research on this subject. In addition, the dimensions and properties of synthetic and natural apatite particles will be studied by means of small-angle scattering techniques.

221. In Tokyo in 1965, a representative of the Agency was elected Rapporteur of the WMO Working Group on Methods of Measurement of Atmospheric Radioactivity. He has been asked to prepare a technical note on this subject for the Commission on Instruments and Methods of Observation, which WMO expects to publish in 1967.

222. In-service training of fellows from Member States will be continued and training courses will again be held. A course on the use of isotopes in agricultural biochemistry is under consideration for 1967, and one on monitoring of environmental radioactivity is planned for 1968.

223. The Laboratory will, as in the past, be able to accept fellows for training in various sections as follows:

Section	Subject	Number of trainees at a time	Number of trainees in 1965
Physics	Calibration methods and instrumentation for radionuclides	2	4
Dosimetry	Measurement of radiation doses by various methods	2	
Chemistry	Analytical methods for nuclear materials	6	0
Low-level Radioactivity	Radiochemical methods for analysis and measurement of low-level radioactivity and related problems	8	5
Agriculture	Applications of radioisotope techniques in various branches of agriculture and related subjects	8	5
Hydrology (water resources development)	Applications of carbon-14 and tritium techniques to water resources development	2	7
Medical Physics	Whole-body counting and activation analysis for medical purposes	2	6
		30	27

224. As indicated in paragraph 137 above, one additional Professional post will be required in the Laboratory in 1967 for increased work in hydrology.

225. The problem of space in the Laboratory is being discussed with FAO, and it is hoped that a solution may be found by 1968.

(c) The Monaco Laboratory

226. The Monaco Laboratory is engaged in the following physical, chemical, biological and geochemical work:

(a) Transport of radioactive isotopes in the sea by currents, diffusion processes, waves, tides, etc.;

(b) Chemical behaviour of radionuclides in the sea;

(c) Uptake, loss and transport of radionuclides by marine organisms; and

(d) Exchange of radionuclides between the water and the sea bottom.

227. It is planned to continue this work and extend it to further radionuclides, animals and sea areas in collaboration with other laboratories, especially in the Mediterranean area.

228. Among the completed projects are a substantial study of an ecosystem in the coastal waters of the Ligurian Sea. Details of this and other completed work will be found in the third (1965) report on IAEA Laboratory activities [15].

[15] STI/DOC/10/55 - Technical Reports Series No. 55.

(d) The International Centre for Theoretical Physics at Trieste

229. The training of young scientists will proceed at the Centre, as during its first two years of operation. Instruction will be given at the post-graduate level by means of courses, lectures and seminars covering the main branches of theoretical and experimental physics related, in a wide sense, to nuclear energy. The existing facilities of the Advanced School of Physics, jointly operated for this purpose by the Centre, UNESCO and the University of Trieste, will be used. About 20 places for fellows will be available.

230. Research will continue to be done on high-energy and elementary particle physics, as well as low-energy nuclear physics. In accordance with the recommendations of the Centre's Scientific Council, solid-state physics, many-body problems and plasma physics may be taken as additional subjects of research.

231. Consideration is being given to the organization in 1967 of an extended seminar covering the whole spectrum of theoretical physics, the aim being to promote the cross-fertilization of ideas in the various branches of this discipline, including elementary particle theory, low-energy nuclear physics, cosmology and astrophysics, as well as solid-state physics. This seminar, which is strongly supported by leading scientists, would constitute a significant milestone in the whole progress of physics, and is something which has not been attempted on this scale for half a century.

VII. INFORMATION AND TECHNICAL SERVICES

(a) General

232. The Agency will continue, in 1967 and 1968, to carry out its statutory function of the exchange and distribution of information on the peaceful uses of nuclear energy through scientific meetings, scientific and technical publications, library and documentation services, and visual media.

(b) Scientific meetings

233. As recommended by SAC, symposia on the following subjects are contemplated for 1967:

(a) Activation analysis in the life sciences;

(b) Radiation sterilization of medical devices, pharmaceuticals and bio-products;

(c) The techniques and instruments for assessing airborne radioactivity in nuclear operations;

(d) Containment and siting of nuclear power plants;

(e) Neutron thermalization and reactor spectra;

(f) Radioactive dating and methods of low-level counting;

(g) Thermodynamics of nuclear materials;

(h) Physics and related safety problems of fast reactors;

(i) International extrapolation and comparison of nuclear power costs;

(j) Heavy-water reactors;

(k) The use of plutonium as a reactor fuel;

(l) The use of isotopes and radiation in soil physics and irrigation studies; [16]

(m) The use of radiation and isotopes in entomology; [16]

(n) Radioisotope applications in plant pathology; [16]

(o) The use of isotopes in studies of nitrogen metabolism in the soil-plant-animal system. [16]

234. Consultation with SAC will take place at a future date concerning the programme of meetings for 1968; it is expected that the number of meetings in that year will be approximately the same as in 1967. Other international organizations will, as appropriate, be invited to participate in or co-sponsor Agency meetings; the Agency for its part will continue to co-sponsor scientific meetings of other organizations on subjects which fall within its sphere of interest.

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[16] It is expected that half the cost will be borne by FAO.

(c) Publications

235. The Agency's publications programme for 1967 and 1968 will be developed along the same lines as hitherto. The Proceedings Series will have to include coverage of meetings organized by the Joint FAO/IAEA Division of Atomic Energy in Agriculture and of meetings organized jointly with such bodies as WHO and ENEA. The Agency will also act as publisher for the International Centre for Theoretical Physics. The Safety Series will be extended by several issues. The Technical Reports Series will cover appropriate panel meetings as well as laboratory and research work, including that done at Monaco. The Directories of Nuclear Reactors [17] and the International Directory of Isotopes [18] will have to be brought up to date and the scientific journals - Nuclear Fusion and Atomic Energy Review - will be published as at present.

236. It is expected that the equivalent of some 60 000-65 000 printed pages will be available as manuscripts for publication. Of this quantity, it is planned to publish about 24 000 pages in 1967 and 27 000 pages in 1968. To keep the cost of the programme down as much as possible, steps will be taken to limit both the length and number of conference papers, to produce a larger number of books with non-justified margin and by direct photography of the pages, to lower slightly the standard of paper used, to produce a greater proportion of reference lists and bibliographies from computer-based texts, and to rely on increased editorial assistance by scientific secretaries of meetings.

(d) Documentation

237. With the introduction of computer services, work and assistance in documentation will be centralized as much as possible and extended. Consideration will be given in 1967-68 to the production of a computerized international nuclear science abstracts journal. The Generalized Information Processing System has been developed, by which documentary and bibliographical material prepared with the computer is coded and stored on tape. A self-generating key-word system will be used, and a retrieval system developed. In addition, programmes for preparation of key-word-in-context indexes will be improved and such indexes provided for several publications. As a result of these activities, the Agency's mechanized information storage and retrieval system should be in operation by 1967-68.

238. Preparation of the following documentation will be continued:

Title	Issues per year	Proposed production method
Atomic Energy Review	4	Type-set
List of References on Nuclear Energy	24	Computer
Index to above list	1	Computer
Conferences, Meetings, Training Courses in Atomic Energy	6	Type-set
Waste disposal abstracts	2	Computer
Nuclear Medicine (A Guide to Recent Literature)	6	Computer
Technical directories	3-4	Type-set
Bibliographies	6-8	Computer

[17] STI/PUB/9, 22, 53 and 73.

[18] STI/PUB/83.

239. In co-operation with the Abstracting Board of ICSU, the exchange and preparation of abstracts will continue. In particular, a service will be initiated for dispatching page-proofs or advance copies of publications to abstracting journals, to speed up their publication. Co-operation will also continue with the Fédération Internationale de la documentation and similar bodies for the preparation and publication of documents on the universal decimal classification.

(e) Library

240. The transfer of the Agency's Library to more spacious rooms, its consequent re-organization and greater shelving capacity has resulted in a much more extensive use of its facilities. A new law section will provide a comprehensive international collection of legal material on atomic energy.

241. Duplicates of publications received through distribution, exchange and gifts will continue to be sent on request to institutions in Member States; new reproduction equipment will permit distribution of microfiches. In order to solve a growing space problem in the Library, consideration is being given to the acquisition and installation of additional microfiche equipment, so that part of the Library's holdings may be filmed and more easily stored.

242. As in previous years, it is expected that three or four fellows will work in the Library for various periods to receive special training.

243. It is expected that the film library will continue to expand through the receipt of gifts from Member States and the purchase of certain special films. Requests for loans have already become so numerous that multiple copies of many films have had to be obtained.

244. As an indication of the probable future expansion of the Library's activities, the increase in its holdings and services between 1964 and 1965 is shown below:

	1964	1965
Library holdings (Headquarters)		
Books	27 175	31 500
Journals (current subscriptions)	770	998
Abstract journals (current subscriptions)	86	214
Microfiches	42 986	51 500
Reports (full size)	24 780	31 700
Library services (Headquarters)		
External circulation (interlibrary loans, requests from Member States)	810	1 252[a/]
Internal circulation (Secretariat)	30 358	33 890
Number of outside (non-Agency) visitors	1 437	2 559
Library holdings (Seibersdorf)		
Books	1 600	2 097
Journals (current subscriptions)	95	103
Film Library		
Film holdings (separate titles)	301	370
Film holdings (total)	472	610
Loans (external)	520	615
Film shows at Headquarters	28	38
(Number of persons attending)	1 061	2 128

a/ This figure is significant in comparison with the amount borrowed from other libraries - 1067. Thus 1965 was the first year in which other libraries borrowed more from the Agency than the Agency's Library borrowed from them - a good indication of the increasing importance of the collection.

(f) Staffing

245. Instead of utilizing a vacant Professional post in the Library, it is proposed to use it for a computer specialist in information retrieval in 1967. In addition, some reclassifications of editorial staff from the GS to the Professional category are planned.

(g) Public information and visual media

246. In 1965 it became possible to a larger extent than before to present an image of the Agency in action in the field, since a number of activities and world events having a bearing on the Agency's work particularly caught the imagination of journalists and of people having an influence on public opinion, e.g.:

(a) Safeguards and the prevention of nuclear proliferation;

(b) Desalination of sea water for the benefit of mankind;

(c) The Mediterranean fruit fly project and its possible effects in other parts of the world and on other specimens of insects; and

(d) The use of radioisotopes in agriculture, medicine and industry.

247. It is expected that these subjects will continue to be of primary importance in the public relations and information work of the Agency in 1967-68. Present activities to be continued include the issuing and distribution of press releases, the bulletin, a monthly summary of Agency activities, feature articles, as started in 1965, photographs, and pamphlets and leaflets, as well as the preparation of exhibits, and radio and television programmes, as appropriate. General public relations work will continue as in the past, including briefing for journalists, public lectures, and some travel in connection with Agency conferences abroad and public relations missions.

248. The publication of a popular booklet on the Agency's aims and achievements is foreseen to commemorate the tenth anniversary of the coming-into-force of the Statute (29 July 1967). Activities at Headquarters as well as in the field, and the work done by the Agency laboratories and centres would be the main subjects of this booklet.

249. Preparation and distribution of film strips, colour slides, picture stories and posters will become possible thanks to the still photos which members of the team shooting the new version of the Agency's film have been commissioned to take in conjunction with their film work in 1966. This will enable the Agency to meet the numerous requests for such material received from schools, adult education classes, students', women's and youth organizations, teachers, lecturers and organizers of United Nations Day and similar events.

250. A short documentary film (provisional title: A Decade of Atoms for Peace) may be prepared showing the main events in the Agency's history from its foundation.

(h) Regulatory and legal activities

251. Apart from the many administrative matters for which the Agency's legal services are obviously required, these services are also, to a considerable extent, concerned with programme activities, such as safeguards, model codes and regulations, technical assistance arrangements and research contracts. In 1967 and 1968, for example, they will have to deal with questions relating to the coming into force and, if appropriate, the revision of the conventions on liability in respect of nuclear ships and land-based reactors concluded in 1962 and 1963; this work may extend to giving advice and assistance in the elaboration of relevant national legislation and, possibly, regional conventions.

252. Assistance will be given in the drafting of regulations concerning health, safety and waste disposal which might either become binding in the case of the Agency's own operations or Agency-assisted projects or intended to be incorporated into national legislation or related international conventions, e.g. on transport. On the basis of technical studies, the legal services will assist in dealing with questions relating, for example, to waste disposal.

253. It is difficult to determine what particular subjects will require priority attention in 1967 because some of them will depend on external developments. With regard to the problem of State responsibility - as distinct from civil liability - for nuclear damage, for example, this can only be determined on completion of the International Law Commission's study of State responsibility.

VIII. SAFEGUARDS

254. In 1965 the Agency's safeguards activities expanded much faster than had been foreseen in the programme for that year, and it is expected that in 1966 the expansion will continue. By the end of 1966, as far as can now be foreseen, the thermal capacity of reactors under Agency safeguards will be about 2700 MW or almost twice as much as in 1965, embracing approximately 50-55 facilities in 21-25 Member States. It is expected that, in 1966, the Agency's safeguards responsibilities will include three large power facilities and, for a time, one chemical processing plant, as well as facilities using produced or substituted plutonium totalling several hundred kilograms. Thus it is foreseen that in 1966 the operational safeguards activities will exceed by more than 50% those of 1965; for instance, the maximum number of routine inspections in 1965 was less than 60, whereas in 1966 it will probably reach 90.

255. For 1967-68 the upward trend is expected to continue. It is expected that in 1967 and 1968 the Agency will be responsible for safeguarding at least one sizeable fast reactor research facility under a project agreement; that it will be asked to apply safeguards to more research reactors under Safeguards Transfer Agreements; and that at least one or two power reactors will be brought under Agency safeguards. After 1967 there may be a decrease in the number of additional facilities placed under safeguards each year, but this will be offset by the addition of more complicated and powerful facilities and by the application of safeguards to increasing quantities of plutonium produced in materials and facilities already subject to Agency safeguards. It can thus be expected that the Agency's safeguards activities will continue to expand at the same rate as in 1965-66, assuming that no large new responsibility will be placed upon it.

256. The addition, in 1966, of further research reactors and of two facilities using or processing safeguarded nuclear materials will bring the number of facilities covered by safeguards agreements in force in 1967 up to approximately 75. The thermal capacity of reactors under safeguards is expected to be about 4500 MW. The Agency will also be responsible for applying safeguards to much larger amounts of plutonium than in 1966. The total number of routine inspections to be carried out in 1967 is likely to be around 80, which will be three-quarters of the maximum number permitted. In this estimate the average number of inspections of facilities to which access is permitted at all times is taken as 10. In 1968, more than 100 routine inspections may be made.

257. Up to 1965, work on safeguards was largely concerned with the preparation of the basic procedures for safeguarding reactors. Although these have to be refined and new ones have to be developed for different reactor types and facilities such as chemical reprocessing plants, the emphasis is shifting to operational activities. Nevertheless the work of devising procedures and practices, promoting the development of technical aids and generally making the administration of safeguards more effective and simpler, must not be neglected.

258. In 1967-68 more emphasis will be laid on the development of tamper-proof monitoring equipment for many purposes. It may also be possible to develop devices which would enable the Agency's inspectors to follow in absentia some physical operations in certain types of facilities under safeguards. This development work may eventually lead to a simplification of safeguards techniques.

259. In 1967 or 1968 a symposium on nuclear materials management should be held as a follow-up to that which took place in 1965. Two panels or meetings of consultants are planned for 1967 to deal with safeguards techniques and practices for various new types and facilities. Similar meetings on safeguards matters are envisaged for 1968 and consideration is also being given to the possibility of organizing in that year a training course aimed at giving employees of atomic energy authorities an insight into nuclear materials management and other safeguards techniques.

260. While the staff need not be increased in direct proportion to the growth of the operational safeguards activities, it will be necessary to provide four additional Professional posts in 1967 for operational and procedural work.