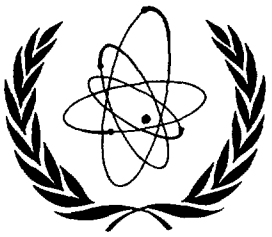

International Atomic Energy Agency

ANNUAL REPORT OF THE BOARD OF GOVERNORS TO THE GENERAL CONFERENCE

1 July 1964 - 30 June 1965

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CONTENTS

ANNEXES

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
EPTA	United Nations Expanded Programme of Technical Assistance
FAO	Food and Agriculture Organization of the United Nations
IAEA	International Atomic Energy Agency
IANEC	Inter-American Nuclear Energy Commission of the Organization of American States
ICRP	International Commission on Radiological Protection
ICRU	International Commission on Radiological Units and Measurements
ICSU	International Council of Scientific Unions
ILO	International Labour Organisation or International Labour Office
IMCO	Intergovernmental Maritime Consultative Organization
JCAR	Joint Commission on Applied Radioactivity (of ICSU)
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
WHO	World Health Organization
WMO	World Meteorological Organization

NOTE

Unless otherwise indicated all sums of money are expressed in United States dollars.

INTRODUCTION

1. The Board of Governors [1] presents to the General Conference the following report on the Agency's work during its eighth year.

2. The membership of the Agency increased from 87 to 92 during the period covered by the report, the new Members being Cameroon, Costa Rica, Cyprus, Kuwait and Madagascar.

3. The main event during this period has been the Third International Conference on the Peaceful Uses of Atomic Energy (Third Geneva Conference). The Conference has provided a full evaluation of the experience that has been gained since 1958 in designing, building and operating nuclear power plants, and of future prospects for nuclear power which is being introduced in an increasing number of countries. [2] This development is reflected in the greater stress on nuclear power and related matters in the Agency's work, as was foreseen in the Agency's long-term programme. [3]

4. There has been a noteworthy expansion in safeguards activities. The growth in safeguards activities is illustrated by the fact that on 30 June 1964 twelve safeguards agreements had been approved by the Board, whereas a year later the number had increased to 24. [4] Accordingly, a Department of Safeguards and Inspection was set up under an Inspector General.

5. The Board has completed its review of the Agency's safeguards system. The revised system [5] which resulted from that review was provisionally approved without dissenting vote in February.

6. The regrouping of the Secretariat's activities in providing technical assistance has also been completed. The re-organization is fostering a better integrated programme as well as permitting some economies in manpower that can now be used for other technical work. Pursuant to a request made by the Conference last year [6], a panel was convened in April 1965 to study the training of specialists in nuclear science and technology in the developing countries.

7. Next year's report of the Board will be prepared so as to show the progress achieved and difficulties encountered in implementing the various parts of the biennial programme for 1965-66 [7], as well as any significant changes which have become desirable since the programme was approved by the General Conference in 1964. At the time of writing the report, only six months of the biennium had elapsed. It is therefore difficult at this stage to make more than a tentative evaluation. Subject to this reservation, the following general comments can be made in addition to those contained in paragraphs 3 to 6 above:

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[1] The composition of the Board is given in Annex I to this report.

[2] A list of nuclear power stations in Member States in operation, under construction or planned for commissioning during the present decade is given in Annex II.

[3] INFCIRC/50, paragraph 21.

[4] See also the chart at the end of Chapter V.

[5] Document GC(IX)/294.

[6] Resolution GC(VIII)/RES/182.

[7] GC(VIII)/275.

(a) The technical assistance programme has continued to be hampered by financial stringency and depends increasingly upon sources other than the Agency's own resources.

(b) Modifications to the nuclear power and reactors programme have already been necessary because of the limitation of resources. The small group of technical services available in the Agency has not been able to respond fully to the demands on them from Member States, which have increased as nuclear power has become economically competitive and an industrial prospect. The research reactor utilization programme and work relating to the safety of reactors, including the development of accepted safety standards, have continued modestly as foreseen in the programme. It has not, however, been possible to publish an evaluation and summation of the Third Geneva Conference, nor follow up all recommendations of technical panels on power reactors using plutonium and thorium, due to shortage of staff and non-availability of funds at the time.

(c) The Agency has made a limited start on activities relating to the use of nuclear energy for desalting water and is becoming the focal point for international co-operation on this subject. For the Agency to fulfil its function in the development of nuclear desalting, however, increased resources will be required in the future.

(d) The programme with isotopes and radiation sources is generally being carried out according to plan. The Agency's work on the agricultural applications of nuclear science, in co-operation with FAO through the newly established joint division, is taking the form of a growing number of large field experiments in which laboratories in several countries take part. The Governing Council of the Special Fund has approved the first major project whereby radiation will be used in an attempt to exterminate an insect pest, the Mediterranean fruit fly, in six countries in Central America. The Special Fund is, moreover, obtaining the Agency's help in applying radioisotope techniques in a number of projects for the development of water resources.

(e) The Agency's work in health, safety and waste management is being generally carried out as foreseen in the programme.

(f) With regard to research services in the physical sciences, there has been a considerable increase in the work of the Agency's laboratories in preparing and distributing radioactive standards to Member States. The Agency's laboratories also continue to provide supporting services in many field programmes, particularly in agriculture and hydrology. The International Centre for Theoretical Physics at Trieste, which started its operations on 1 October with a seminar on plasma physics, is now well launched into its training and research programmes. In the words of the report by the Centre's Scientific Council to the Director General, "there has seldom been a case of a scientific institution developing so successfully in such a short time".

(g) As far as the Agency's research contract programme is concerned, although this is not designed as a technical assistance programme, the assistance provided to laboratories in developing countries under the programme is increasing rapidly, e.g. in 1964, 68% of all research contracts funds went to developing countries.

(h) The work of the Agency in promoting the exchange of scientific and technical information is described in detail, under the relevant technical programmes, in several parts of the report [8]. It will be noted, however, that it has

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[8] See also Annex III for details of conferences, symposia and publications.

become necessary to postpone until 1966 the symposium on the use of radioisotopes in tropical medicine contemplated for 1965, and it has been decided to collaborate with FAO in holding a symposium on the use of isotopes in weed research in October 1965.

(i) Particular reference should be made to the programme that the Agency is starting for the creation of an international scientific documentation centre which will be equipped with an electronic computer and which will serve the various technical programmes of the Agency. For this purpose a rented IBM 1401 computer will be available from October 1965. Preparatory work on mechanized information storage and retrieval is under way in co-operation with Governments of Member States and other international organizations. Considerable experience in the field has already been gained by the preparation of documentation for the Third Geneva Conference and of specialized subject indexes for bibliographies.

8. The Board, in addition, invites the Conference's attention to the following reports which give more detailed information on certain parts of the Agency's recent work:

(a) Review of the technical assistance provided by the Agency in 1964 [9]; and

(b) IAEA Laboratory Activities - Second Report [10].

9. The hospitable offer made by the Japanese Government last year [11] will enable the General Conference to hold its ninth regular session in Tokyo. The Board also wishes to record its appreciation of the continued help extended to the Agency by the Austrian Government which has been marked during the period covered by this report by the handing over of new facilities in the Agency's Headquarters building as well as by further arrangements for technical co-operation at Seibersdorf.

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[9] GC(IX)/INF/80.

[10] Technical Reports Series No. 41.

[11] GC(VIII)/269.

CHAPTER I. NUCLEAR POWER AND NUCLEAR TECHNOLOGY

1. The Third International Conference on the Peaceful Uses of Atomic Energy

10. It will be recalled that by Resolution 1770 (XVII) of the General Assembly the Secretary-General was requested to arrange for a third International Conference on the Peaceful Uses of Atomic Energy to meet in Geneva in 1964.

11. The Secretary-General set the dates for the Conference at 31 August to 9 September 1964, appointed as President Professor Vasili S. Emelyanov, Vice-Chairman of the State Committee for the Utilization of Atomic Energy of the Union of Soviet Socialist Republics, and entrusted the scientific aspects of the Conference to the Director General. The Agency furnished 14 of the 21 scientific secretaries from its staff and helped run the Conference and prepare the documents for it.

12. The responsibility for the administrative arrangements for the Conference and for the organization of the governmental scientific exhibitions was delegated to the Director of the European Office of the United Nations.

13. The topical agenda for the Conference was drawn up by the Scientific Advisory Committee. Besides the formal opening and closing sessions there were six general sessions and 36 technical sessions as well as an evening lecture summing up the Conference.

14. Seventy-five States, ten specialized agencies and the Agency were represented at the Conference. The total number of delegates and advisers was 1823, of whom 1783 represented States and 40 represented agencies. There were also 1841 registered observers from intergovernmental and non-governmental organizations, academic and scientific institutions and industrial concerns. Table I below gives the figures for papers and abstracts for the first, second and third conferences.

Table I

Item	1955	1958	1964
Abstracts submitted	1132	2535	992
Papers accepted	1067	2135	747
Papers selected for oral presentation	450	714	358

Eighteen Governments presented scientific exhibitions in the Palais des Expositions in Geneva, making up a total area of 7627 square metres. Eighty-five documentary films were shown by 12 countries.

15. The publication of the proceedings of the Conference is being undertaken by the United Nations. The Agency has sent a team of editors and record officers to Geneva for the pre-editing of manuscripts and the preparation of the records of the discussion.

16. Unlike the 1955 and 1958 conferences, the 1964 Conference focused its attention on one main theme - nuclear power - the rapid rise of which as a major source of energy promises to be of decisive importance to the economic development of the world. The

technical discussions and conclusions of the Conference are reflected in other parts of this report; it will suffice to say here that it showed that nuclear energy has reached maturity as a source of power and has entered a period of rapid growth. [12]

17. Subjects in which important progress can be expected in the next decade are the development of advanced and breeder reactors, the use of nuclear energy to desalt water (possibly in dual-purpose plants which also generate electricity), nuclear package plants to supply power and heat in remote locations, and the use of very high flux reactors for testing materials and for producing transuranic elements.

2. The economics of nuclear power

18. The Third Geneva Conference offered a unique opportunity for worldwide comparison of the latest cost data and a comprehensive analysis is being prepared by the Agency, whose work on nuclear power economics concentrates on:

(a) Collecting, evaluating and providing cost data;

(b) Studying the methods to be used in making comparisons of the economics of nuclear and conventional stations; and

(c) Helping developing countries to start nuclear power programmes by giving advice and services on economics.

19. The Conference confirmed that nuclear stations have continued to operate with exceptional safety and reliability. Striking reductions were announced in the cost of power and fuel for proven reactor types. The Conference also showed that the development of advanced nuclear power systems is likely to take place sooner than expected; full-sized fast breeder power stations will probably be commissioned in the early 1970s.

20. There have been sharp increases in the forecasts, summed up in Table II below, of the nuclear capacity that will be installed in the next two decades. Firm commitments have been made for approximately 18 000 MW(e) of nuclear power plants to be built by 1970. It is expected that some 15-20% of all new electrical capacity built between 1970 and 1980 will be nuclear, and it has been predicted that more than half the electric power requirements of some large industrial countries will be met by nuclear electricity by the end of this century. Developing countries are also entering the field although local circumstances, such as the size of plant that can be installed and the foreign exchange problems that may arise, in their case call for a particularly careful analysis to determine the best time to start and the right size of the plant.

[12] In Annex II a list is given of nuclear power stations in Member States in operation, under construction and planned for commissioning during the present decade.

Table II

Estimated additions to electric power plant capacity during the period 1965-80[a/]

Region	1965-70			1970-75			1975-80		
	Total additional electric power MW(e)	Nuclear power component MW(e)	%	Total additional electric power MW(e)	Nuclear power component MW(e)	%	Total additional electric power MW(e)	Nuclear power component MW(e)	%
Canada	12 000	700	6	13 000	1 900	15	15 000-20 000	4 300	25
France	9 000	1 660	18.5	12 000	3 300	27.5	15 000	9 000	60
India	14 000	1 200	9	14 000	1 800	13	22 000	7 000	32
Japan	20 000	1 000	5	22 000	2 000	9	25 000	3 000-5 000	16
Union of Soviet Socialist Republics	80 000-100 000	~1 000	~1	~140 000	several 1 000	....	~210 000	several 10 000	....
United Kingdom of Great Britain and Northern Ireland	34 000	3 400	10	40 000	5 000	12.5	45 000	7 000	15.5
United States of America	68 000	4 000	6	~110 000	25 000	~23	~140 000	40 000	~29
Belgium) Germany) Italy) Netherlands)	25 000	1 000	4	38 000	5 000	~13	45 000	19 000	~42
Other European countries	~30 000	1 700	6	~35 000	....	....	~45 000	....	....
Others	~8 000	~300	4	~12 000	~1 000	8	~30 000	~3 000	10
TOTAL	~310 000	~17 000	~5	~440 000	~50 000	~11	~600 000	~100 000	~17

a/ These estimates are based on data from the Third Geneva Conference and on additional information subsequently made available to the Agency.

21. While the accuracy of forecasts diminishes with time, it is assumed in Table II above that the promise of an early development of advanced converters and breeders will be realized, and that many benefits are still to be reaped from standardizing reactor components and fuel elements and producing them on a large scale.

22. Table III below shows typical power and fuel cost ranges for proven reactor types in sizes ranging from 50 to 800 MW(e). In the 500 to 1000 MW range, unit capital costs decrease so much more rapidly for nuclear than for conventional stations that power systems sufficiently large to absorb base load units of this size are likely to turn to nuclear plants even in low cost fuel areas (23 to 30 cents/million BTUs). In other cases nuclear power is becoming competitive more gradually. This table is based on the best figures available, but cost estimates in abstracto should be treated with due reserve because of the numerous assumptions they include and the different methods used for calculating costs even within one country, let alone the problems of comparing costs between countries.

Table III

Typical costs for proven reactor types

Nominal plant size - MW(e)	50	200	500	600-800
Unit capital costs - $/kW[a]				
U-gas-graphite[b]	-	350-380	230-280	-
Enriched U-gas-graphite	-	-	-	180-220[h]
U-D_2O - D_2O[c]	-	400	240-270	-
Enriched U - H_2O - H_2O[d]	350-450	200-300	130-200	Less than 115[i]
Fuel costs - mills/kWh				
U-gas-graphite[e]	-	1.6-2.1	1.3-1.8	-
Enriched U-gas-graphite	-	-	-	1.5-2.0[h]
U-D_2O - D_2O[f]	-	0.9-1.2	0.6-0.8	-
Enriched U - H_2O - H_2O[g]	2.9-3.1	2.4-2.6	2-2.3	2.0[i]

a/ Capital costs are total plant costs, including customer cost, interest during construction, etc. Plant uprating was not assumed.

b/ Typical natural-uranium-fuelled, gas-cooled, graphite-moderated plants.

c/ Typical natural-uranium-fuelled, heavy-water-moderated and cooled plants.

d/ Typical slightly enriched uranium, light-water-moderated and cooled plants.

e/ Based on an irradiation level of 3500 MWd/MTU, 80% load factor, fuel element cost at \$40/kgU (\$8/lb U_3O_8) and \$32/kgU (\$5/lb U_3O_8).

f/ Based on an irradiation level of 10 500 MWd/MTU, an average load factor of 80% and fuel element costs of \$47/kgU.

g/ Based on an irradiation level of 22 000 to 24 000 MWd/MTU, an average load factor of 80%, the United States Atomic Energy Commission schedule of charges and \$10/g Pu^{239}-Pu^{241} or toll processed \$6/lb U_3 and \$9/g Pu^{239}-Pu^{241}, and a chemical processing cost of \$32/kgU.

h/ These figures are based on preliminary information received on the United Kingdom reactor Dungeness B.

i/ "Nucleonics", 11 February 1965.

23. The Third Geneva Conference showed the importance of making detailed studies of the use and future of various nuclear fuels. The Agency's panels on the use of plutonium and thorium in power reactors are providing a good opportunity to survey the economic as well as the technical aspects of the use of these materials.

24. The report the Agency is preparing on the economic aspects of integrating nuclear plants into a general power system [13] has been delayed to permit the inclusion of specific system analyses which the Agency is now making, in particular in the Philippines. Preparatory work is being done on the problem of extrapolating nuclear power costs from one country to another - a subject of special interest to developing countries - as well as on the economics of nuclear power programmes and economic prospects of various fuels.

[13] See document GC(VIII)/270, para. 76.

25. The main single nuclear power undertaking that the Agency is carrying out in a Member State continues to be in the Philippines [14], the Pre-investment Study on Power, including Nuclear Power, in Luzon. An evaluation of indigenous energy resources and probable power demand was completed early in 1965. It shows that those indigenous resources will not be adequate to meet the expected power needs of the Philippines during the next decade, that the power needs will be such as to require the construction of more than one million kilowatts of new capacity, and the country will depend on a large quantity of imported fuel. Thus it is essential to study the possibility of using nuclear energy to meet part of this additional capacity. The Special Fund has approved the second part of the project in which consideration will be given to nuclear as well as conventional power plants for which the Agency is now obtaining detailed cost estimates. It is expected that the final report will be finished by the end of 1965.

26. At the request of Pakistan the Agency arranged a meeting of experts in September 1964 to evaluate the tenders submitted for building a 70-MW(e) reactor at Rooppur and to prepare a confidential report covering the technical as well as the economic aspects of the proposed designs. It was the first time that the Agency had arranged a service of this kind.

27. The Agency has also prepared a general study of the prospects for nuclear power in the Republic of Korea during the next decade. A nuclear power plant of 150-200 MW(e) may possibly be an economic prospect in the early 1970s. However, more detailed study, taking into account possible new hydro projects, the exhaustion of domestic coal resources and the price of imported oil, would be needed before any definite conclusions could be drawn regarding timing and size.

3. Technical aspects of reactor development

28. The main technical conclusions of the Third Geneva Conference are summarized below:

(a) Operating experience with pressurized water reactors having a total installed capacity of 900 MW(e) has been most encouraging. The Yankee reactor at Rowe, Massachusetts, was available for more than 96% of the time during four years of operation, excluding refuelling time. The time needed for refuelling was reduced from 17 weeks for the first core to five weeks for the third core; the next refuelling is expected to take not more than three weeks. Certain fuel assemblies achieved an exposure as high as 22 000 MWd/t.

(b) Numerous technological improvements have been achieved in the design and operation of pressurized water reactors. Perhaps the most important are chemical shim control, rod cluster control, improved designs for components for pressure vessels, pumps and steam generators, better fuel management schemes and double containment for enhanced safety.

(c) Reports on the operation of a total of 650 MW(e) of boiling-water reactor capacity demonstrated the reliability and stability of this type of plant. They showed that the amount of radioactivity collecting in the turbines is insignificant despite the fact that steam passes directly into them from the reactors (and not through a heat exchanger). The trend in boiling water reactors is towards higher power density (45 to 60 kW/l instead of the 28 kW/l in existing plants), controlled coolant flow, small pressure vessels and extensive in-core instrumentation.

[14] Ibid., para. 78.

(d) With regard to light-water reactors generally - both boiling and pressurized - there is a tendency to construct very large sizes ranging from 500 MW(e) to 800 MW(e) and above. By using modular designs with standard heat removal loops as well as standard control rod units, fuel assemblies and other components, it is possible to use an appropriate number of modules to obtain whatever power level is desired. This is expected to lead to significant reductions in capital cost as well as in operating and maintenance costs.

(e) The next steps in light-water reactors are likely to be the more general use of nuclear superheat and supercritical (very high) steam pressures so as to increase thermal efficiency from the present level of 30% to more than 40%. Nuclear superheat reactors already in operation (including one at Beloyarsk in the Soviet Union and Bonus and Pathfinder in the United States) are yielding valuable data on questions such as integrity (reliability and performance) of superheater fuels and how to control the power generated by the boiler and superheater respectively.

(f) Experience with heavy-water reactors has also been most satisfactory; they have been proved to be safe and reliable (examples: NPD, Canada; Halden, Norway; AGESTA, Sweden; and CVTR, United States). It is expected that the 200-MW(t) CANDU reactor in Canada will become critical by the end of 1965. Better design and engineering of cooling systems and improved methods of recovery are solving the problems of heavy water losses - for instance, the heavy water losses at the NPD reactor in Canada have been greatly reduced to five kilograms per day, and it proved possible to operate it at more than 83% capacity factor (rated output) during 1964 including refuelling time.

(g) Interest in the heavy-water systems is growing and the price of heavy water is expected to decline from $28 to about $13.5 per pound (the figure quoted for the latest Canadian plant). The United States has shown interest in the development of the heavy-water-moderated, organic-cooled concept for desalting, and is undertaking research and development jointly with Canada which is building the Whiteshell heavy-water organic-moderated test reactor (WR-1).

(h) The use of organic coolants has been encouraged by the satisfactory operating experience at the PIQUA reactor in the United States and ARBUS in the Soviet Union. Other promising coolants for heavy-water reactors include gas, which will be used at the EL-4 in France and the HWGCR in the Czechoslovak Socialist Republic, and eventually boiling water and steam.

(i) More experience has been obtained with graphite-moderated, gas-cooled reactors than with any other type. During the past year the Trawsfynydd first and second units (in the United Kingdom) and EDF-2 (in France) gas-cooled reactors became operational, thereby increasing the total installed capacity of this type of plant to 2600 MW(e). Several stations have bettered their design rating, and burn-up is expected to rise from 3000 MWd/t to 4500 MWd/t as a result of new fuel designs. The trend in this type of reactor is towards higher temperatures, as in the enriched uranium reactors such as AGR and Dragon in the United Kingdom and Peach Bottom in the United States. AGR has performed exceptionally well and has been available for a very high proportion of the time during its first year of operation. It appears that the problem of avoiding carbon-dioxide reactions with graphite has largely been solved. Dragon started operation towards the end of 1964 and Peach Bottom is expected to go into operation shortly. These reactors are designed for high temperature and high power density with compact cores, small pressure vessels, higher pressures of coolant gas and smaller heat exchangers. It appears that the release of fission products into the coolant gas will be far less than originally foreseen. Use of the thorium fuel cycle and ceramic fuels will eventually permit much higher burn-ups (above 80 000 MWd/t) and possibly breeding.

(j) The development of pre-stressed concrete pressure vessels has been of great significance for gas-cooled reactors, reducing their capital costs and increasing their safety; such vessels are built for the EDF-3 and EDF-4 in France and the Oldbury and Wylfa in the United Kingdom. These vessels may also be useful for other types of reactors.

(k) Virtually all countries with major nuclear energy programmes now devote considerable efforts to developing fast reactor systems, the economic breeder reactor being the ultimate goal. This effort reflects growing awareness of the need to husband the world's resources of nuclear fuels and especially of fertile materials. This work on fast breeders is the largest single research and development programme in the United Kingdom, which has gained much experience from the Dounreay fast reactor. In the Soviet Union, experience with the BR-5 reactor has led to the construction of a 350-MW(e) fast breeder plant which will be completed in 1968, for the dual purpose of producing electricity and desalting. The EBR-II, in the United States, has been taken up to full power and will make it possible, for the first time, to study the truly closed fuel cycle. In France the Rapsodie reactor will be completed in 1966. Several other countries are making extensive fast reactor physics and engineering studies.

(l) Although many serious problems remain, for instance in physics, in the choice of materials and engineering, and no common approach to safety questions has yet emerged, the experience already gained has led some authorities to predict that commercial fast breeder reactors will be in operation by 1975 rather than, as earlier foreseen, in 1980. It should also be noted that advanced converter reactors (heavy water and graphite-moderated) are receiving much attention and may become competitive in the near future.

29. The developments in both thermal and fast reactor technology are being taken into account in planning the Agency's work. In the next two years, the Agency will hold a series of meetings on the technical and economic aspects of various reactor concepts and will stress the exchange of information on basic physics and engineering data, technical and economic problems of fuel cycles and the safety of nuclear plants. The Secretariat is also continuing to follow the design, construction and operation of several nuclear power reactor projects in Member States. Information obtained so far is summarized in the report on Selected Power Reactor Projects in Canada and the United States of America [15].

30. With regard to fast reactors, recent technical advances and the need to husband the world's nuclear fuels have provided the stimulus for two Agency panels on plutonium and thorium, respectively. The large quantities of plutonium being produced by commercial power reactors (it is estimated that 450 tons of plutonium are available in the leading nuclear countries) make it imperative to give more attention to its use as a fuel. The Panel on the Utilization of Plutonium for Power Production, held by the Agency in December 1964, showed the value of work being done on plutonium in thermal and fast reactors, reviewed developments in manufacturing and reprocessing plutonium fuels, and exchanged information about the behaviour of these fuels under irradiation and the problems of the plutonium/thorium fuel systems. The main conclusions were that the technology for recycling plutonium for thermal reactors is now well established and will be further improved during the next years. However, the value of plutonium as a fuel in fast reactors is much higher. Instead of using plutonium in thermal reactors it could be stock-piled for later use in fast reactors when these come into commercial operation. The choice between present and deferred use can only be made in the light of the needs and

[15] Agency publication, Technical Reports Series No. 36.

circumstances of the country concerned, and there are wide differences between countries in this respect. The panel recommended that the Agency should continue its study of the use of plutonium for power production and organize follow-up meetings during the next two or three years on more specialized topics and lines of development listed in detail in the panel's report.

31. Three thorium-based power reactors - SRE, Indian Point and ERR, Elk River - are already in operation in the United States and a number are being constructed. In June 1965 the use of thorium as a fuel was discussed by an Agency panel entitled The Utilization of Thorium in Power Reactors. Extensive research and development work is now being done on thorium fuels in several countries and since thorium is about ten times more common than uranium in the earth's crust (particularly large deposits existing in countries such as Brazil and India) this subject should be of special interest to developing Member States of the Agency.

32. Non-destructive testing techniques for reactor fuels not only reduce the cost of nuclear power but also simplify the application of safeguards. These techniques are used in measuring dimensions, assaying fuels and determining plutonium content, detecting faults in fuel elements and other reactor components, and controlling manufacturing processes. Rapid progress is being made in many of these techniques. At the Symposium on Non-Destructive Testing in Nuclear Technology held in Bucharest in May 1965, the rapid progress in the application of production-line non-destructive testing techniques and the development of new techniques to deal with finned and other complex designs of fuel rods was stressed. Since it is imperative to maintain a very precise control of conditions in modern high efficiency power reactors, the symposium also stressed the need to devise thorough but cheap non-destructive techniques for testing materials during reactor operation as well as before operation.

33. Other work of the Secretariat during the reporting period that may be more briefly mentioned includes:

(a) The publication in July 1964 of the fifth volume of Directory of Nuclear Reactors [16]. It gives comprehensive information on 78 research reactors in 16 Member States and brings to 306 the total number of reactors described in the five volumes of the directory. The sixth volume, dealing with the latest research reactors, will be published early in 1966;

(b) The compilation of a reactor card index giving basic information on 440 reactors. This was published in August 1964, and a supplement covering 100 further reactors, in February 1965 [17]. This index complements the Directory by making it possible to include projects that are still being developed; and

(c) The publication in February 1965 of a Manual for the Operation of Research Reactors [18] designed to provide practical reference material for reactor operators and technicians.

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[16] Agency publication, STI/PUB/73.

[17] Agency publication, STI/PUB/85.

[18] Agency publication, STI/DOC/10/37.

4. Reactor safety

34. The Agency has had several requests from Member States for help in assessing the possible hazards in siting, designing, operating and administering nuclear reactors. It has therefore compiled a roster of international experts in various fields of reactor safety, from nominations received from Member States. When the Agency receives a request it selects a panel, from the roster, to carry out the required evaluation of reactor hazards or of the site.

35. During the period under review the following three evaluations have been arranged:

(a) An Advisory Panel on Reactor Safety met in Arnhem, Netherlands, from 16 to 20 November 1964, to review the safety aspects of the KEMA Suspension Test Reactor;

(b) An Advisory Panel on Reactor Siting met in Manila, from 15 to 26 February 1965, to review four possible power reactor sites under the second part of the Special Fund power study in Luzon [19]; and

(c) An Advisory Panel on Reactor Siting met in Seoul, Republic of Korea, from 14 to 30 June 1965 to review sites for a proposed nuclear power reactor.

5. Co-operation with research reactors

36. During the reporting period Colombia, Indonesia, Mexico and South Africa, among others, have joined the countries with research reactors, thus bringing to 49 the total number of Member States in which such reactors are in advanced stages of construction or in operation. The Agency has continued to help Member States procure fuel and facilities for research reactor centres; projects of this kind for Argentina and Uruguay were approved by the Board in December 1964 and February 1965 respectively.

37. In the most advanced centres the old general purpose reactors are being supplemented by specialized reactors, with higher radiation fields and facilities designed for particular types of research. The Agency's programme therefore now also includes such specialized reactors and their applications, and ways of converting older reactors to make them more suitable for specialized research.

38. The series of regional study groups on research reactor utilization [20] has continued. Meetings of such groups were held in Bucharest in October and in Bombay in December 1964. The discussions at Bucharest on in-pile dosimetry (measurement of radiation within the core of the reactor), techniques of irradiation at very low and very high temperatures, and neutron spectroscopy with cold neutrons were particularly interesting, showing that new techniques have opened many possibilities for original research.

39. The value of these meetings has been described in earlier reports. [21] They continue to provide a most useful and indeed unique means of fostering working co-operation between scientists and centres in the region. A similar purpose was served by the meeting in Puerto Rico on the Technical and Economic Problems Related to the Generation of Nuclear Power in Latin America organized by the Inter-American Nuclear Energy Commission in February 1965, in which the Agency took an active part.

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[19] See para. 25 above.

[20] See document GC(VIII)/270, para. 100.

[21] Ibid., paras. 101 and 102.

40. An example of the type of practical arrangement that these meetings produce is the Agency/Indian/Philippines Joint Programme using a crystal spectrometer [22]. Work on this programme started with the installation of the spectrometer at the Philippine Atomic Research Centre in December 1964. The joint committee in charge of the project met in Bombay at the same time as the regional study group (see paragraph 38 above) to plan further work. The project is attracting considerable interest in the region, and it is hoped that it may be possible to expand it and to go on to other regional projects.

41. In October 1964 an expert was sent to Latin American countries that have built or are planning to build research reactors, to advise the Agency on the best way of continuing its research reactor utilization programme in the region. The expert made several suggestions which are now being studied, for training courses, joint projects and future meetings.

42. Amongst the more specialized research reactors now coming to the fore are those than can be pulsed to produce very high neutron fluxes for fractions of a second. These high fluxes permit advanced research on, for instance, reactor safety and technology as well as fundamental aspects of radiation damage, radiation chemistry and recoil chemistry. In May 1965 the Agency held a Panel on the Kinetics and Applications of Pulsed Research Reactors in which the trends in the design of the two major classes of such reactors, the high-frequency, repetitive-pulse type and the single-burst type, were reviewed. The relative advantages and disadvantages of the various kinds of pulsed systems as well as their unique value in certain types of experimental studies of fast transient phenomena in fundamental and applied research were also studied. The panel, moreover, discussed the problems encountered in converting an existing research reactor to pulsed operation and the conditions in which such a conversion could be desirable for programmatic reasons.

43. A Panel on the Problems of In-Pile Dosimetry in July 1964 made recommendations on the techniques to be used in measuring radioactivity within reactors, and the Agency will support co-ordinated research programmes at centres in Member States on such problems.

44. Experiments at NORA [23] have given valuable data on reactor physics of heavy water, mixed heavy and light water and pure light water lattices enriched by 1.5 per cent and 3 per cent uranium fuel. Theoretical work has included testing various methods of interpreting experimental results and has also been developing better computational models. This type of research is contributing to the understanding of the fundamental physics of heavy and light water reactors.

45. Two joint papers arising out of the NPY project [24] for co-operative research in reactor physics between the Agency and the Governments of Norway, Poland and Yugoslavia) were presented to the Third Geneva Conference. A number of joint seminars have been organized (resonance absorption in Belgrade and reactor kinetics at Kjeller in Norway) and a joint monograph is being prepared on experimental and theoretical results in research on thermalization and slowing down on neutrons.

6. Desalting

46. The growth of interest in the use of nuclear energy for desalting has been reflected for instance in the United States Government's announcement of an "aggressive and imaginative programme to advance progress in large scale desalting of sea water", in the decision of the United Kingdom to give its Atomic Energy Authority sole responsibility for

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[22] For the text of the agreement see document INFCIRC/56.

[23] Joint Agency/Norwegian research programme on reactor physics (see document GC(VIII)/270, para. 107).

[24] See document GC(VIII)/270, para. 108.

research and development into methods of desalting for civil use and to start a programme in this field, as well as in statements by leading statesmen in several other countries and in a number of projects started during the year.

47. While several studies have already shown that good prospects exist in the long term for this technology, particularly in dual-purpose installations producing both electricity and fresh water, a distinction should be drawn between progress in the technology of desalting as such, and in that of the energy source used to operate the desalting plant. Several reactors of 1500 MW(t) are already under construction (for electricity generation); each could produce more than enough heat to desalt 150 million gallons a day; the largest desalting unit now in operation, however, produces only 1.5 million gallons per day.

48. Present techniques offer desalted water at less than a dollar per thousand gallons, a price low enough for domestic and several industrial uses but too high for agriculture. It is expected that during the next decade the price will be reduced by one half or two thirds by improving desalting techniques, by increasing the size of desalting plants and by using cheaper energy, as available in large nuclear dual-purpose installations.

49. During the period under review, the Agency has been associated with the following activities that may lead to low-cost desalting:

(a) In November 1964 the Governments of the Soviet Union and the United States concluded an agreement for co-operation in the field of desalination, including the use of atomic energy. The agreement, the text of which was transmitted to the Agency in January 1965 [25], provides that the Soviet Union and the United States will give the Agency copies of the accounts, reports and other documents they exchange and also invite observers from the Agency, in appropriate cases, to scientific meetings they hold;

(b) Pursuant to an agreement between Israel and the United States for a joint programme for desalting, an Agency staff member has taken part as an observer in all meetings of the Joint Israeli/United States technical team which reviewed power and water needs in Israel. A joint Israeli/United States Committee, including an observer from the Agency, has been entrusted with a feasibility study for a dual-purpose plant having an installed capacity of 175-200 MW(e) and a water output of the order of 120 million gallons per day. The Israeli/United States agreement states that "the knowledge and experience obtained from the joint effort will be available to all countries with water deficiencies";

(c) At the request of the Governments of the United Arab Republic and the United States, an observer from the Secretariat took part in discussions between a United States desalting and power mission and the United Arab Republic authorities in November 1964 concerning the latter's proposal to construct a plant having 150 MW(e) capacity and producing five million gallons a day of desalted water, chiefly for use in an agricultural research centre; and

(d) At the request of the Governments of Tunisia and the United States an observer from the Secretariat took part in December 1964 in the work of a United States mission to Tunisia where the construction of a nuclear dual-purpose plant (50-70 MW(e), five million gallons per day) in the southern part of the country is being considered.

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[25] INFCIRC/60.

50. The fourth meeting of the Agency's Panel on the Use of Nuclear Energy for Desalting [26] was held in Geneva on 8 September 1964 to take advantage of the presence of delegates to the Third Geneva Conference. A number of Member States described their interest in nuclear desalting and the role they foresaw for the Agency in this matter. The fifth meeting of the panel was held in April 1965 and paid particular attention to the possibilities offered by dual-purpose concepts. The first results of the study being made in Israel under an Agency research contract were also examined. The panel considered that the growing interest in desalting and the potential role of nuclear energy for this purpose justify a continuing programme of the Agency in this field. It accordingly made recommendations about the work the Agency should undertake as the international focal point for nuclear desalting.

51. Several other Member States, including Chile, Greece, Mexico, Peru and Turkey, have requested the Agency's advice on single- or dual-purpose plants, and the work of the Agency in providing help in the study of individual projects will undoubtedly expand in the future.

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[26] See document GC(VIII)/270, para. 98.

CHAPTER II. RESEARCH AND SERVICES IN THE LIFE SCIENCES

1. Nuclear medicine and radiation biology

52. The Agency has continued to concentrate on research into and development of the physical and biochemical aspects of nuclear medicine and radiation biology, leaving their purely medical aspects to other organizations. It is obvious, however, that the research supported by the Agency cannot be completely divorced from the medical problems that this research is designed to help solve. The Agency has therefore continued to seek close and effective collaboration with WHO.

Radiation sensitivity

53. Of the many biological effects of ionizing radiation, its capacity to debilitate and kill is of utmost concern to society and therefore to the future development of the nuclear industry. The growing use of atomic power as a source of energy increases the chances that accidental radiation exposure will occur. If for no other reason, this makes it essential to understand how radiation can cause biological damage and how its effects could be diminished or avoided. The main work of the Agency in radiation biology has therefore been concentrated, during the past year, on radiation sensitivity, the object being to obtain information of practical value for:

(i) Combating the detrimental effects of radiation;

(ii) Better radiation therapy; and

(iii) Using ionizing radiation to sterilize drugs, medical supplies and food.

As shown in Annex IV, the Agency supported 26 research contracts in 20 Member States on radiation sensitivity.

54. Research, some of it supported by the Agency, has shown that the use of bone marrow transplants to replace radiation-damaged bone marrow can counteract the effects of lower doses of radiation. [27] However, many questions must be answered before the treatment can be used routinely or with complete confidence. In accordance with the recommendations made by a Panel on Irradiation and the Immune Response held in London in April 1965, the Agency will support additional studies to further the understanding of haematopoietic tissue therapy.

55. The Agency's Panel on the Molecular Basis of Radiosensitivity, held in November 1964, pointed out that many of the results of the Agency's research contracts can be used in studies of the application of radiation to preserve food and to sterilize and prepare pharmaceuticals and medical supplies, although these research contracts were not originally directed to this end. The Agency has accordingly started a programme on the irradiation of pharmaceuticals; a meeting, which included experts from WHO and ENEA, has defined the subjects that must be studied, and the Agency has started small-scale experiments at its Laboratory to establish the radiosensitivity of vitamin B_6.

Radiation toxicology

56. Experiments on animals provide much of the information used as a basis for international recommendations on maximum permissible body burdens of radioisotopes. The results of such experiments are often difficult to extrapolate to man and must be supplemented by observations on humans; obviously the only human source that can be used is persons who have been exposed to radiation accidentally or in the course of medical treatment.

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[27] It will be recalled that this therapy was used in the treatment of radiation workers after the criticality accident in 1958 in Vinca, Yugoslavia.

57. Most radiation workers are exposed, if at all, to only very small doses over very long periods. To collect data of relevance to this type of exposure, observations must be made on persons whose bodies have been contaminated by radioisotopes for a very long time. One such group consists of workers in the dial-painting industry who use luminous paints containing radium or strontium-90; [28] another group are persons injected, many years ago, with the colloidal thorium dioxide thorotrast.

58. Studies of these persons require an accurate estimate of the body burden, usually by whole-body counting and/or excretion measurements, and careful observation over a long time of the clinical effects that can be associated with increased radiation dose. The latter observation should be compared simultaneously with that of a suitably constituted control group. The eventual aim of these studies is to establish a relationship between radiation dose and clinical effect in order to assess the limits for radioisotope body burdens that may be considered safe.

59. The Agency is giving support to studies of watch-dial painters in three Member States. These studies have identified a number of cases having radium burdens at approximately the maximum permissible level (of 0.1 μci) and above. Clinical effects are beginning to appear but it will be several years before final conclusions can be drawn. It will also be necessary to establish a control group so as to distinguish effects caused by radiation from effects of other origin.

60. Between 1935 and 1948 several hundred patients were injected with thorotrast, for diagnostic purposes, in hospitals in Vienna. A summary of the study of surviving patients, which is being made by the Agency's medical physics laboratory with the help of the Agency's whole-body counter, is given in the table below.

Table IV

Thorotrast cases from Vienna

Cases traced	
Living in Vienna, already measured for radioactivity	41
Living in Vienna, not yet measured for radioactivity	42
Died before release from hospital	102
Died after release from hospital	228
Cases being traced	
Living or dead in Austria outside Vienna	166
Cases not traced	
No address recorded	56
Foreign address	72
Disappeared	19
	726

[28] See document GC(VIII)/270, para. 16.

61. The laboratory is ascertaining the cause of death of those patients who died after release from hospital, and the same data are being collected for a suitable control group not having thorotrast burdens. It is too early to evaluate possible clinical effects.

62. Results of the Agency's study as well as work in other centres will be discussed in a panel that the Agency and WHO are jointly convening in October 1965.

63. A good deal of work has had to be done to calibrate the Agency's whole-body counter for the thorotrast measurements. Other continuing projects include co-ordinated programmes of animal experiments in Denmark and the United Kingdom, to compare the radiological and medical effects of colloidal thorium dioxide.

Diagnostic and research applications of tracers

64. The number and variety of diagnostic and medical research applications of radioisotopes continues to increase in all parts of the world. [29] Figure 1 below gives an example; it shows the increase in the medical isotope licences granted in a Latin American country during the last six years. Figure 2 is an example showing the particularly rapid growth of radioisotope consumption for medical work in the developing countries.

[29] See survey paper (document A/Conf.28/P/880) presented to the Third Geneva Conference: Belcher, E.H., Cohen, M., Dudley, R.A., Parker, H.G., Tsien, K.C. and Vetter, H.: Advances in the use of isotopes and radiation sources in medicine.

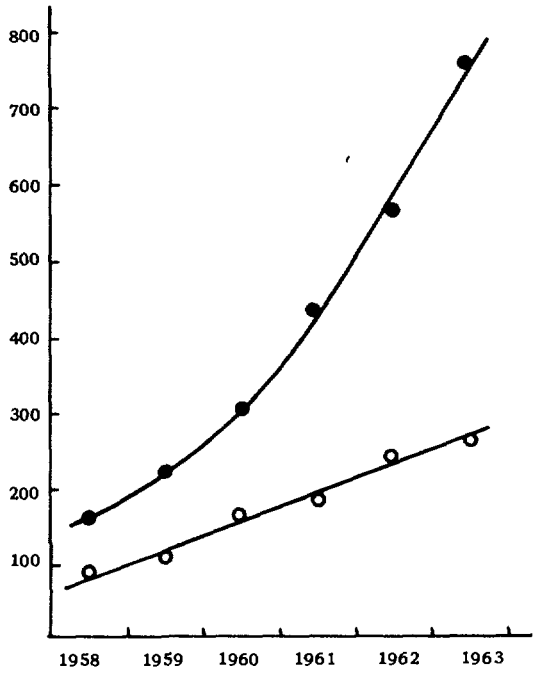

Fig. 1 Number of licences granted in a Latin American country to physicians to use radioactive isotopes (closed circles). Open circles indicate licences for therapy only.

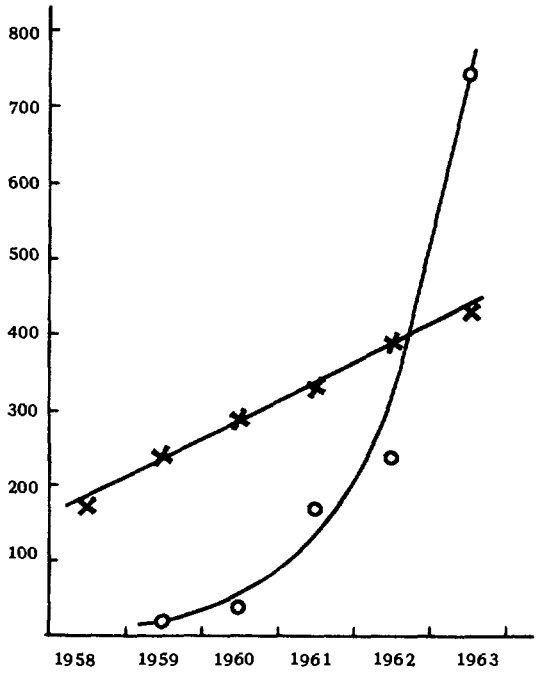

Fig. 2 Number of annual shipments of radioisotopes and labelled compounds for medical use by a European (crosses) and an Asian (closed circles) firm.

65. The technical assistance given is analysed in the relevant report; [30] it included 15 experts, 35 fellowships and a regional training course on medical isotope applications in the Philippines. The support given to this programme by technically advanced Member States is illustrated by the offers made by Austria and the Czechoslovak Socialist Republic to establish an international centre for nuclear medicine under the auspices of the Agency. These offers are at present under consideration by the Board.

66. The development of the Agency's research contract programme is illustrated by Table V below; the research topics are of special importance to the developing countries and were selected jointly with WHO.

Table V

Distribution of medical isotope research contracts by subject and by country

Research topic	Countries in which medical isotope research is being done with Agency support
Anaemia	Argentina, Ceylon, Ecuador, Republic of Korea, Nigeria, Romania, South Africa, Sweden, Turkey, United Arab Republic
Goitre	Australia, Austria, Belgium, Chile, Israel(2), Lebanon, Philippines, Spain
Parasitology	Ceylon, Colombia, Japan, Portugal, Thailand, Venezuela
Malnutrition	Belgium, Chile, Democratic Republic of the Congo, Guatemala, India(2), Jamaica, Mexico, Nigeria, Pakistan

With regard to malnutrition, the Agency is developing a special programme of co-ordinated research on the relationship between protein metabolism and malnutrition.

67. Recent advances in radioisotope sample measurement techniques in medicine and biology made it timely to hold a symposium on the subject in Vienna in May 1965. This complemented previous symposia of the Agency that dealt with the techniques for measuring radioactivity in human beings (such as the symposium referred to in the next paragraph). The symposium reviewed the recent progress in alpha-, beta- and gamma-ray measurement techniques, autoradiography, liquid scintillation counting techniques, computer applications, methods of activation analysis and application of solid state detectors.

68. A Symposium on Medical Radioisotope Scanning, held in Athens in April 1964, [31] had shown the very rapid progress made in developing new instruments and techniques for localizing radioisotopes in the human body. Since several scanning machines are being sent to Member States under the Agency's technical assistance programmes, a small research programme has been started in the Agency's medical physics laboratory to develop methods for evaluating the performance of scanning machines and to obtain fundamental physical data about their potentialities and limitations. The results of this work, which

[30] GC(IX)/INF/80.

[31] See document GC(VIII)/270, para. 14.

includes a simple method of testing collimators [32], will be transmitted to ICRU and incorporated in its standardization programme.

69. The most widely used of all diagnostic radioisotope techniques is to measure the uptake of radioiodine by the thyroid gland and thus see how efficiently the gland is functioning. In 1961 the Agency began a programme to achieve as much uniformity of techniques as possible so that the results obtained by various hospitals throughout the world could be more easily compared with each other. [33] This programme, which is summarized in Table VI below, was carried out by an expert from the Secretariat using calibration equipment developed by the Agency's medical physics laboratory.

Table VI

Number of hospital isotope laboratories participating in the Agency's thyroid uptake calibration project

Country	Number of hospitals	Country	Number of hospitals
Argentina	17	Netherlands	7
Australia	4	New Zealand	5
Austria	3	Pakistan	3
Brazil	10	Paraguay	1
Bulgaria	3	Peru	3
Chile	8	Philippines	5
China	1	Poland	7
Colombia	3	Portugal	5
Czechoslovak Socialist Republic	6	Spain	9
Ecuador	3	Sweden	7
El Salvador	1	Switzerland	7
Finland	13	Thailand	3
France	1	Tunisia	1
Greece	4	Turkey	2
Guatemala	1	United Arab Republic	4
Hungary	6	United Kingdom of Great Britain	
Iraq	1	and Northern Ireland	7
Israel	3	United States of America	3
Italy	8	Venezuela	5
Mexico	14	Viet-Nam	1
		Yugoslavia	10

70. A full report on the project will be published in 1966. In view of the wide variety of equipment and techniques used by hospitals, it is not surprising that, according to preliminary analyses, the errors found exceeded plus or minus 5 per cent in most of the participating laboratories. However, another intercomparison made between 15 laboratories in 13 countries of the results of chemical determinations of non-radioactive iodine plasma - another widely used test of thyroid function - has shown a similar lack of precision.

[32] Hine, G.J. and Vetter, H.: Evaluation of focussing collimator performance, Nuclear-Medizin 4, 333 (1965).

[33] See documents GC(V)/154, para. 101 and GC(VI)/195, para. 61.

71. More than 100 whole-body counters are, at present, in use in various countries chiefly for radiation protection work but also for certain medical research and diagnostic tests. The Agency receives many requests for advice on constructing and using these instruments. If they are designed only for diagnostic purposes, they can be much simpler and cheaper than the standard machines and more easily afforded even in the smaller developing countries. This and other aspects of the problem were discussed by a Panel on the Clinical Uses of Whole-Body Radioactivity Counting in Vienna at the end of June 1965. The medical physics laboratory has started certain fundamental measurements with its whole-body counter, and it is expected that the results will usefully supplement the information provided by the panel.

72. Electronic equipment given by France to the medical physics laboratory in March 1965 (and valued at $40 000) is being used to develop advanced techniques to determine, by neutron activation analysis, trace elements in biological samples. This technique will be used particularly to study trace element deficiencies in the blood of malnourished patients, the blood samples to be provided by Agency-assisted laboratories in countries where serious malnutrition is prevalent.

Dosimetry

73. The understanding of the mechanism of radiation effects on biological systems is impeded chiefly by:

(a) The complexity of the basic physical and chemical reactions in matter exposed to ionizing radiation. These reactions are very well understood in gases but not in liquids and solids; and

(b) The complex nature of the response of a living system to ionizing radiation. Interpreting the effects of radiation in terms of the so-called "dose-effect-relationship" is difficult.

74. Progress in radiation biology depends, therefore, on increasing our knowledge of radiation physics and radiation chemistry which are fundamental to all concepts of the interaction of radiation with living systems. Because of the interdisciplinary nature of this subject, the Agency brought together physicists and radiobiologists in a Panel on the Biophysical Aspects of Radiation Quality in Vienna in March 1965. The panel discussed new and promising progress in, for instance:

(a) The experimental and theoretical determination of dose-distribution on a microscopic scale;

(b) The interpretation of the dose-effect-relationship in terms of a generalized target-theory; and

(c) The kinetics of the radiation effect.

75. To meet the practical needs of health physicists and engineers, the Agency is helping to publish an up-to-date engineering compendium on radiation shielding. This will deal with all main problems in designing, constructing and supervising shielding against nuclear energy and is being written by a group of well-known experts.

Application of radiation sources in medicine

76. The principal medical application of radiation is in therapy and the number of radiocobalt and radiocaesium sources is rapidly growing, particularly in developing countries. The role the Agency can play in such countries was underlined by the offer of the Government of the Soviet Union to supply to developing Member States equipment for two complete medical radiological centres in 1965 and two in 1966 together with experts and facilities for training, and by the offers of the Governments of Hungary and Poland each to provide a radiological centre under the same conditions.

77. Besides the inter-regional adviser on the physical aspects of radiotherapy now working in the Eastern Mediterranean area, [34] the Agency has appointed a regional adviser to a number of countries in South-East Asia and the Far East.

78. As a service to hospitals, especially in the developing countries, the Agency and WHO convened a meeting of radiotherapists, hospital physicists and architects in Geneva in December 1964 to deal with questions such as:

(a) The organization of radiotherapy services in the framework of other hospital services; and

(b) The specific requirements for radiotherapy departments (accommodation, layout of building, equipment, radiation protection, staff).

79. Cancer is also treated with small radioisotope sources placed in suitable cavities in the body or implanted directly into the tumour. A panel on this subject which met in November 1963 [35] recommended particular attention to this type of therapy. A survey made by the Agency in 1964 has shown (see Table VII below) that, although certain types of cancer particularly susceptible to this therapy are more common in developing countries, 25 times more radium sources are available per capita in the technically advanced countries surveyed.

Table VII

Availability of radium for radiotherapy of cancer in advanced and developing countries

	Total population (in millions)	Total amount of radium (milligrams)	Milligrams of radium per million population
6 advanced countries	91	110 230	1 210
7 developing countries	87	4 154	48

80. The panel recommended that the new radiotherapy centres in developing countries should use radioisotope sources such as those made from Cs^{137}, Ta^{182} or Ir^{192} which are not only cheaper but also usually more suitable for implant therapy than radium tubes and needles. The work the Agency is doing in the meantime will be reviewed by a second meeting of the panel in 1966.

81. The Agency has set up a service to provide information, in the form of diagrams and data, at cost price [36], on the physical aspects of teletherapy and brachytherapy with radioisotope sources. Requests received from November 1963 to March 1965 are shown in the table below.

[34] See document GC(VIII)/270, para. 19.

[35] Ibid., para. 22.

[36] Ibid., para. 21.

Table VIII

Demands on the Agency's radiation data for medical use service

Type of information	Number of items requested
General physical data	17
Biophysical data	37
Discrete source data	213
Isodose charts	406
	637 (from 13 Member States)

82. The service aims to provide new data as soon as they are produced; this sometimes involves the use of digital computers and the Agency has started a programme of cost-free research contracts to obtain the data. The first contract was awarded to an institute in Sweden in November 1964.

83. The three atlases containing data on high energy radiation used in single-field, multiple-field and moving-field teletherapy [36] have been completed and the Agency will publish two of them during 1965.

2. Agriculture

The Joint FAO/IAEA Division of Atomic Energy in Agriculture

84. As a result of discussions between the Directors General of the Agency and FAO, [37] a Joint FAO/IAEA Division of Atomic Energy in Agriculture has been established and started work at the Agency's Headquarters on 1 October 1964. The object of the Joint Division is to develop a single joint programme for atomic energy on behalf of both agencies, and to ensure that the technical services of both are brought fully into the joint operations. Besides its responsibilities for scientific meetings, missions, training courses and publications concerned with atomic energy in agriculture, the Joint Division has scientific responsibility for agricultural projects in the technical assistance, research contract and Agency laboratory programmes. The single programme will be financed from the budgets of both agencies, from EPTA, the Special Fund, and from Trust Funds and other outside sources of support for work in this field.

85. The work of the Joint Division deals with:

(a) Soil fertility, irrigation and crop production;

(b) Plant breeding and genetics;

(c) Insect eradication and pest control;

(d) Pesticide residues and food protection;

(e) Animal production and health; and

(f) Food preservation.

Soil fertility, irrigation and crop production

86. The importance to crops of a proper use of fertilizers and an adequate amount of moisture in the soil is obvious, and the unique value of radiation and isotope techniques for

[37] Ibid., para. 152.

acquiring basic and practical knowledge in both these matters has often been pointed out. Fertilizer nutrients tagged with radioisotopes can be followed through the soil and into the plant and the efficiency of various types of fertilizers and of different rates, methods and times of applying them can be compared. The invention of the neutron moisture meter has made it unnecessary to carry out large numbers of laborious individual measurements of soil moisture; it has thus opened the way to intensive studies of the efficiency of various methods of using and conserving water, particularly important for farming in arid or semi-arid conditions.

87. The co-ordinated research programme on the application of isotopes and radiation in rice fertilization, started in 1962, and the similar programme on maize fertilization, started in 1963, have been described in previous reports [38]. The Joint Division is beginning a similar programme on the use of isotope and radiation techniques in soil moisture and irrigation studies in the Mediterranean region.

88. Some of the findings so far of the rice fertilization programme are: [39]

(a) That late application of nitrogen in a single dose results in better use of the fertilizer than its application during the early growing stages of the rice crop;

(b) That there is little advantage in several small rather than a single large application of the fertilizer during the growing period; and

(c) That the time when nitrogen is applied makes no difference to the uptake of phosphorus fertilizer unless the soil is very deficient in phosphorus; in this case late application of the nitrogen is best.

The plans for 1965 of this programme were drawn up at a meeting in Cairo in December 1964.

89. Under the maize programme, the first year's experiments compared methods of applying nitrogen fertilizer such as ploughing down, side-dressing, banding and combinations of these techniques. During the early growing stage of the plants, banding gave the best results (that is to say the highest uptake of nitrogen fertilizer). Later in the season the differences resulting from various techniques diminished. The plans for 1965 for this programme were drawn up at a meeting in Lima in January 1965.

90. Technical assistance in this and other agricultural subjects is described in the relevant report but reference may be made to the following training courses:

(a) Regional Training Course on the Application of Radioisotopes in Soil-Plant Relations, Piracicaba, Brazil, September/November 1964;

(b) International Course on the Use of Isotopes and Agricultural Biochemistry at the Agency's Laboratory, October/December 1964; and

(c) International Course on the Use of Radioisotopes and Radiation in Forestry Research, Hanover, Federal Republic of Germany, May/July 1965.

91. The co-ordinated research programme for the study of basic factors associated with plant nutrient supply and movements in the soil was reviewed by a meeting of the participating institutes and other experts in November 1964.

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[38] See documents GC(VI)/195, para. 62, GC(VII)/228, para. 66, and GC(VIII)/270, para. 24.

[39] See document GC(VIII)/270, para. 25, for some earlier findings on the use of phosphorus fertilizers.

Plant breeding and genetics

92. The FAO/Agency technical meeting on the Use of Induced Mutations in Plant Breeding [40], in Rome in May 1964, showed that the use of mutations chiefly induced by radiation has become an accepted means of breeding in a number of crop species. The main advantages of this technique are:

(a) It broadens the spectrum of variations thus giving the plant breeder a wider choice in selecting the agronomic traits he needs to develop new varieties;

(b) It is particularly effective in breaking an association of good and bad characteristics in a particular variety; and

(c) It is also particularly effective in transferring isolated beneficial characteristics from a wild relative to a commercial crop variety.

The problems now are chiefly to apply this technique effectively to major crops, to explore its use in additional crop species and to improve existing methods of producing and using induced mutations in breeding.

93. The Joint Division has started a co-ordinated programme of research on the use of induced mutations to improve rice crops. The programme is being carried out in five countries in South-East Asia and was reviewed at a meeting in Bangkok in February 1965. The support of the United Nations Special Fund is being sought.

94. The Joint Division is also supporting a more general research programme at 13 research institutes on methods of producing and using induced mutations in various major crop species. The programme was started in February 1965.

95. A third programme, to test mutant varieties of wheat and barley, has been organized jointly with the Field Crops Branch of FAO as part of the FAO Near East Wheat and Barley Improvement and Production Project.

Insect eradication and pest control

96. The joint FAO/Agency programme has concentrated on applying the sterile male technique to various insects of the order Diptera (flies), especially the Mediterranean fruit fly, the olive fly and, more recently, the tsetse fly. This technique is most effective when the total insect population has been naturally or artificially reduced - by cyclical variations or by measures such as spraying. It requires the artificial rearing of very large numbers of the insect which are then sterilized and thereafter released in the field. Before the insect can be reared, much preliminary study may be needed of its habits of life and nature. In some cases, such as the tsetse fly, the great number of species makes eradication especially difficult. Moreover, the tsetse fly, unlike most other flies, is viviparous (bears live offspring) and before the sterile male technique can be applied it may be necessary to breed an oviparous (egg-laying) type that can be mass reared and that can also mate effectively with the existing wild types. Long, complicated and costly research may thus be necessary before launching a field attack on any particular species of insect.

97. In the case of the Mediterranean fruit fly, which is the most destructive insect enemy of the fruit harvest and has migrated from Europe to Central America, the technique has been successfully developed and the problems that must now be solved are those of field application. The United Nations Special Fund has recently designated the Agency as Executing Agency for a $1.3 million project on eradication of this fly from parts of Central America. The purpose will be to demonstrate on a large scale (60 000 acres) that eradication is scientifically and economically feasible. The project will start in mid-1965 and last

[40] Ibid., para. 39.

three years. It will be carried out with the help of the Organismo Internacional Regional de Sanidad Agropecuaria - whose laboratory in Costa Rica will serve as the project's headquarters - and the Inter-American Institute of Agricultural Sciences.

98. The programme of research on the olive fly, carried out chiefly by a contractor in Greece, ran into initial difficulties in rearing the insect artificially. These have now been overcome but it has not yet been possible to proceed to a field experiment.

99. The problems of tsetse fly eradication, described above, are being investigated under the Agency's research contract programme.

Pesticide residues and food protection

100. The rapidly growing use of insecticides, herbicides and fungicides throughout the world presents hazards to man and nature that have been well publicized in recent years. Harm can result from extremely small quantities which may be very difficult to detect and analyse. A panel which met in Vienna in April 1965 confirmed the unique value of radioisotopes in the detection of pesticide residues and recommended various analytical procedures for such detection and control.

101. The Joint Division has continued FAO's earlier work of assessing the extent to which food has been contaminated as a result of radioactivity in the environment. At UNSCEAR's request data have been supplied for the years 1961, 1962 and part of 1963. A report covering the period 1961/1963 will shortly be published. These data are obtained by collecting and reviewing reports from countries in all parts of the world.

102. To further UNSCEAR's studies of radiosensitivity in man, the Joint Division and other divisions concerned will extend this review to cover the contamination of soil, herbage, human diet and human tissues by natural radioactive materials.

103. To review the progress made in methods of radiochemical analysis since the WHO/FAO meeting on this subject in 1958, a joint WHO/FAO/Agency meeting was held in September 1964. This meeting paid attention especially to methods of radiochemical analysis relevant to work on contamination and food processing.

Animal production and health

104. Radioisotope techniques provide an effective means for studying many research problems in animal husbandry, for instance certain aspects of nutrition, rumen and endocrine function, synthesis of milk, metabolic and other diseases. They are also useful in studying the influence of such factors as heat and high humidity on domestic animals. Such studies are expected to lead to more efficient production of animal products such as meat and milk.

105. An Agency/FAO symposium in Prague in November 1964 discussed the use of radioisotopes in animal nutrition and physiology. It gave special attention to studies of milk secretion, the role of trace elements in certain metabolic processes and the influence of environmental factors on animals. The symposium provided many examples of the value of tracers in studies of the nutrition and physiology of farm livestock and the problems of adapting domestic animals to unfavourable environments. A laboratory training manual on the use of isotopes and radiation in animal research will be published in 1965.

106. Helminth diseases, or worm infections, present a serious problem in animal and man, particularly in developing areas of the world where livestock production is severely affected. To prepare vaccines against helminths, the virulence of helminthic larvae must be attenuated and irradiation provides the only known means to this end. The Agency is continuing to support research in this field by means of research contracts.

Food preservation

107. Research during the last 15 years has shown the technical feasibility of using radiation to preserve food, by destroying insects or harmful microorganisms. Several foodstuffs, preserved by radiation, have now been licensed for public consumption in a number of countries (Canada, the Soviet Union and the United States). Radiation is generally used in conjunction with other methods of preservation such as refrigeration and it can, in some cases, achieve results beyond the reach of conventional techniques. It can, for instance, destroy pathogenic organisms that cause food poisoning; microorganisms in fresh meat and in dried or frozen goods; it can stabilize products such as bacon that cannot be sterilized without gross changes in quality by heat treatment; it can disinfest, that is destroy insects in foods such as smoked and dried fish, preserved fruits and vegetables; and it can delay deterioration, ripening or sprouting of fruits and vegetables.

108. The way is thus open to the commercial use of the process and future work tends to focus more on economic and technical aspects and on the steps needed to protect public health.

109. In April 1964, FAO, WHO and the Agency convened in Rome an Expert Committee on the Technical Basis for Legislation on Irradiated Food. Its work was taken further by a Panel on Microbiological Specifications and Testing Methods for Irradiated Foods, in Vienna in June 1965. It is hoped that the recommendations of these meetings will encourage Governments to adopt similar legislation on this subject, thus fostering the commercial development of food irradiation and, eventually, international commerce in irradiated food.

110. An Agency Panel on the Application of Food Irradiation in Developing Countries (Vienna, August 1964) recommended the establishment of food irradiation centres in developing countries, stressed the importance of training food irradiation scientists for such areas, and asked that special priority be given to research on preserving fish and marine products, disinfesting dried and smoked fish and preserving and disinfesting fruits and vegetables - all these being particularly important to the developing countries.

111. Drawing partly upon the panel's recommendations, the Joint Division has prepared four long-term co-ordinated research contract programmes aimed at:

(a) Minimizing the radiation dose required to preserve food, by sensitizing the most radioresistant microorganisms responsible for its deterioration;

(b) Increasing the radiosensitivity of noxious insects;

(c) Preventing undesirable changes in irradiated foods; and

(d) Solving some of the technical and technological problems of commercial food irradiation (for instance, radiation sources, packaging materials).

112. Research contracts in progress in seven countries have continued to give useful information on the radiosensitivity and radiosensitization of various microorganisms as well as on control by irradiation of food poisoning bacteria.

113. The Austrian Atomic Energy Society, ENEA and the Agency jointly started work in January 1965 on an agreed International Programme on Irradiation of Fruit and Fruit Juices. The programme is being carried out at the nuclear research centre of the Austrian Atomic Energy Society at Seibersdorf. The Agency is providing a full-time technical adviser, some fellowships, and may assign additional experts.

114. Following work begun in 1963 [41] special missions have studied the possible use of pilot irradiation plants to disinfest grain in Turkey and Argentina as well as grain, fruit and vegetable products in Lebanon. In June 1965 the Special Fund agreed to provide $564 500

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[41] Ibid., para. 43.

for the project in Turkey (the contribution of Turkey amounts to $985 000). A pilot plant using a cobalt-60 source to disinfest grain will be built and operated. The Secretariat has also given advice to Algeria in planning a research programme on food preservation.

Research and training in Yugoslavia

115. It will be recalled that in 1963 the Agency entered into a Plan of Operation with the Government of Yugoslavia for the extension of research and training facilities at the Institute for the Applications of Nuclear Energy in Agriculture, Veterinary Science and Forestry at Zemun, Yugoslavia. The central laboratory is now completed and occupied by the various sections, and research programmes have been initiated in soil fertility studies, plant breeding, animal production, nutrition and health protection. The training of scientists and technicians at the Institute has proceeded according to plan. It is expected that the construction of a certain amount of apparatus, laboratories and buildings will be completed during the third and final year of the project.

[41] Ibid., para. 43.

CHAPTER III. RESEARCH AND SERVICES IN THE PHYSICAL SCIENCES

1. Hydrology

116. The International Hydrological Decade, which started in January 1965 and in which the Agency is taking part, provides a useful means to spread the knowledge of modern hydrological techniques at a time when the world is becoming more aware of its mounting needs for water. Isotope techniques are being used in more countries and more types of hydrological study chiefly to:

(a) Measure the velocity and direction of groundwater flow, by injecting a short-lived radioisotope in a borehole;

(b) Trace groundwater inter-connections (natural or artificial radioisotope tracers may be used); and

(c) Determine areas of recharge and measure the recharge (both techniques (a) and (b) above are used together with a measurement of the concentration of naturally occurring and stable isotopes).

117. The Agency already provides an advisory and experimental service to Member States developing their water resources.[42] To co-ordinate this work and encourage co-operation between scientists of various countries, the Agency has fostered the creation of national or regional working groups which usually meet once a year. These meetings are not only very helpful to the participants, but also to the Agency in selecting subjects for research contracts [43].

118. An expert committee was convened in October 1964 in Vienna to discuss various approaches to the problem of measuring the volume of sand movement in rivers; isotope techniques are quite widely used to measure the direction and nature of movement, but have not yet been perfected for measuring quantitative movement. The participants then visited a site in Yugoslavia where this matter is being studied under an Agency research contract. While a commercially produced instrument to measure the discharge of suspended sediment in streams is at present being tried in the field, the Agency's Laboratory is studying the feasibility of a simpler system.

119. In October 1964 a panel examined the information obtained by the Agency/WMO project to measure the concentration of hydrogen and oxygen isotopes in precipitation at more than a hundred stations in various parts of the world.[44] The panel felt that the survey should be continued and that major rivers should be included. It believed that this work, which has already provided useful information, will be of great importance in helping to make use of variations - in both time and location - that occur in the amount and composition of radioactive and stable isotopes in the environment, and to investigate large-scale hydrological phenomena. These include the water balance of the continents, meteorological patterns within whole regions and relationships of various atmospheric layers to each other. The panel also recommended that the network of sampling stations should be expanded, especially over the oceans, and that the programme should include the measuring of isotopes in water vapour at various altitudes.

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[42] Ibid., para. 52.

[43] In 1964 the value of research contracts in hydrological subjects amounted to $60 000.

[44] See document GC(VIII)/270, para. 56.

120. In the Antalya (Turkey) hydroelectric and irrigation project of the Special Fund, in which the Agency is a sub-contractor of FAO [45], experts from the Secretariat have collected further information on the patterns of underground water in different parts of the region and of the areas from which the underground water is recharged. Deuterium, oxygen-18 and tritium analyses are being applied for this purpose.

121. The preliminary findings under the Special Fund project in the Azraq region of Jordan are that groundwater is moving very slowly or that there is considerable mixing with old stored water.[45] This project has been completed, but the study may be continued under another project in an adjacent area; if so, it is expected that more precise conclusions will make it possible to determine the technical and economic feasibility of future groundwater development in the region.

122. While no hard and fast conclusions can yet be drawn from the study of Lake Chala in Kenya [46], preliminary results suggest that it takes about two years for the associated underground water system to recharge the lake.

123. In Chile radioisotopes have been used, with the help of experts from the Secretariat, to find and measure leaks from a reservoir which is being built for a hydroelectric project. Radioisotopes were injected into boreholes to measure the velocity and direction of the flow of groundwater seeping from the reservoir.

124. One of the projects that is being carried out under the research contract programme is of special interest to those semi-arid and arid zones in the developing countries where a precise water balance must be struck, the amount of water used over a period must not exceed the amount received from precipitation - underground or other sources - and where there must be an exact accounting of the way in which the water is distributed. The research project consists of a series of quantitative studies of the water balance in a semi-arid setting, each study dealing with a small area having a different amount of vegetation cover. Isotope and conventional techniques are being used together in this investigation, which is the first of its kind and promises to provide an accurate and sensitive technique for measuring the water balance in any area.

125. The Agency's tritium laboratory is being used throughout the year in support of the work described in this section. A system for the analysis of C^{14} is being built at the laboratory in view of the potential usefulness of this isotope in groundwater studies.

2. Chemistry

126. The Agency has continued to concentrate on:

(a) Thermodynamics of nuclear materials;

(b) Reactor-based chemistry research, radiochemistry, and nuclear chemistry; and

(c) Industrial applications of radioisotopes and large radiation sources.

Thermodynamics of nuclear materials

127. Together with nuclear data, thermodynamic and other physico-chemical data constitute the fundamental knowledge needed for advanced nuclear technology. Thus, thermodynamic data, especially in high temperature regions, and knowledge of the vaporization processes of nuclear materials are essential for the design of advanced types of reactors and of plants for the chemical reprocessing of spent fuels.

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[45] Ibid., para. 54.

[46] Ibid., para. 52.

128. It is therefore necessary from time to time to assess the thermodynamic data that are currently available and to identify the areas, particularly in the high temperature regions, where they are lacking or where further investigation is needed. For this purpose the Agency held a panel in October 1962 [47] on the thermodynamic data of uranium-carbon and plutonium-carbon systems.

129. Another important fuel is uranium dioxide, but much has still to be learned of its fundamental physico-chemical properties. These were considered by the second and third panels in this series. The second, in March 1964 [48], concentrated on thermodynamic data, transport and other properties, while the third, in April 1965, concentrated on thermal conductivity and, in particular, the measurements made of thermal conductivity of uranium dioxide as affected by temperature, stoichiometry, particle size and radiation damage. The panel disclosed areas where further work is needed.

130. In the Monograph Series on Thermodynamics a manuscript on plutonium has been completed and will be published during the second half of 1965. Manuscripts on other elements are being prepared.

Reactor-based chemistry research, radiochemistry and nuclear chemistry

131. The Agency's regional meetings on research reactor utilization have stressed the important place that must be given to radioisotope production in drawing up programmes for research reactors. Lack of information about current isotope production processes and about internationally acceptable standards of purity makes this difficult for centres in the developing countries. The Agency has accordingly prepared a manual on radioisotope production designed especially for such centres. This gives general advice about how to start a radioisotope production programme and detailed information on 15 of the more important short-lived radioisotopes and how to produce them.

132. Analytical chemists are becoming more dependent upon radioactive techniques. Radioactivation analysis makes it possible to determine extremely low concentrations of individual elements. Isotope dilution analysis and labelled reagents are extensively used. Several analytical methods make use of the interaction between radiation and matter. These and other related topics provided the basis for a Symposium on Radiochemical Methods of Analysis held in Salzburg in October 1964.

133. Two regional study group meetings on research reactors were held in Bucharest and Bombay. The former dealt with irradiation techniques applied to chemistry research and is further described in paragraph 38 above; the latter dealt with chemical questions, such as fission chemistry, hot-atom chemistry, isotope production and activation analysis.

134. A great deal of attention is being given to the chemical effects of radioactive recoil atoms. This research is important for the study of radiation chemistry and radiation damage. In December 1964 the Agency held a Symposium on the Chemical Effects Associated with Nuclear Reactions and Radioactive Transformations to review progress. It was apparent that the theoretical side of the subject has advanced less than the experimental; sophisticated new techniques are furnishing a large amount of new experimental data.

135. The Mössbauer Effect is one of the few techniques whereby a strictly nuclear phenomenon gives information about the chemical state of a system. This technique is only a few years old but it has been developed very vigorously. The Agency held a Panel on the Application of the Mössbauer Effect in Chemistry and Solid State Physics in April 1965 to discuss the progress achieved and the probable directions of future advances, particularly

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[47] See document GC(VII)/228, para. 54.

[48] See document GC(VIII)/270, para. 58.

chemical applications, as well as the role which the Agency could play. The technique has the advantage of bringing together many scientific disciplines. The cost of the equipment is relatively small and the technique could thus be used as a means of fostering research in developing countries.

136. The study of exchange reactions is a branch of chemistry in which the use of isotopes has played a leading part. Much stress is now being placed on the study of fast exchange reactions, where nuclear magnetic resonance and ultrasonic relaxation spectroscopy are amongst the most frequently used methods of study. The Agency's Symposium on Exchange Reactions held in Brookhaven in June 1965 discussed modern as well as classical radiochemical methods.

137. Isotope techniques are used in many different ways to study the universe as well as the earth. One of the most interesting problems of cosmology is the origin of cosmic radiation - is it the sun or does it lie in other parts of the galaxy? One clue is the intensity of cosmic radiation at different distances from the sun and this can be measured with the aid of meteorites. Cosmic radiation produces different radioactive nuclides in meteorites and the measurement of these nuclides makes it possible to estimate the intensity of cosmic radiation along the path of the meteorite. The Agency's meteorite service now makes it possible for meteorites falling in Member States to be analysed as quickly as possible at qualified laboratories.

Industrial applications of radioisotopes and large radiation sources

138. To measure the economic benefits resulting from the industrial applications of radioisotopes the Agency made an international survey from 1962 to 1964. Twenty-four industrialized countries - apart from the Soviet Union and the United States which contributed information separately - took part in the survey. The survey showed that net world savings are of the order of $300-400 million a year or almost 0.1 per cent of the total industrial output of the world. Most of the savings result from the use of radioisotope instruments to control various industrial processes, ranging from ensuring the uniform thickness of steel plate to automation of oil refineries. The survey showed that almost 9000 such instruments were being used in 21 countries outside the Soviet Union and the United States.

139. The results of the survey were discussed by a study group in March 1964. There is clearly considerable scope for a wider use of all techniques, particularly in developing countries where they are at present little applied, and where industrialization will play such an important economic role. The Secretariat has accordingly arranged to provide an advisory service for Member States on all aspects of the industrial uses of isotopes, and to compile, on request, appropriate bibliographies and guides. It is also fostering the setting up of national organizations, where they do not already exist, to promote the industrial uses of isotopes. More attention will be given to this subject in the Agency's research contract programme.

3. Physics

Nuclear data

140. As a result of the setting up of the Agency's Nuclear Data Unit [49] good progress is being made in fostering exchange of information through the Agency between nuclear data specialists in North America, Eastern and Western Europe, Australia, Brazil, India and Japan, and the systematic collecting of data for compilation is being arranged. It is hoped that arrangements will be concluded in due course for exchange of data, in defined categories, with the nuclear data compilation centres in the Soviet Union and the United States and the one organized by ENEA.

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[49] Ibid., paras. 65 and 66.

141. The third meeting of the Agency International Nuclear Data Scientific Working Group was held in Warsaw in November 1964. Following its recommendations, the Agency is circulating a list of the main facilities in all parts of the world for measuring nuclear data and is reviewing, with the help of specialized consultants, certain chosen technical fields of data measurement. The first such review deals with the 2200 m/s neutron constants for fissile nuclei, whose values are fundamental to many reactor calculations. The Agency presented a paper on this subject at the Third Geneva Conference, and expects to publish a revision of these results, in greater detail, later in 1965. Generally speaking, the Warsaw meeting showed that good progress was being made in laying the groundwork for co-operation between centres in Eastern and Western countries as well as in other parts of the world.

142. A technical meeting on problems of compilation was held in Vienna in March 1965, and the fourth meeting of the International Nuclear Data Scientific Working Group will be held in Tokyo just before the ninth regular session of the General Conference.

Neutron diffraction

143. The research being carried out at the Institute of Nuclear Research, Swierk, Poland, under an Agency contract [50], has progressed to the point where the technique it is developing will be directly applicable to low flux research reactors of the type now running in many developing countries. This "variable-lambda" technique is a method using neutron time-of-flight measurements for studying the structure of crystals.

Pulsed neutron research

144. Pulsed neutron techniques offer an excellent tool for training in neutron and reactor physics at relatively low cost and therefore can be of much value to developing countries. The techniques are also useful in a wide range of research. The Agency will accordingly lend a small versatile pulsed neutron source to institutes in developing countries which have the personnel and facilities needed for such work. The source will be used under the supervision of Agency staff and should be of great help in starting or furthering reactor physics programmes in developing countries as cheaply as possible. Research is being carried out with the source in Yugoslavia under an Agency contract on anisotropic diffusion coefficients (one of the characteristics or properties of neutron diffusion).

145. The value and range of pulsed neutron techniques in research was shown at a symposium held on this subject in Karlsruhe in May 1965. Both theoretical and experimental aspects were discussed. Amongst other results the interpretation of pulsed source experiments in thermal multiplying systems showed the value of the technique.

Noise analysis in nuclear systems

146. The analysis of noise in reactors (fluctuations in the power of the reactor), a relatively new technique for studying the dynamics of chain-reactions, can also be used to investigate reactor physics parameters with very little perturbation of the quantities being measured. The method does not require the use of expensive instruments, is especially suitable for low background systems that operate at low power and may prove very useful in the Agency's research reactor programmes.

Inelastic scattering of neutrons

147. The third of the Agency's symposia on the Inelastic Scattering of Neutrons was held in Bombay in December 1964. While the earlier symposia in this series - in Vienna in 1960 and in Chalk River in 1962 - concentrated on equipment and techniques, the 1964 meeting dealt with experimental results and their interpretation. This change of emphasis reflects the general conclusion that neutron inelastic scattering provides indispensable information about the structural properties of solids and liquids.

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[50] Ibid., para. 68.

Fission research

148. Our understanding of the phenomenon of fission, fundamental to nuclear energy, has lagged far behind its practical applications to fission reactors. This lag becomes all the more important as attention turns to advanced power-breeder reactors. The first international conference concerned specifically with these problems was the Agency's Symposium on the Physics and Chemistry of Fission at Salzburg in March 1965. All aspects of theory as well as recent experimental studies were discussed, and areas that most need further research were indicated.

Ultra-high energy accelerator

149. The possibility of international co-operation in setting up an ultra-high energy accelerator centre was discussed at a meeting in Vienna of scientists from the Soviet Union, the United States and CERN in July 1964. The meeting noted that accelerators having an energy much above 300 GeV would be so costly that international co-operation might be desirable. The Director General was asked to keep in touch with the scientists and countries concerned.

International Centre for Theoretical Physics

150. The International Centre for Theoretical Physics started to operate in Trieste on 5 October 1964 with a four-weeks' Seminar on Theoretical Plasma Physics. Under the direction of Professor B. B. Kadomtsev (Soviet Union), Professor M. N. Rosenbluth (United States) and Professor W. B. Thompson (United Kingdom) (Scientific Secretary: Professor C. Oberman) the seminar attracted 63 participants from 19 countries and was very successful. The Agency is publishing the proceedings. In May and June 1965 a Seminar on High Energy Physics and Elementary Particle Physics was held at the Centre under the direction of Professor A. Salam, the Scientific Secretary being Professor C. Fronsdal. The seminar was attended by 129 participants from 25 countries.

151. The Agency, UNESCO and the University of Trieste are collaborating in providing training at the Centre at an Advanced School of Physics. Weekly internal seminars and lectures have also been held by scientists from the Centre and guest scientists from abroad.

152. Twenty-six scientists worked with the Centre during 1964-65 for periods from two to nine months. The research at the Centre in high energy elementary particles and plasma physics is reflected in about 80 publications which are being distributed in the form of preprints to 500 institutions throughout the world. For the academic year 1964-65 21 fellowships have been awarded for training and research at the Centre. The fellows came from Argentina, Austria, Bulgaria, Chile, Czechoslovak Socialist Republic, Federal Republic of Germany, Ghana (2), Greece (2), Iran, Iraq, Japan, Mexico (2), Netherlands, Pakistan (2), Poland, Romania and Yugoslavia.

153. The Scientific Council of the Centre met in June to review the scientific achievements of the first year of operation of the Centre, and to discuss the programme and activities planned for the academic year 1965-66.

CHAPTER IV. HEALTH, SAFETY AND WASTE MANAGEMENT

154. The Agency's work in health, safety and waste disposal must be adapted to the general development of atomic energy. It began with standards for the safe handling of radioisotopes and it has dealt since then with matters of general interest such as basic safety standards for radioactive protection, the organization of radioactive protection services and arrangements for monitoring of personnel. The Agency has also dealt with more specialized subjects such as the transport of radioactive materials, the management of radioactive wastes and monitoring of the environment. This specialization is likely to increase so as to respond effectively to the needs of Member States. Standards will be prepared for the safe operation of research and power reactors and detailed technical manuals on subjects such as the production of nuclear fuel decontamination and protective equipment. The management and disposal of radioactive waste will become a matter of intense concern in the years ahead. [51]

155. The spread of nuclear power also makes it essential to solve the problems that are arising in shipping irradiated fuel, such as designing suitable transport casks, arranging shipment through canals and on inland waterways and easier access to transit ports.

Basic Safety Standards

156. The Agency's Basic Safety Standards for Radiation Protection [52] have been revised to take into account recent ICRP publications as well as comments received from Member States and other international bodies on the practical experience gained with the first edition of these standards.

Transport Regulations

157. The Secretariat has endeavoured to develop general requirements for packaging, to establish criteria that may be applied to the safe transport of fissile materials and to improve methods for testing the safety of standard packages. This work has provided much more detailed information for designing standard packages that will be internationally acceptable. The results of this work have been incorporated into the revised edition of the Agency's Regulations for the Safe Transport of Radioactive Materials [53], published in May 1965.

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[51] In a paper presented at the Third Geneva Conference (W. G. Belter: Advances in Radioactive Waste Management Technology - its effect on the future U.S. nuclear power industry), it was estimated that the amount of high-level radioactive waste in the United States would increase as shown below:

	1970	1980	2000
Estimated installed nuclear power, MW(e)	5 000	40 000	734 000
Fuel irradiation level MWd/t	18 000	25 000	25 000
Volume of high activity waste (based on 760 litres high activity waste/ton U processed)			
Annual volume (m^3/year)	150	570	10 600
Accumulated volume (m^3)	680	3 400	83 600
Total Sr^{90} (megacuries)	40	340	6 700
Total fission products (megacuries)	3 000	20 000	530 000

[52] Safety Series No. 9; approved by the Board and published in 1962.

[53] Safety Series No. 6, revised edition; approved by the Board in June 1964.

158. The Agency is continuing to encourage the adoption of these Regulations by international and national authorities. They are being incorporated into the International Convention on the Transport of Goods by Rail, which is in force in 24 countries in Western and Eastern Europe and the Near East. It is also expected that several main radioisotope-producing countries, amongst them France and the United Kingdom, will shortly adopt the Agency's Regulations in their air transport systems, and that the International Air Transport Association will follow suit.

159. The United Kingdom Atomic Energy Authority has produced a film on the safe transport of radioactive materials for the Agency's series "Handle with Care".

Radioluminescent products

160. The Agency and ENEA are doing work on radioluminescent time pieces, with a view to publishing safety standards and methods of testing the safety of luminous dials. The Agency, ILO, WHO and ENEA are also studying the need for safety standards for other manufactured products containing radioisotopes.

Accidents and emergencies

161. The panel on maximum permissible doses to the public [54] held its second meeting in November 1964. It suggested a range of reference doses and discussed the possible associated biological risks that could result from such exposures. These reference doses could be used as one of the many factors that must be weighed in many practical decisions concerned with health and safety evaluation of nuclear installations and in selecting appropriate health protection actions in case of an emergency involving the public or in planning to protect the public from conceivable radiation accidents.

162. In May 1965 the composition of the panel was broadened to include a number of experts and a scientific secretary provided by WHO. It is believed that this step, besides marking close co-operation between the two agencies, will increase the authority of the panel's recommendations.

163. To help Member States deal with an emergency, the Agency and WHO held a Symposium on Personnel Dosimetry for Accidental High Level Exposure to External and Internal Radiation in March 1965. The symposium provided much information on recent advances in the techniques of measuring high-level radiation exposure.

164. The Agency, WHO and FAO are also revising the information distributed previously about the help that various Member States may be prepared to give if a nuclear accident takes place in another Member State.

165. Work on a manual on environmental monitoring in emergency situations has also been completed.

Radiological safety in establishments

166. In the past year the Agency has published Codes of Practice on the Provision of Radiological Protection Services (Safety Series No. 13) and on Personnel Monitoring (Safety Series No. 14). It is doing preliminary work with ILO and WHO on permissible levels of surface contamination in working areas, and is preparing a manual on the safe design and equipment of hot radiochemical laboratories. The Norwegian Institute for Atomic Energy has produced a film on personnel monitoring for the "Handle with Care" series.

167. The Agency, ILO and WHO are revising jointly the medical addendum to the manual on the Safe Handling of Radioisotopes published in 1961 (Safety Series No. 3).

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[54] See document GC(VIII)/270, para. 111.

Control of environmental contamination

168. The control of environmental contamination has also been dealt with by:

(a) A WHO/FAO/Agency panel in September 1964 to revise the WHO/FAO 1959 Manual on Methods of Radiochemical Analysis used in assessing the radioactive contamination of biological and environmental samples; and

(b) The publication of manuals on Methods of Surveying and Monitoring Marine Radioactivity (Safety Series No. 11) and on Environmental Monitoring in Normal Operations (Safety Series No. 15).

The manual on environmental monitoring in emergency situations (see paragraph 165) will also be relevant to this work. A manual is also being prepared on the safe handling of radioisotopes in hydrology.

Waste management

169. When the scope of work on the peaceful uses of atomic energy was still relatively small, wastes of very low specific activity could be discharged directly into the environment with little effect on the total radiation background. The growth of the nuclear industry and the adoption of more stringent rules of disposal and release are diminishing the amount that can be discharged in this way from any particular plant, and have stimulated research in, and experiments with, systems for treating and disposing of large volumes of low activity wastes. Much progress has also been made in the technology of converting high activity liquid wastes into inert solids.

170. For many years a number of technically advanced countries have been disposing of radioactive waste into the ground. Since this technique is of growing international interest the Agency will shortly publish a manual on this subject in the Safety Series.

171. Disposal of a growing volume of radioactive waste is beginning to pose grave problems to many countries that do not have suitable burial grounds. The Agency, together with other interested international bodies, is undertaking studies of the technical, economic and legal aspects of possible international burial grounds in Europe where the problem is most acute.

172. Many developing countries are encountering difficulties in safely treating and disposing of the wastes that their nuclear facilities are beginning to produce. The Agency has published a Code of Practice on the Management of Radioactive Waste produced by Radioisotope Users (Safety Series No. 12) especially designed to deal with the problems encountered by small isotope laboratories, agricultural research stations, etc. It is preparing a series of technical guide books on standard processes for treating waste, especially on a small scale, and has also sponsored studies designed to find cheaper means of small-scale processing and on the economics of waste management in general.

173. A manual has been prepared on techniques to control atmospheric pollution that may result from the operation of nuclear facilities.

174. The fundamental processes of dispersion and release of radioactive materials in the sea, fresh waters and the ground are being studied under various research contracts as well as by the Laboratory in Monaco.

175. The Agency has arranged for a number of Member States to exchange information on their research programmes in waste management and to publish the results of completed research.

Advisory service for Member States

176. To supplement the technical assistance given by field experts, the Agency, ILO and FAO have established a Joint Advisory Service on Radiation Protection and Waste Management. The joint service will be able to give advice on all problems of radiation protection and to deal with any necessary preparatory work before a technical assistance expert is sent into the field. The service will usually be provided by correspondence but brief visits by specialists on the staffs of the organizations or of consultants will be arranged when necessary. The Agency will provide the secretariat for the service and will process requests for advice. In the meantime the Agency's Secretariat has dealt with requests from Tunisia, Yugoslavia and Venezuela, the latter in connection with the general environmental monitoring programme needed for starting the IVIC reactor.

CHAPTER V. SAFEGUARDS

177. The past year was marked by increased optimism about the development of nuclear power in both the near and the more distant future. There has been corresponding awareness that nuclear materials produced in power reactors might increasingly add to the world stock of materials capable of use for development of nuclear weapons or their production.

178. During the year three significant developments in the Agency's safeguards system took place. First, a general revision of the Agency's safeguards system was accomplished by the Board by means of a Working Group on which all Board Members were invited to be represented. Second, requests to the Agency to apply safeguards to bilateral arrangements increased considerably, so that by now a significant number of the Member States of the Agency have accepted the Agency's safeguards with respect to particular nuclear activities within their jurisdiction. Third, and consequent upon these developments, the Secretariat's Department of Safeguards and Inspection was reorganized: the first Inspector General was appointed in September 1964 and the Division of Inspection, whose establishment had been proposed by the Preparatory Commission, was activated by merger with the Division of Safeguards into a new Division of Safeguards and Inspection.

Revision of the safeguards system

179. Following its earlier meetings in February and May 1964 the Working Group established by the Board to review the Agency's safeguards system [55] met in October 1964 and January 1965 to elaborate a revised system. After a total of 32 meetings a draft was completed and submitted to the Board. On 25 February the Board provisionally approved it, with some amendments, by a vote of 21 in favour, none against and two abstentions. As it had done in the case of the Agency's original safeguards system [56] and its extension [57], the Board has submitted the revised system to the General Conference for consideration and appropriate action [58]. The Board agreed that pending the final adoption of the new system, the Agency would negotiate further safeguards agreements on the basis of either the old or the provisionally approved system, depending on the preference of the Member States concerned.

Implementation of safeguards by the Agency

(a) Transfer of bilateral safeguards

180. Where the Agency assumed responsibility for applying safeguards to an existing bilateral arrangement, it did so by entering into a trilateral agreement with the States concerned. These safeguards transfer agreements are all substantially similar. They provide for "umbrella"-type safeguards arrangements, whereby the States concerned agree to notify to the Agency the transfer of - and thereby to submit to safeguards - particular items such as nuclear materials, facilities and equipment; they also provide that the Agency's safeguards will apply to all nuclear materials produced by the use of such safeguarded items. The Agency's safeguards will continue to apply even if such produced materials are later transferred to the State that originally provided the assistance.

181. On 1 July 1964, at the beginning of the reporting period, only one such safeguards transfer agreement was in force: that relating to the bilateral agreement between Japan and the United States. Four others had just been approved by the Board, namely those relating to agreements between the United States and Austria, Greece, Norway and the Philippines respectively.

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[55] See document GC(VIII)/270, para. 134.

[56] INFCIRC/26 - see document GC(IV)/108/Rev.1.

[57] INFCIRC/26/Add.1 - see document GC(VII)/235.

[58] Document GC(IX)/294.

182. During the past year the Board has approved ten further transfer agreements, relating to the agreements between the United Kingdom and respectively Denmark and Japan, and the United States and respectively Argentina, China, Iran, Israel, Portugal, South Africa, Thailand and Viet-Nam.

183. The Government of Sweden informed the Agency in June 1965 of its readiness to enter into consultations with the Agency and the Governments of the United Kingdom and the United States with a view to transferring to the Agency the safeguards under its bilateral agreements with these Governments; the Agency is arranging to enter into these consultations and is continuing others begun as a result of requests made during previous years. It may confidently be expected that several further bilateral agreements will be submitted to the Agency's safeguards within the near future.

(b) Agency projects

184. The Agency's safeguards were in the first instance applied to Agency projects, that is projects in Member States to which the Agency itself had given assistance, as distinct from bilateral arrangements. At the beginning of the reporting period the Agency was applying safeguards to three such projects:

(i) The FiR-1 (Triga II plus sub-critical assemblies) project in Finland;

(ii) The NORA joint project in Norway; and

(iii) The TRICO (Triga I) project in the Democratic Republic of the Congo.

185. During the year, safeguards on the previously approved Pinstech (AMF) project in Pakistan became active by the delivery of fuel to the reactor. The Mexican (Triga III) and the Yugoslav (Triga II) reactors were still under construction and no safeguards were being applied, pending completion of the reactors or delivery of fuel to them. In December 1964 the Board approved a project whereby title to approximately 3270 grams of 90% enriched uranium, which the United States had previously leased to Argentina, was transferred to that Government for use in the 5 MW RAEP reactor now under construction near Buenos Aires; since that material was already located in Argentina safeguards were immediately applied to it.

(c) Unilateral submissions

186. On 1 August 1964 the Agency's agreement with the United States for safeguarding the Yankee Nuclear Power Station and for continuing safeguards on three other reactors entered into force.[59] While this is at present the only arrangement under which the Agency is safeguarding nuclear activities in a Member State at the State's own request, the Government of the United Kingdom announced in June 1965 that it is prepared to place the two identical 538 MW(t) gas-cooled natural uranium reactors of the Bradwell Nuclear Power Station under Agency safeguards.

(d) Summary

187. Thus by 30 June 1965 the Board had approved a total of 24 safeguards agreements with 21 Member States,[60] which agreements covered or were expected to cover on their entry into force 40 reactors in operation, while six more would be covered as soon as their construction was completed; the aggregate thermal capacity of these reactors exceeds 1400 megawatts. The chart at the end of this chapter summarizes the significant numerical data about safeguards since the start of the Agency's programme.

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[59] INFCIRC/57.

[60] Argentina, Austria, China, Democratic Republic of the Congo, Denmark, Finland, Greece, Iran, Israel, Japan, Mexico, Norway, Pakistan, Philippines, Portugal, South Africa, Thailand, United Kingdom, United States, Viet-Nam and Yugoslavia.

Safeguards inspections

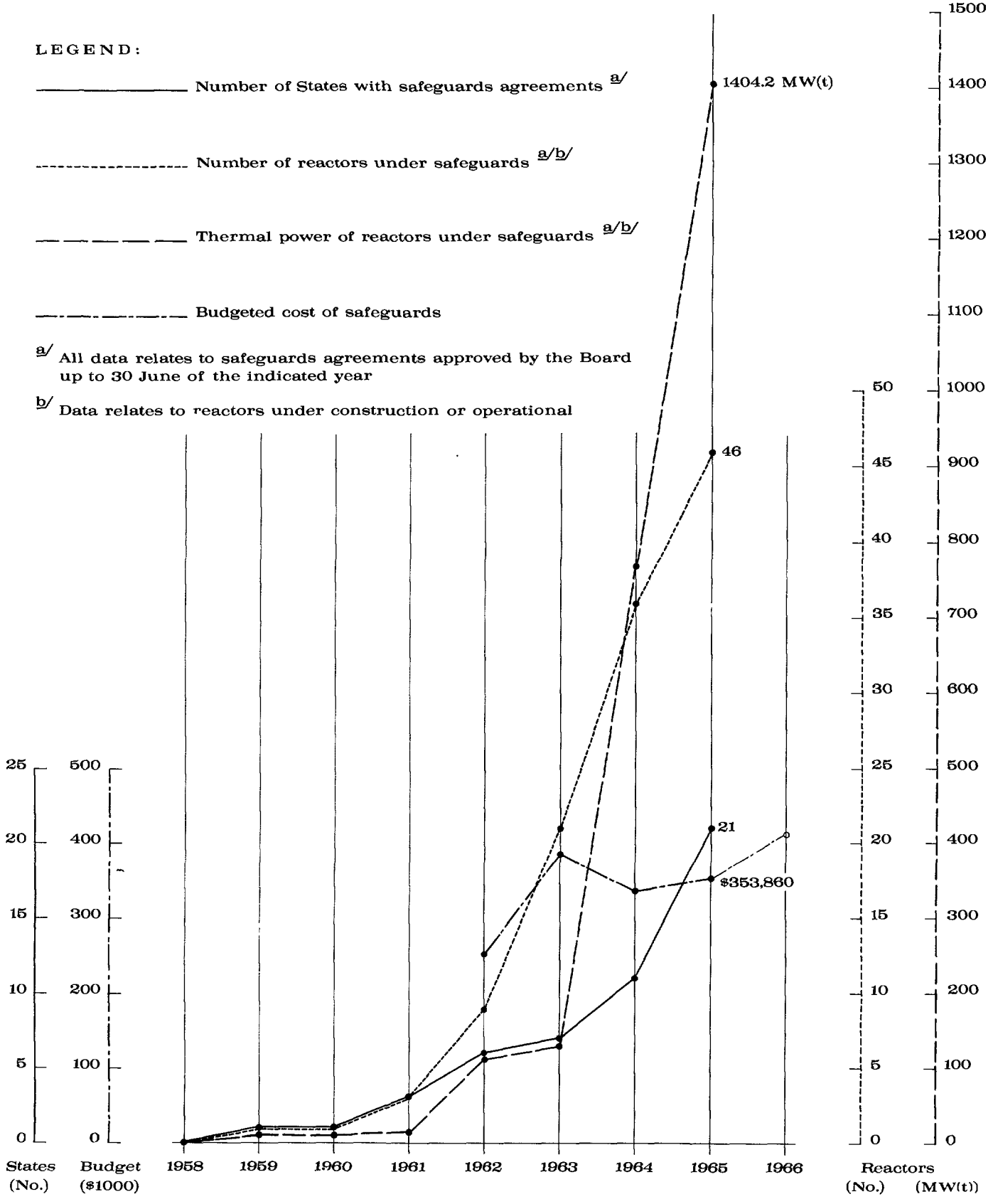
188. In implementing the safeguards provided for in the agreements mentioned in the above paragraphs, Agency inspectors during the past year carried out 15 inspections of 11 reactors in three Member States. In addition, in order to complete the arrangements for bringing into force or for implementing safeguards agreements, Agency officials carried out pre-operational visits to 23 facilities in 13 Member States with which safeguards agreements had been concluded or were under negotiation; as far as possible these trips were carried out in conjunction with travel on inspections.

189. In order to permit the Agency to carry out its responsibilities under the increasing number of safeguards agreements, the Board has authorized the use of 14 Agency officials as safeguards inspectors.

Research and development programme

190. In continuing its programme of improving techniques for carrying out safeguards, the Agency's emphasis has shifted in the past year from more or less theoretical studies to the development of practical devices. The purpose of this work is both to enable the Agency to improve the efficacy of inspections, that is the degree of probability with which any possible diversion would be detected, and to make the Agency's administration of safeguards as little burdensome as possible on Member States. To help to accomplish this objective the Agency has awarded two new research contracts: one to develop a monitoring device for fuel charge/discharge machines, which should assist in the safeguarding of nuclear materials in continuous-refuelling type reactors; the other to develop photovoltaic monitors for integrated reactor power determinations (i.e. measure the total amount of power generated over a period of time) so that the Agency may have an additional check on the actual power at which safeguarded reactors are operated. In addition, a research programme was initiated in the Agency's Laboratory at Seibersdorf aimed at developing a technique for the determination of integrated power in heavy-water reactors by measuring the increase in the tritium concentration in the heavy water.

GROWTH OF AGENCY SAFEGUARDS



CHAPTER VI. TECHNICAL ASSISTANCE

191. A detailed report on the technical assistance provided by the Agency in 1964 is being submitted separately. [61] The main trends are summarized in the paragraphs below.

192. As in previous years, the requests to the Agency for all forms of technical assistance have continued to grow in 1964 and to exceed the resources available. Voluntary contributions from Member States again failed to reach the target, and the financing of the Agency's regular technical assistance programme continues to be a serious problem. For 1964 $1 393 780 were pledged for a target of $2 million. Pledges for voluntary contributions for 1965 reached $1 210 751 by 30 June 1965. In addition to these voluntary contributions to the General Fund Member States have continued to donate equipment and to make contributions in kind to further the purposes of the Agency. Details of such donations and contributions are given in Annex V.

193. Data on Agency funds and EPTA allocations for technical assistance are given in Table IX below:

Table IX

Item	1959 $	1960 $	1961 $	1962 $	1963 $	1964 $
Target for voluntary contributions to the Agency General Fund	1 500 000	1 500 000	1 800 000	2 000 000	2 000 000	2 000 000
Amount pledged	1 183 044	996 103	1 261 200	1 380 470	1 437 394	1 393 780
Budgeted by the Agency for technical assistance	1 000 000	1 367 000	1 361 000	1 625 000	1 799 000	1 680 000
Funds available for Agency technical assistance	875 133	1 007 842	980 881	1 146 294	1 230 000	1 115 711
EPTA allocations for technical assistance[a]	306 556	639 362	808 614	843 259	1 049 000	1 050 500

a/ Including country, regional and contingency authorizations as well as administrative and operational services costs.

194. The trend noted in 1963 towards a greater volume and more variegated requests for technical assistance has continued, reflecting the progress of nuclear energy programmes in many Member States. In particular more requests are being made for assistance in reactor programming, reactor physics, radiochemistry, radioisotope production and irradiation techniques.

195. Further developments in the EPTA and regular programmes are shown in Tables X to XII below:

[61] GC(IX)/INF/80.

Table X

Experts and visiting professors

Year	Number	Cost[a/] $
1963	160	800 300
1964	178	991 200

Table XI

Equipment

Year	Cost[a/] $	Percentage of total regular programme	Percentage of regular EPTA programme	Value of "free" equipment $
1963	394 800	19%	25%	1 000
1964	640 200	22%	31%	71 000

Table XII

Fellowships

Year	Cost[a/] $	Total number	Type I	Type II	EPTA	Fellows on	
						Short-term courses	Research grants
1963	1 234 500	412	132	133	30	104	13
1964	1 414 700	533	149	144	48	180	12

a/ Including payments on prior years' obligations (but excluding unliquidated obligations on which payments will be shown as "costs" in subsequent years), and value of "free experts" and Type II fellowships.

196. The Agency has been acting as Executing Agency for two Special Fund projects: a project for nuclear research and training in Yugoslavia, and a pre-investment study on power, including nuclear power in Luzon in the Philippines.

197. During the first half of 1965 two further projects, for which the Agency will be Executing Agency, were approved by the Governing Council of the Special Fund: a project in Central America for the eradication of the Mediterranean fruit fly, and a pilot project in Turkey for radiation disinfestation of stored grain.

198. Details of the duration, total cost and Special Fund contribution to each project [62] are given in the following table.

Table XIII

Special Fund projects for which the Agency is Executing Agency

Country or region	Duration	Total cost of project $	Special Fund contribution $
1. Yugoslavia			
Nuclear research and training in agriculture	36 months (beginning in April 1963)	2 477 200	613 200
2. Philippines			
Pre-investment study on power, including nuclear power, in Luzon	27 months (beginning in February 1964)	700 500	477 500
3. Central America			
Eradication of the Mediterranean fruit fly	36 months (approved in 1965)	1 386 400	870 200
4. Turkey			
Pilot project for radiation disinfestation of stored grain	36 months (approved in 1965)	1 549 500	564 500

199. In addition, the Agency has acted as a sub-contractor to FAO under two Special Fund projects covering the use of radioisotopes in hydrology: one of these was designed to assist in the formulation of a long-term plan for the development of the Antalya region of Turkey in studying the groundwater systems in the region, and the other one dealt with developing information on the age of water in different strata of the Azraq region of Jordan.

Training courses

200. During the period under review the Agency organized nine training courses as part of its technical assistance programme. The data on these courses are shown in the table below:

[62] Further information on each project is given in the technical chapters in paras. 115, 25, 97 and 114 respectively.

Table XIV

Date	Title	Country
1964		
17 Aug to 24 Dec	Inter-regional Training Course on the Application of Radioisotopes in Engineering, Chemistry, Biology and Agriculture[a]	Japan
12 Sep to 6 Nov	General Radioisotope Course[a]	United Arab Republic (Cairo Centre)
14 Sep to 29 Sep	International Advanced Summer School on Reactor Physics	Poland
22 Sep to 13 Nov	Regional Training Course on the Application of Radioactive Isotopes in Soil-Plant Relations[a]	Brazil
19 Oct to 11 Dec	Inter-regional Training Course on the Applications of Radioisotopes in Medicine[a]	Philippines
26 Oct to 18 Dec	Inter-regional Training Course on the Use of Research Reactors for the Production of Radioisotopes and Activation Analysis[a]	India
28 Oct to 23 Dec	Inter-regional Training Course on the Use of Radioisotopes in Agricultural Biochemistry[a]	Austria
1965		
17 Apr to 10 Jun	General Course in Agricultural Application of Radioisotopes[a]	United Arab Republic (Cairo Centre)
11 May to 3 Jul	International Training Course on the Use of Radioisotopes and Radiation in Forestry Research[b]	Federal Republic of Germany

a/ Financed under EPTA.

b/ Co-sponsored by FAO.

201. During 1964 the Middle Eastern Regional Radioisotope Centre for the Arab Countries received $46 225 from EPTA through the Agency, which was spent on fellowships ($8525), equipment ($20 700) and the technical adviser and visiting professors ($17 000). The host country contributed 35 000 Egyptian pounds (approximately $80 500) while six participating Arab States pledged a total contribution of $13 500.

202. Further to General Conference Resolution GC(VIII)/RES/182 on scientific training of nationals of the developing countries, a panel of experts was convened in Vienna in April 1965. The panel voiced its general satisfaction with the role of the Agency in the world-wide advancement of the peaceful uses of atomic energy, and stated that it was impressed by the accomplishment of present programmes. It expressed the opinion that atomic energy research and its applications were most important in the fields of food and

power in the near future. In these and other fields it was suggested that opportunities should be taken of co-operating in training programmes with other United Nations agencies and regional organizations and collecting information on bilateral programmes, and that a pilot atomic teaching project for secondary schools might also be considered. The panel observed further that the Agency might give high priority to the allocation of its resources for training, and suggested that the Agency recognize the growing need for technician-level training (electronics, health physics and isotope techniques), and consider promoting training courses in developing countries. The panel recognized, moreover, that some developing countries have not yet begun atomic energy activities and suggested that the Agency co-operate in the training of teachers of the basic sciences by introducing courses in elementary atomic study.

203. The Director General presented a detailed report on the work of the panel to the Board in June, in which he also informed the Board that the Secretariat was studying the panel's recommendations with a view to ascertaining how far it might be desirable to modify existing programmes or to start new projects.

204. Pursuant to General Conference Resolution GC(VIII)/RES/176 requesting

> "The Board of Governors and the Director General, in consultation with the Scientific Advisory Committee and UNESCO, to study the possibility of issuing a publication encompassing, so far as possible, all disciplines related to the peaceful uses of atomic energy",

the Scientific Advisory Committee, at its meeting held in February 1965, felt that there was no real need for a nuclear energy encyclopaedia in view of the vast amount of material already available. It suggested, however, that the editors of some existing publications might be prevailed upon to produce special cheap editions so as to bring such works within the reach of a wider public including, for example, students.

205. With a view to achieving better integrated and more rationally organized programmes of technical assistance, all technical assistance activities within the Secretariat have been concentrated in the Department of Technical Assistance which was established on 1 February 1964. Since 1 January 1965 the Department is composed of a Programme Division which is divided into regional units and is responsible for planning, and an Implementation Division which administers the three elements of the programme: experts, training and equipment.

CHAPTER VII. ADMINISTRATION

1. External relations

The United Nations and the specialized agencies

206. The main co-operative undertaking between the Agency and the United Nations during the reporting period has been the Third Geneva Conference which is more fully discussed in Chapter I. Throughout the preparations and during the Conference itself the two secretariats worked closely together, and the Secretary-General of the United Nations has informed the General Assembly that the pattern of collaboration between the organizations which emerged from the meetings provided an example which he would hope to see followed in different contexts on future occasions.

207. The Agency has continued to work with the United Nations in more general questions of energy and power. The secondment of the Agency's staff member who has been working with the Resources and Transport Branch of the United Nations in New York has been extended until August 1965, and he is now dealing with co-operation between the two organizations in questions concerning desalination as well as energy [63]. The Agency also submitted a paper to the United Nations Inter-Regional Seminar on Energy Policy in Developing Countries, which was held at Bréau, France, from 3 to 18 May 1965.

208. In paragraph 84 above, information is given about the setting up of the Joint FAO/IAEA Division of Atomic Energy in Agriculture. As far as can be judged from experience since October 1964 the Joint Division is bringing about an effective pooling of the resources of both agencies, to their mutual advantage and that of their Member States. The Agency has also continued to work closely with FAO on various hydrological questions (isotope techniques in developments of water resources) which are not within the scope of the Joint Division.

209. With regard to co-operation with WHO the Board has reported to the Economic and Social Council that:

> During 1964 the Directors General of WHO and the Agency appointed technical liaison officers to serve at Agency and WHO headquarters respectively. In December the Directors General met in Vienna, when they reviewed co-operation between the two organizations, in particular the technical liaison arrangements. It was agreed that these arrangements should continue and that the closest possible co-operation should exist to promote common approaches to problems of mutual interest and to avoid any undesirable duplication of effort, so that the two organizations can be of the greatest possible service to their Member States. [64]

210. These liaison arrangements have proved helpful in settling a number of questions that have arisen between the two organizations. Insofar as medical application of radiation is concerned the Agency's work is concentrating increasingly on physical aspects of work with radioisotopes. With regard to radiation protection the two agencies are adopting a joint approach to the question of maximum permissible doses to the public (see paragraph 162 above) and it is hoped that this will lead to closer co-operation in other regulatory questions of mutual interest.

211. UNESCO has designated a member of the Scientific Council of the International Centre for Theoretical Physics in Trieste and contributed to the cost of fellowships, the secondment of professors and the organization of an Advanced School of Physics at the Centre. [65]

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[63] See document GC(VIII)/270, para. 155.

[64] INFCIRC/61, para. 26.

[65] See also para. 151 above.

212. The Agency is also working with UNESCO in the International Hydrological Decade (for instance, by collaborating in some of the proposed representative basin studies in providing isotope data) and with regard to implementing General Conference Resolution GC(VIII)/RES/182 on the scientific training of nationals of the developing countries. [66]

213. The Agency and ILO held a joint meeting on Radiological Protection in Mining and Milling of Radioactive Ores, in Geneva in May 1965, to review a draft manual of safe practice. The manual is the outcome of discussions at the joint Agency/ILO/WHO Symposium on Radiological Health and Safety in Nuclear Materials Mining and Milling (August 1963).

214. There have been consultations with IMCO about future co-operation in questions concerning nuclear-propelled merchant ships, particularly on regulations for the safety of harbours and narrow waters.

International Co-operation Year

215. Pursuant to General Conference Resolution GC(VIII)/175 the Board in February endorsed the following action in connection with the International Co-operation Year:

(a) The issue of a special number of the Agency's Bulletin in March. Fifty thousand copies of the main section of the bulletin dealing with co-operation in the peaceful uses of atomic energy are being distributed by United Nations Information Centres in various parts of the world;

(b) The bringing up to date of the Agency's film "The International Atom" produced in 1960;

(c) Co-operation with the United Nations in publicizing the twentieth anniversary of the United Nations in Austria; and

(d) Various other measures to co-operate with the United Nations in publicizing the work of the Agency.

Advisory Committee on the Application of Science and Technology to Development

216. In February 1965 the Agency submitted its first periodic report to the Advisory Committee containing six topics in research and development in nuclear energy, selected by the Secretariat as being of particular importance to developing countries. These topics are:

(a) The development of nuclear power for electricity production;

(b) The use of nuclear energy for desalting sea water;

(c) The use of nuclear techniques to develop water resources;

(d) The use of radiation to increase the storage life of food;

(e) The use of radiation to control or eliminate insect pests (with special reference to the tsetse fly); and

(f) The use of radioisotope techniques in research in tropical and endemic diseases (this section was prepared jointly with WHO).

[66] See also paras. 202 and 203 above.

217. This report to the Advisory Committee presented a detailed account of new scientific knowledge available under each of the topics, indicated promising lines of uncompleted research, and outlined the extent of application in developing countries of the new knowledge available and the work being carried out by the Agency.

218. The report to the Advisory Committee was reproduced in the annex to the Agency's annual report to the Economic and Social Council of the United Nations for 1964-65 [67]. The Agency also submitted a paper to the Advisory Committee on the savings that could be achieved by the use in the developing countries of various isotope and radiation applications in industry; this was given as an example of the benefits that could result from the more extensive application of an existing technology.

Regional matters

219. Pursuant to General Conference Resolution GC(VIII)/RES/179 the Director General approached the Secretary General of the Organisation of African Unity (OAU) in November 1964 with a view to starting consultations on a relationship agreement that would provide for co-operation between the Agency and the Scientific and Technical Research Commission of OAU. A draft of such an agreement has been sent by the Director General to the Secretary General of OAU.

220. Paragraph 113 above gives information about the co-operation between the Agency, ENEA and the Austrian Atomic Energy Society in carrying out a programme at Seibersdorf on the use of radiation for the preservation of fruit and fruit juices. The Agency is also working closely with ENEA on questions of health, safety and waste management (the two organizations will jointly sponsor a meeting on Practices in the Treatment of Low and Intermediate Level Radioactive Wastes in December 1965) and are jointly providing various standards and codes. ENEA is, moreover, considering accepting the Agency's Basic Safety Standards for Radiological Protection as the starting point for its own work. A member of the Secretariat is taking part in the meetings of ENEA's study group on the Long-Term Role of Nuclear Energy in Western Europe, and the two agencies are co-operating in plans for a symposium on magnetohydrodynamics in 1966.

221. The Agency has continued to help IANEC in carrying out its survey on the possibilities of using nuclear power in Latin America.[68] Experts from the Secretariat presented two papers at the Inter-American Conference on the Technical and Economic Aspects of Nuclear Power Generation in Latin America, which was held in Puerto Rico in February 1965; IANEC, for its part, is helping the Agency in the study of scientific training problems under Resolution GC(VIII)/RES/182.

222. The arrangement of stationing a regional officer for Asia and the Far East, in Bangkok, is being continued for another year on a trial basis.

2. Personnel

223. On 30 June 1965 the staff of the Agency at Headquarters was composed of 283 staff members in the Professional category and above, and 365 in the General Service category. The number of nationalities represented among that section of staff subject to geographical distribution was 46. In addition, there were five Professional staff members and eight General Service staff members at the International Centre for Theoretical Physics at Trieste and four Professional staff members and ten General Service staff members at the Laboratory at Monaco.

224. The organizational chart of the Agency's Secretariat below shows the structure of the Secretariat as at 30 June 1965.

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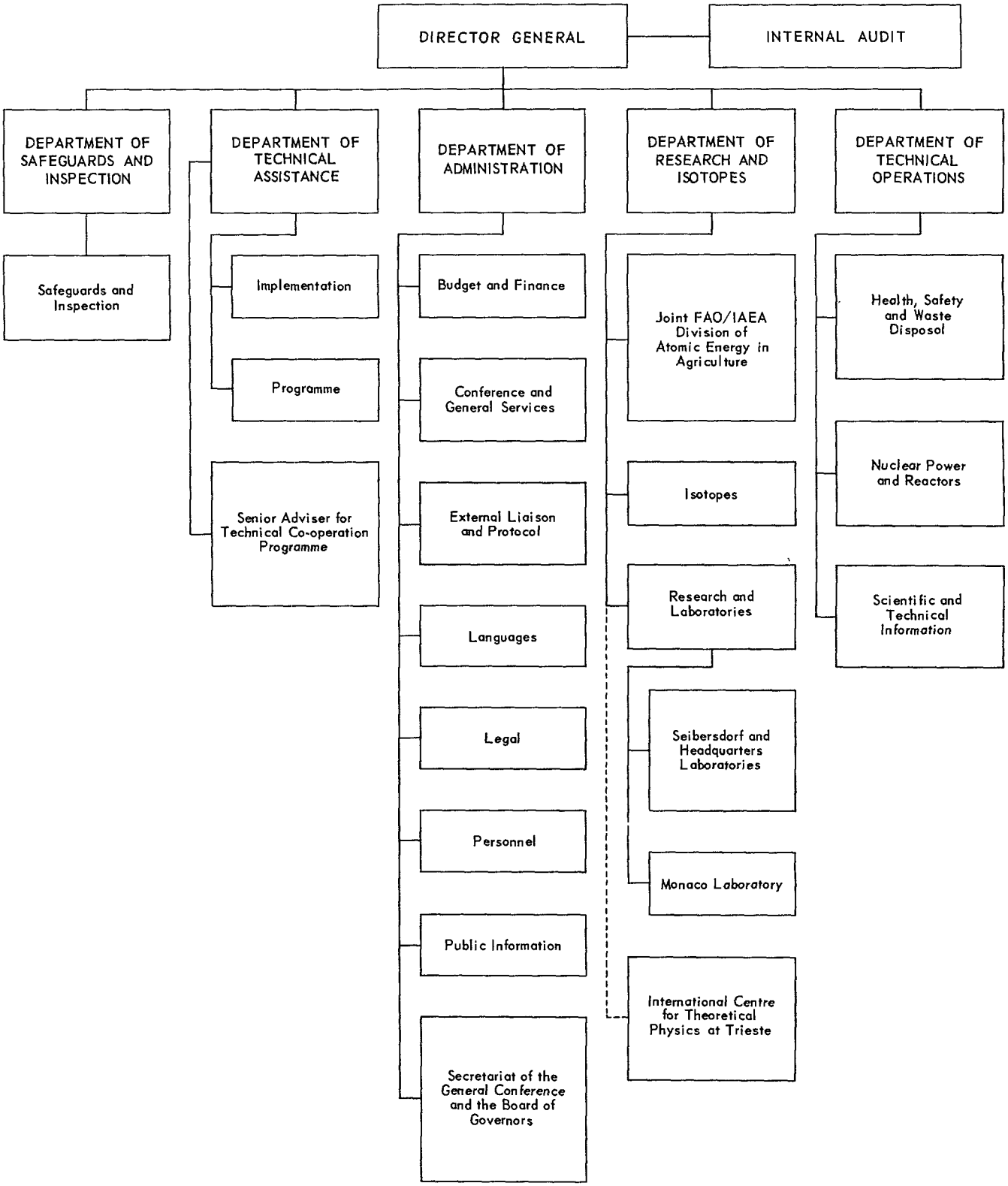
[67] INFCIRC/61.

[68] See document GC(VIII)/270, para. 157.

Organizational Chart



3. Finance

Regular Budget

(a) The financial year 1964

225. The assessment of contributions for 1964 of Member States included in the scale of assessment for that year amounted to $7 220 000; it was subsequently reduced to $7 195 618 by the retroactive reduction of the percentage assessment of the Czechoslovak Socialist Republic and Hungary for 1963 and 1964 [69]. The additional assessment of seven new Member States (Algeria, Cameroon, Gabon, Ivory Coast, Kuwait, Libya and Nigeria) increased the total by $34 656 to $7 230 274.

226. By 31 December 1964, the Agency had received contributions towards the Regular Budget for 1964 amounting to $6 605 083, which represents 91.35% of the total assessment. By June 1965 $6 737 789 or 93.19% of the total contributions due had been received.[70]

227. The Agency's obligations for 1964 amounted to $7 287 179 which resulted in budgetary savings of $157 321 from the appropriations for 1964. A further $46 452 from miscellaneous income and assessments on new Member States brought the total budgetary surplus at 31 December 1964 to $203 773, as follows:

Budgetary savings		$157 321
Contributions assessed on new Member States		34 656
Excess of miscellaneous income over budget:		
Actual miscellaneous income	$260 678	
Less: Budget (GC(VIII)/RES/169)	248 882	11 796
Budgetary surplus for 1964		$203 773

Although the budgetary surplus for 1964 was $203 773, contributions outstanding for the same year amounted to $625 191, leaving a provisional cash deficit of $421 418.

228. Unliquidated obligations in respect of 1964 appropriations at 31 December 1964 were $813 248, of which $361 028 had been liquidated by 30 June 1965.

229. In September 1964 the Board authorized the transfer of funds not exceeding $5000 as needed between appropriation sections. This authority was utilized to cover part of the salary increases for staff in the General and Maintenance and Operatives Services categories under Section 6 - Distribution of information ($2059) and Section 8 - Salaries and wages ($784), by reducing Section 9 - Common staff costs ($2843). In February 1965 the Board authorized an additional transfer of $31 050 from the appropriation for Common staff costs to the appropriation for Salaries and wages of the Regular Budget for 1964 for the increase in the Vienna post adjustment from class 1 to class 2 with effect from 1 September 1964.

(b) The financial year 1965

230. By 30 June 1965 the following advances to the Working Capital Fund and contributions to the Regular Budget for 1965 had been received:

Advances to the Working Capital Fund	$1 999 800
Contributions to the 1965 Regular Budget	$3 383 023

[69] General Conference Resolution GC(VIII)/RES/169.

[70] See Annex VI, part B, which shows outstanding contributions to the 1958, 1959, 1960, 1961, 1962, 1963 and 1964 Regular Budgets.

By that date Member States had thus paid 99.83% of the total advances due to the Working Capital Fund and 43.79% of the total contributions due to the 1965 Regular Budget.[71]

Operational Budget

231. Of a total amount of $1 310 980 pledged to the General Fund for 1964, $600 656 had been paid by 31 December 1964. By June 1965 the total pledged was increased to $1 393 780 and receipts amounted to $1 119 656, leaving a balance of $274 124 still to be paid. With regard to the target of $2 million set for 1964 by the General Conference at its seventh regular session, there was a shortfall of approximately $600 000 in the actual pledges made by Member States.

232. The total operational obligations incurred during 1964 amounted to $1 766 486. Unliquidated obligations at 31 December 1964, including obligations brought forward from previous years, amounted to $990 608.

233. The total amount pledged to the General Fund for 1965 at 30 June 1965 was $1 210 715 of which $398 244 had been paid by that date.[72]

The Agency's resources in 1964

234. Resources equivalent to almost $12 300 000 were at the Agency's disposal during 1964 under its own programmes, EPTA, Special Fund projects and other Special Projects, including contributions in cash, services and in kind. Details concerning these resources are set out in Table XV below:

Table XV

Resources at the disposal of the Agency in 1964

		$	$
Administrative Fund			
Assessed contributions to the Regular Budget			
Member States included in the scale of assessment for 1964		7 195 618	
New Members		34 656	7 230 274
Actual miscellaneous income			260 678
General Fund			
Voluntary contributions to the General Fund			1 310 980
Other voluntary contributions:			
For Trieste Centre	Italy	278 000	
	Denmark	2 405	
	South Africa	1 400	
	Switzerland	4 630	
For Monaco Laboratory:	Monaco	40 816	327 251
Miscellaneous income (from investments, laboratory, local project costs, exchange difference)			152 795
Income from United States Atomic Energy Commission			34 105

[71] Ibid., Parts A and C.

[72] Ibid., Part D.

	$	$
Publications Revolving Fund		
Expenditure including unliquidated obligations in 1964		70 995
Special Accounts		
Saudi Arabian Project Trust Fund		24 100
Joint Research Programme of the Agency and the United States Atomic Energy Commission		204 189
Special fellowships offered by the Government of the Soviet Union		-
United Nations Korean Reconstruction Agency Residual Fund		7 000
EPTA		
Earmarkings from contributions and other available funds in 1964		1 050 523
Special Fund		
Funds allocated during 1964		535 840
Contributions in services and in kind		
Research contracts		204 189
Type II fellowships awarded		621 050
Technical assistance equipment and supplies		89 500
Laboratory equipment and supplies		108 982
Library, etc.		13 646
Special nuclear materials		50 000
Total resources		12 296 097

4. Legal matters

235. By 1 June 1965, 311 agreements concluded by the Agency had entered into force and had accordingly been registered with the Agency, in implementation of Article XXII.B of the Statute [73]. Of these, 77 were registered during the period covered by this report and seven were registered with the United Nations pursuant to Article 102 of its Charter. A list of all the agreements registered up to 31 December 1964 has been published as Volume 3 of the Agency's Legal Series.

236. The following States have signed the Vienna Convention on Civil Liability for Nuclear Damage: China, Colombia, Cuba, Philippines, Spain, the United Kingdom and Yugoslavia. The Optional Protocol has been signed by China, Colombia, Philippines, the United Kingdom and Yugoslavia. An Instrument of Acceptance in accordance with Article XXIV, paragraph 1, of the Convention has been deposited by Cameroon.

237. In relation to Resolution GC(VIII)/RES/177 adopted by the General Conference in 1964, in February 1965 the Board considered a draft of a multilateral agreement on emergency assistance in the event of radiation accidents setting out the administrative, financial and legal terms on which such assistance could be given. The draft was subsequently circulated to all Member States for comment, and is being revised to reflect the comments received.

[73] INFCIRC/12.

5. Public information

238. The public information services of the Third Geneva Conference functioned under the general supervision of and largely with staff provided by the Agency. The service rendered to the 450 representatives of the press and other information media contributed to the world-wide publicity given to the nuclear energy problems in general and to the Agency's activities in particular.

239. During the first half of 1965, the main emphasis has been placed on the various aspects of the Agency's contribution to the International Co-operation Year. Special attention has been given furthermore to the selected topics in research and development in nuclear energy which are of particular importance to developing countries.

ANNEX I

THE BOARD OF GOVERNORS

To 18 September 1964	1964 - 1965	From 18 September 1964
	Afghanistan[a]	
	Argentina[b/c]	
	Australia[b/d]	
		Belgium[e]
	Brazil[d/f]	
	Canada[b/d]	
		Chile[c]
	China[a]	
	Congo, Democratic Republic of[a]	
Czechoslovak Socialist Republic[g]		
		Finland[e]
	France[b/d]	
	India[b/d]	
Indonesia[f]		
Iran[f]		
Italy[f]		
	Japan[b/d]	
Mexico[f]		
	Morocco[a]	
		Netherlands[c]
Norway[g]		
		Poland[e]
Portugal[g]		
	Romania[a]	
	South Africa[b/d]	
	Switzerland[a]	
		Thailand[c]
	Union of Soviet Socialist Republics[b/d]	
		United Arab Republic[c]
	United Kingdom of Great Britain and Northern Ireland[b/d]	

To 18 September 1964	1964 - 1965	From 18 September 1964
	United States of America[b/d/]	
	Uruguay[a/]	

a/ Elected by the General Conference on 1 October 1963 under Article VI.A.3 of the Statute.

b/ Designated by the Board on 21 June 1963 under Article VI.A.1 of the Statute.

c/ Elected by the General Conference on 18 September 1964 under Article VI.A.3 of the Statute.

d/ Designated by the Board on 10 June 1964 under Article VI.A.1 of the Statute.

e/ Designated by the Board on 10 June 1964 under Article VI.A.2 of the Statute.

f/ Elected by the General Conference on 26 September 1962 under Article VI.A.3 of the Statute.

g/ Designated by the Board on 21 June 1963 under Article VI.A.2 of the Statute.

ANNEX II

NUCLEAR POWER STATIONS IN MEMBER STATES

(in operation, under construction and planned for commissioning during the present decade)

Name	Location	Type	Net output (MW(e))	Criticality date
A. POWER REACTORS IN OPERATION				
(1) Belgium				
BR-3	Mol	Press. H_2O, 3.7 + 4.4% U	10.5	Aug 1962
(2) Canada				
NPD	Rolphton	Press. D_2O, nat. U	20	Apr 1962
(3) France				
G-1	Marcoule	Nat. U, graphite, air	1.7	Jan 1956
G-2 (G-3)	Marcoule	Nat. U, graphite, CO_2	2 x 35	Jul 58/Jun 59
EDF-1	Chinon	Nat. U, graphite, CO_2	68	Sep 1962
EDF-2	Chinon	Nat. U, graphite, CO_2	198.5	Aug 1964
(4) Germany, Federal Republic of				
KAHL	Grosswelzheim/ Kahl (Main)	Boiling H_2O, 2.6% U	15	Nov 1960
(5) Italy				
LATINA	Latina	Nat. U, graphite, CO_2	200	Dec 1962
SENN	Sessa Aurunca	Boiling H_2O, 2% U	150	Jun 1963
SELNI	Trino Vercelleze	Press. H_2O, 2.6% U	270	Jun 1964
(6) Japan				
JPDR	Tokai-Mura	Boiling H_2O, 2.5% U	11.7	Aug 1963
TOKAI-MURA	Tokai-Mura	Nat. U, graphite, CO_2	158	May 1965
(7) Sweden				
R-3/ADAM	Agesta	Press. D_2O, nat. U	9	Jul 1963

Name	Location	Type	Net output (MW(e))	Criticality date
(8) United Kingdom				
CALDER HALL	Calder Hall	Nat. U, graphite, CO_2	4 x 45	May 56/Dec 58
CHAPELCROSS	Chapelcross	Nat. U, graphite, CO_2	4 x 45	Oct 58/Dec 59
DFR	Dounreay	Fast breeder, 45.5% U, NaK	15	Nov 1959
BERKELEY	Berkeley	Nat. U, graphite, CO_2	2 x 138	Aug 61/Mar 62
BRADWELL	Bradwell	Nat. U, graphite, CO_2	2 x 150	Aug 61/Apr 62
AGR	Windscale	2.5% U, graphite, CO_2	27.3	Aug 1962
HUNTERSTON	Hunterston	Nat. U, graphite, CO_2	2 x 170	Sep 63/Apr 64
HINKLEY POINT	Hinkley Point	Nat. U, graphite, CO_2	2 x 250	May 64/late 64
TRAWSFYNYDD	Trawsfynydd	Nat. U, graphite, CO_2	2 x 250	Sep 64/Dec 64
(9) United States of America				
EBWR	Lemont	Boiling H_2O, 1.5 + 90% U	4.5	Dec 1956
SM-1	Fort Belvoir	Press. H_2O, 93% U	1.9	Apr 1957
SRE	Santa Susana	Graphite-sodium, 90% U + Th	5.1	Apr 1957
VBWR	Pleasanton	Boiling H_2O, 2-5% U	shut-down '63	Aug 1957
SHIPPINGPORT	Shippingport	Press. H_2O, nat. + 93% U	60	Dec 1957
DRESDEN	Dresden	Boiling H_2O, 1.5% U	208	Oct 1959
YANKEE	Rowe	Press. H_2O, 3.4% U	175	Aug 1960
PM-2A	Greenland	Press. H_2O, 93% U	1.5	Oct 1960
BORAX-5	Idaho Falls	Nucl. superheat, 5 + 93% U	2.7	Feb 1962
PM-1	Sundance	Press. H_2O, 93% U	1.0	Feb 1962
PM-3A	Antarctica	Press. H_2O, 93% U	1.5	Mar 1962
SM-1A	Alaska	Press. H_2O, 93% U	1.7	Mar 1962
SAXTON	Saxton	Press. H_2O, 5.7% U	3.3	Apr 1962
INDIAN POINT	Indian Point	Press. H_2O, 93% U + Th	255	Aug 1962
HNPF	Hallam	Sodium-graphite, 3.6% U	75	Aug 1962
BIG ROCK POINT	Charlevoix	Boiling H_2O, 3.2% U	75	Sep 1962

Name	Location	Type	Net output (MW(e))	Criticality date
(9) United States of America (cont'd)				
ERR	Elk River	Boiling H_2O, 93% U + Th	20	Nov 1962
HUMBOLDT BAY	Eureka	Boiling H_2O, 2.6% U	50	Feb 1963
CVTR	Parr	Press. D_2O, 1.5 + 2.0% U	17	Mar 1963
PNPF	Piqua	Organic, 1.9% U	11.4	Jun 1963
ENRICO FERMI	Laguna Beach	Fast breeder, 25% + nat. U	60.1	Aug 1963
EBR-2	Idaho Falls	Fast breeder, 49% + nat. U, Na	16.5	Nov 1963
NPR	Richland	0.9% U, graphite, H_2O	776	Dec 1963[a/]
PATHFINDER	Sioux Falls	Nucl. superheat, 2.2 + 93% U	58.5	Mar 1964
BONUS	Punta Higuera	Nucl. superheat, nat. + 3% U	16.3	Apr 1964
(10) Union of Soviet Socialist Republics				
APS	Obninsk	5% U, graphite, H_2O	5	May 1954
SIBERIAN	Troitsk	Nat. U, graphite, H_2O	600 (6 x 100)	Sep 58/Dec 62
URAL I.	Beloyarsk	Nucl. superheat, 1.3% U	94	Sep 1963
WWER I.	Novo Voronezh	Press. H_2O, 1.5% U	196	Dec 1963
TES-3	Obninsk	Press. H_2O, enr. UO_2	1.5	1961
ARBUS	Melekes	Organic, 36% UAl_4 + Al	0.75	Jun 1963
VK-50 (Ulyanovsk)	Melekes	Boiling H_2O, 1.5% U	70	Apr 1965
B. POWER REACTORS UNDER CONSTRUCTION				
(1) Canada				
CANDU-PHW-200	Douglas Point	Press. D_2O, nat. U	203	1966
(2) Czechoslovak Socialist Republic				
HWGCR	Bohunice	Nat. U, D_2O, CO_2	150	1968
(3) France				
EDF-3	Chinon	Nat. U, graphite, CO_2	375	1965
EL-4	Monts d'Arrée	Enr. U, D_2O, CO_2	80	1966
EDF-4	Saint Laurent des Eaux	Nat. U, graphite, CO_2	480	1967

Name	Location	Type	Net output (MW(e))	Criticality date
(3) France (cont'd)				
SENA	Chooz[b/]	Press. H_2O, 3.1% U	266	1965
(4) Germany, Federal Republic of				
AVR	Jülich	Pebble bed, 90% U, Th, graphite, He	13.2	1965
KRB	Gundremmingen	Boiling H_2O, enr. U	237	1966
MZFR	Karlsruhe	Nat. U, press. D_2O	50	1965
KWL	Lingen	Boiling H_2O, fossile superheat, enr. UO_2	250	1968
KBWP	Obrigheim	Press. H_2O, 3% UO_2	283	1968
HDR	Grosswelzheim/ Kahl (Main)	Boiling H_2O, nucl. superheat, enr. UO_2	25	1968
(5) India				
TARAPUR	Tarapur	Boiling H_2O	2 x 190	1968
RAJASTHAN (first unit) (CANDU type)	Rana Pratap Sagar	Press. D_2O, nat. U	200	1969
(6) Netherlands				
GKN	Dodewaard	BWR ("direct cycle")	47	1968
(7) Spain				
ZORITA DE LOS CANES	Zorita de los Canes	Press. H_2O	140	1968
(8) Sweden				
R-4/EVA	Marviken	Boiling D_2O, nat. U	200	1968
(9) Switzerland				
LUCENS	Lucens	1% U, D_2O, CO_2	7.5	1966
(10) United Kingdom				
DUNGENESS A	Dungeness	Nat. U, graphite, CO_2	2 x 275	1964/65
SIZEWELL	Sizewell	Nat. U, graphite, CO_2	2 x 289	1965
OLDBURY	Oldbury	Nat. U, graphite, CO_2	2 x 300	1966
SGHWR	Winfrith	1.4% U, D_2O, boiling H_2O	93	1967
WYLFA	Wylfa	Nat. U, graphite, CO_2	2 x 590	1968/69

Name	Location	Type	Net output (MW(e))	Criticality date
(11) United States of America				
EGCR	Oak Ridge	2.5% U, graphite, He	21.9	1965
HTGR	Peach Bottom	93% U + Th, graphite, He	40	1965
LACBWR	Genoa	3.4% U, boiling H_2O	50	1965
SAN ONOFRE	Camp Pendleton	3.6% U, press. H_2O	375	1967
CONNECTICUT YANKEE	Haddam Neck	3-4% U, press. H_2O	462	1967
JERSEY CENTRAL	Oyster Creek	Boiling H_2O,	515	1968
NINE MILE POINT	Oswego, N.Y.	Boiling H_2O	500	1968
(12) Union of Soviet Socialist Republics				
WWER-II	Novo Voronezh	Press. H_2O, 1.5% U	365	1965
URAL-II	Beloyarsk	Nucl. superheat, 1.3% U	200	1965
BN-350	Shevchenko (Caspian Sea)	Fast breeder, 23% UO_2 + Pu, Na	350	-
C. POWER REACTORS PLANNED				
(1) Austria				
AUSTRIA	-	Press. H_2O, enr. UO_2	15	-
(2) Brazil				
GUANABARA	Guanabara	Nat. U, graphite, CO_2	300	1969
(3) Canada				
CANDU-PHW-500	Pickering	Press. D_2O, nat. U	2 x 500	1970-71
CANDU-BLW-250	Quebec	Nat. U, D_2O, boiling H_2O	257	1971
(4) China				
KAOSHIUNG	Kaoshiung	-	300	1971
(5) France				
EDF-5	Saint Vulbas	Nat. U, graphite, CO_2	500	1970/71
(6) Germany, Federal Republic of				
KKN	Niederaichbach	D_2O, CO_2, press. tube type, UO_2 1% enr.	100	1968/69
KNK	Karlsruhe	ZrH, Na, enr. UC_2 or UO_2	20	1968/69

Name	Location	Type	Net output (MW(e))	Criticality date
(7) India				
RAJASTHAN (second unit) (CANDU type)	Rana Pratap Sagar	Press. D_2O, nat. U	200	-
MADRAS (CANDU type)	Kalpakkam (near Madras)	Press. D_2O, nat. U	2 x 200	-
(8) Japan				
TSURUGA	Tsuruga	Press. or boiling H_2O	300	1969
(9) Pakistan				
HWR 132	Buleji Beach	Nat. U, press. D_2O	132	1969
East Pakistan	Rooppur	Press. H_2O, enr. UO_2	70	1968
(10) Spain				
BILBAO-EBRO	Tobalina	-	250	1968
CASTREJON	Castrejon	-	250	1970
SANTA MARIA LA GARONA	Santa Maria la Garona	-	300	1970
ZORITA II	Zorita de los Canes	-	300	1970
DON	Alberche River	D_2O, organic nat. U	30	-
MARISMAS	Marismas, near Seville	-	250	1972
(11) Switzerland				
NOK	Döttingen	-	300	1969
BKW	Berne	Press. H_2O, enr. UO_2	250	-
(12) United Arab Republic				
ALEXANDRIA	Alexandria	-	150	-
(13) United Kingdom				
DUNGENESS B	Dungeness	Graphite, enr. U, CO_2	2 x 600	1970 (first reactor commissioning)
(14) United States of America				
LADWPR	Malibu Beach	3.8% U, press. H_2O	463	1968
DRESDEN II	Dresden	Boiling H_2O	714	1969

a/ Reactor critical, power generation scheduled for late 1965 or early 1966.

b/ Electricity production is equally shared between Belgium and France.

ANNEX III

CONFERENCES, SYMPOSIA AND PUBLICATIONS

A. Conferences and symposia held in 1964

Date and place	Title	Co-sponsoring organizations	Number of participants	Number of countries represented	Number of organizations represented	Number of papers presented
20-24 April Athens	Symposium on Medical Radioisotope Scanning		162	26	4	58
11-16 May Heidelberg (Federal Republic of Germany)	Symposium on Assessment of Radioactive Body Burdens in Man	ILO WHO	181	28	6	66
19-23 October Salzburg (Austria)	Symposium on Radiochemical Methods of Analysis		278	28	5	61
23-27 November Prague	Symposium on the Use of Radioisotopes in Animal Nutrition and Physiology	FAO	135	21	1	48
7-11 December Vienna	Symposium on Chemical Effects associated with Nuclear Reactions and Radioactive Transformations	JCAR (ICSU)	136	29	4	62
15-19 December Bombay (India)	Symposium on Inelastic Scattering of Neutrons		92	17	2	66

B. Conference and symposium programme for 1965

Date	Title	Place	Co-sponsoring organizations
8-12 March	Symposium on Personnel Dosimetry for Accidental High-level Exposure to External and Internal Radiation	Vienna	WHO
22-26 March	Symposium on the Physics and Chemistry of Fission	Salzburg (Austria)	
10-14 May	Symposium on Pulsed Neutron Research	Karlsruhe (Federal Republic of Germany)	
17-21 May	Symposium on Non-Destructive Testing in Nuclear Technology	Bucharest	
24-28 May	Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology	Vienna	
31 May - 4 June	Symposium on Exchange Reactions	Brookhaven (United States)	
28 June - 2 July	Symposium on the Use of Isotopes and Radiation in Soil-Plant Nutrition Studies	Ankara	FAO
22-27 July	Symposium on Thermodynamics with Emphasis on Nuclear Materials and Atomic Transport in Solids	Vienna	IUPAC
30 August - 3 September	Symposium on Nuclear Materials Management		
6-10 September	Conference on Plasma Physics and Controlled Nuclear Fusion Research	Culham (United Kingdom)	
18-22 October	Symposium on Radioisotope Instruments in Industry and Geophysics	Warsaw	
25-29 October	Symposium on the Use of Isotopes in Weed Research	Vienna	FAO
1-5 November	Symposium on Criticality Control of Fissile Materials	Stockholm	
22-26 November	Conference on Nuclear Electronics	Bombay (India)	
6-10 December	Symposium on Practices in the Treatment of Low and Intermediate Level Radioactive Wastes	Vienna	ENEA

C. Agency publications[a]

1. Proceedings of Conferences, Symposia and Seminars[b]

Assessment of Radioactivity in Man, two volumes
Chemical Effects of Nuclear Transformations, two volumes
Inelastic Scattering of Neutrons, two volumes
Medical Radioisotope Scanning, two volumes
Plasma Physics
Radiochemical Methods of Analysis, two volumes

2. Technical Directories

Directory of Nuclear Reactors, Volume V
International Directory of Isotopes - Third Edition
Reactor Card Index

3. Safety Series

No. 11 Methods of Surveying and Monitoring Marine Radioactivity
No. 12 Management of Radioactive Wastes Produced by Radioisotope Users
No. 13 The Provision of Radiological Protection Services
No. 14 The Basic Requirements for Personnel Monitoring

4. Bibliographical Series

No. 12 Capture Reactions
No. 13 Nuclear Power Economics
No. 14 Uranium Carbides, Nitrides and Silicides

5. Technical Reports Series

No. 24 Desalination of Water Using Conventional and Nuclear Energy[c]
No. 25 IAEA Laboratory Activities - First Report[c]
No. 28 IAEA Research Contracts - Fourth Annual Report[c]
No. 29 Laboratory Training Manual on the Use of Isotopes and Radiation in Soil-Plant Relations Research
No. 30 Production and Utilization of Radiation Vaccines against Helminthic Diseases
No. 31 Training in Radiological Protection: Curricula and Programming
No. 32 Medical Uses of Calcium-47: Second Panel Report
No. 33 Low-Background High-Efficiency Geiger-Müller Counter
No. 34 Reactor Shielding
No. 35 Study on the Potentialities of Use of a Nuclear Reactor for the Industrialization of Southern Tunisia[d]
No. 36 Selected Power Reactor Projects in Canada and the United States of America
No. 37 Manual on the Operation of Research Reactors
No. 38 Tables of Thermodynamic Data
No. 39 Thermodynamic and Transport Properties of Uranium Dioxide and Related Phases
No. 40 Industrial Radioisotope Economics
No. 41 IAEA Laboratory Activities - Second Report
No. 42 IAEA Research Contracts - Fifth Annual Report
No. 43 Clinical Dosimetry[e]

6. Journals

Nuclear Fusion - Journal of Plasma Physics and Thermonuclear Fusion, Volume 4, Nos. 3 and 4; Volume 5, Nos. 1 and 2
Atomic Energy Review, Volume 2, Nos. 3 and 4; Volume 3, Nos. 1 and 2
International Atomic Energy Agency Bulletin

7. Miscellaneous

Conferences, Meetings, Training Courses in Atomic Energy, Nos. 32-36
Journal Holdings in the IAEA Library
Legal Series, No. 2: Civil Liability for Nuclear Damage[f/]
List of References on Nuclear Energy, Volume 6, Nos. 13-24; Volume 7, Nos. 1-12
List of Bibliographies on Nuclear Energy, Volume 3, No. 1
Publications in the Nuclear Sciences (Catalogue)[g/]

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a/ Published in English, unless otherwise indicated.

b/ Contributions published in the original language (English, French, Russian or Spanish) with abstracts in English, French, Russian and Spanish. Discussions in English.

c/ Published in French, Russian and Spanish.

d/ Published in English and French.

e/ Published in Spanish.

f/ Published in English, French, Russian and Spanish.

g/ Published in English, French, Russian, Spanish and German.

ANNEX IV

RESEARCH CONTRACTS

A. Total value of contracts in 1963 and 1964

Year	New contracts	Renewals	Total	Value[a]
				$
1963	56	58	114	770 757
1964	55	77	132	762 391

a/ From the Agency's funds. In addition, nine contracts to the value of $86 902 were awarded or renewed in 1963 and 11 contracts to the value of $175 395 were awarded or renewed in 1964 from funds made available by the United States Government under the United States/Agency Joint Research Programme.

B. Analysis by subject matter of contracts awarded or renewed in 1964

Subject matter of research	Number of contracts placed	Number of contracts renewed	Contribution from Regular Budget	Contribution from Operational Budget	Total
			$	$	$
Radioactive waste management and environmental research	3	5	69 460	-	69 460
Health physics and radiation protection	6	12	112 343	-	112 343
Radiobiology	6	13	96 820	-	96 820
Safeguards methods	2	-	37 700	-	37 700
Studies involving reactors	4	2	73 150	-	73 150
Application of radioisotopes in agriculture	19	26	109 518	60 010	169 528
Application of radioisotopes in hydrology	5	5	57 350	-	57 350
Application of radioisotopes in medicine	10	14	98 680	47 360	146 040
Total	55	77	655 021	107 370	762 391

C. Analysis by country of contracts awarded or renewed in 1964

Country	Number of contracts placed	Number of contracts renewed	Contribution from Regular Budget	Contribution from Operational Budget	Total
			$	$	$
Argentina	2	1	18 090	-	18 090
Australia	-	2	12 880	-	12 880
Austria	1	3	29 120	-	29 120
Belgium	1	5	25 948	-	25 948
Burma	-	1	-	3 050	3 050
Ceylon	2	-	-	6 060	6 060
Chile	1	2	7 000	18 000	25 000
China	3	-	3 500	5 000	8 500
Colombia	1	1	2 000	3 570	5 570
Congo, Democratic Republic of	-	1	1 000	-	1 000
Czechoslovak Socialist Republic	1	2	22 000	-	22 000
Denmark	-	1	4 200	-	4 200
Ecuador	2	-	11 000	-	11 000
El Salvador	-	1	10 560	-	10 560
Finland	1	-	9 000	-	9 000
Germany, Federal Republic of	3	1	40 760	-	40 760
Greece	1	-	11 200	-	11 200
Hungary	2	2	19 090	-	19 090
India	2	2	27 800	3 900	31 700
Israel	1	4	41 580	-	41 580
Italy	3	2	17 370	-	17 370
Jamaica	1	-	9 810	-	9 810
Japan	4	8	61 010	-	61 010
Korea, Republic of	2	3	13 540	2 150	15 690
Lebanon	1	1	5 028	-	5 028
Madagascar	1	-	2 950	-	2 950
Mexico	-	1	-	7 800	7 800
Netherlands	-	1	7 000	-	7 000
New Zealand	-	1	2 600	-	2 600
Nigeria	2	-	1 350	4 000	5 350
Norway	1	1	7 100	-	7 100
Pakistan	3	2	8 600	9 050	17 650
Peru	-	1	4 370	-	4 370
Philippines	2	1	6 030	3 100	9 130
Poland	3	2	38 300	-	38 300
Portugal	-	1	5 520	-	5 520
Rhodesia	1	1	5 500	8 550	14 050
Romania	-	1	5 350	-	5 350
South Africa	-	2	7 660	-	7 660
Spain	2	1	13 490	2 480	15 970

Country	Number of contracts placed	Number of contracts renewed	Contribution from Regular Budget	Contribution from Operational Budget	Total
			$	$	$
Sweden	1	2	23 750	-	23 750
Switzerland	-	2	6 950	-	6 950
Thailand	1	3	9 000	6 610	15 610
Tunisia	-	1	-	7 400	7 400
Turkey	-	1	-	5 150	5 150
United Arab Republic	1	1	8 000	3 000	11 000
United Kingdom of Great Britain and Northern Ireland	-	1	3 000	-	3 000
United States of America	1	-	30 000	-	30 000
Venezuela	-	1	-	7 000	7 000
Viet-Nam	-	1	-	1 500	1 500
Yugoslavia	1	5	55 015	-	55 015
Total	55	77	655 021	107 370	762 391

ANNEX V

CONTRIBUTIONS OF EQUIPMENT BY MEMBER STATES

A. Equipment offered as contributions in kind

1. The General Conference will recall that in 1962 the Governments of Bulgaria, the Byelorussian Soviet Socialist Republic, the Czechoslovak Socialist Republic, Hungary, Poland, Romania, the Ukrainian Soviet Socialist Republic and the Union of Soviet Socialist Republics had proposed that the Agency undertake a programme to establish six medical centres and six physics laboratories in the developing countries, one third of which being equipped by the said countries. In February 1964, the provision of one radiological centre by the Czechoslovak Socialist Republic to Algeria was arranged. In September 1964, the eight Governments in question, taking into account the requests received from Member States, replaced the offer of six physics centres by an equivalent offer (in terms of cost) of radiological centres in addition to the one for Algeria and stated their readiness to fulfil their share in the above-mentioned programme, irrespective of the participation of other States.

2. In January 1965, the Government of the Soviet Union informed the Agency that it was prepared to supply to developing Member States of the Agency equipment for two complete medical radiological centres in 1965 and two in 1966, together with experts and facilities for training; these centres would be set up in any four of the eight States that had previously submitted requests for such equipment.

3. The Governments of Hungary and Poland also announced that they will each provide a radiological centre, and the Government of Bulgaria informed the Agency that it will contribute 20 000 roubles in the context of this programme.

4. In June 1965 the Board approved arrangements for the provision of radiotherapy equipment from Hungary to Afghanistan and from the Soviet Union to Morocco and Pakistan respectively.

B. Equipment donated as contributions in kind

5. The following table lists equipment donated during the reporting period, for furthering the purposes of the Agency.

Equipment donated to the Agency's Laboratory

Donor country	Equipment
Canada	14 000 curie cobalt-60 gamma cell
France	Intertechnique two-parameter pulse height analyser and accessories
Germany, Federal Republic of	X-ray fluorescence unit
India	Six radiation survey meters, three contamination monitors
Japan	Analytical balance, Iwaki KM shaker
Netherlands	Low-level tritium counting system
Switzerland	Small precision type equipment: microbalances, electronic instruments, vacuum operator, etc.

Equipment donated for approved technical assistance projects in Member States

Donor country	Equipment
United States of America	1 isotope scanner 1 analyser computer 2 scintillation detectors 1 transformer 3 pulse analysers with pre-amplifiers and power sources 3 pulse height analysers 1 pulse generator 1 oscilloscope 2 medical radioisotope scanners, one with detector 1 scaler 1 power supply unit

6. The Government of the United States has also provided six new spectrometers to replace those in the Agency's two mobile radioisotope laboratories.

ANNEX VI

FINANCE

A. Advances to the Working Capital Fund

Member	Assessed	Paid	Outstanding
	$	$	$
Afghanistan	1 000	1 000	-
Albania	800	800	-
Algeria	1 800	1 800	-
Argentina	18 600	18 600	-
Australia	30 600	30 600	-
Austria	8 200	8 200	-
Belgium	22 000	22 000	-
Bolivia	800	800	-
Brazil	19 000	19 000	-
Bulgaria	3 600	3 600	-
Burma	1 200	1 200	-
Byelorussian Soviet Socialist Republic	9 600	9 600	-
Cambodia	800	800	-
Cameroon	800	800	-
Canada	57 400	57 400	-
Ceylon	1 600	1 600	-
Chile	4 800	4 800	-
China	84 000	84 000	-
Colombia	4 800	4 800	-
Congo, Democratic Republic of	1 200	1 200	-
Cuba	4 000	4 000	-
Czechoslovak Socialist Republic	19 200	19 200	-
Denmark	10 600	10 600	-
Dominican Republic	1 000	1 000	-
Ecuador	1 200	1 200	-
El Salvador	800	800	-
Ethiopia	1 000	1 000	-
Finland	6 800	6 800	-
France	109 400	109 400	-
Gabon	800	800	-
Germany, Federal Republic of	104 800	104 800	-
Ghana	1 600	1 600	-
Greece	4 200	4 200	-
Guatemala	1 000	1 000	-
Haiti	800	800	-
Holy See	800	800	-
Honduras	800	800	-
Hungary	9 400	9 400	-
Iceland	800	800	-
India	37 400	37 400	-

Member	Assessed	Paid	Outstanding
	$	$	$
Indonesia	8 200	8 200	-
Iran	3 600	3 600	-
Iraq	1 600	1 600	-
Israel	2 800	2 800	-
Italy	41 200	41 200	-
Ivory Coast	800	800	-
Japan	41 800	41 800	-
Korea, Republic of	3 400	3 400	-
Lebanon	1 000	1 000	-
Liberia	800	800	-
Libya	800	800	-
Luxembourg	1 000	1 000	-
Mali	800	800	-
Mexico	13 600	13 600	-
Monaco	800	800	-
Morocco	2 600	2 600	-
Netherlands	18 600	18 600	-
New Zealand	7 600	7 600	-
Nicaragua	800	800	-
Nigeria	3 800	3 800	-
Norway	8 200	8 200	-
Pakistan	7 800	7 800	-
Paraguay	800	-	800
Peru	1 800	1 800	-
Philippines	7 400	7 400	-
Poland	23 600	23 600	-
Portugal	3 000	3 000	-
Romania	5 800	5 800	-
Saudi Arabia	1 200	1 200	-
Senegal	1 000	1 000	-
South Africa	9 800	9 800	-
Spain	15 800	15 800	-
Sudan	1 200	1 200	-
Sweden	24 000	24 000	-
Switzerland	17 400	17 400	-
Syrian Arab Republic	1 000	-	1 000
Thailand	3 000	3 000	-
Tunisia	1 000	1 000	-
Turkey	7 400	7 400	-
Ukrainian Soviet Socialist Republic	36 400	36 400	-
Union of Soviet Socialist Republics	275 400	275 400	-
United Arab Republic	4 600	4 600	-
United Kingdom of Great Britain and Northern Ireland	139 400	139 400	-
United States of America	636 800	636 800	-
Uruguay	2 000	2 000	-

Member	Assessed	Paid	Outstanding
	$	$	$
Venezuela	9 600	9 600	-
Viet-Nam	3 000	3 000	-
Yugoslavia	7 000	7 000	-
Total	2 000 000	1 998 200	1 800
New Members			
Costa Rica	800	-	800
Cyprus	800	-	800
Kuwait	800	800	-
Madagascar	800	800	-
Total for new Members	3 200	1 600	1 600

B. Outstanding contributions to the 1958, 1959, 1960, 1961, 1962, 1963 and 1964 Regular Budgets

Member	1958	1959	1960	1961	1962	1963	1964	Total
	$	$	$	$	$	$	$	$
Afghanistan	-	-	-	-	-	3 101	3 610	6 711
Algeria	-	-	-	-	-	1 800	6 498	8 298
Chile	-	-	-	-	-	-	14 528	14 528
China	-	-	-	-	-	274 624	304 684	579 308
Colombia	-	-	-	-	-	-	16 281	16 281
Cuba	-	-	-	10 794	15 111	14 245	14 440	54 590
Dominican Republic	-	-	-	-	3 215	3 561	3 610	10 386
Ecuador	-	-	-	-	-	2 234	4 332	6 566
Ethiopia	-	-	-	-	-	-	3 329	3 329
Guatemala	-	-	-	-	-	3 280	3 610	6 890
Haiti	-	2 021	2 337	2 467	2 652	2 849	2 888	15 214
Honduras	1 635	2 090	2 337	2 467	2 652	2 849	2 888	16 918
Hungary	-	-	-	-	-	17 629	30 373	48 002
Italy	-	-	-	-	-	-	64 952	64 952
Liberia	-	-	-	-	-	-	2 744	2 744
Paraguay	1 636	2 090	2 337	2 467	2 652	2 849	2 888	16 919
Syrian Arab Republic	-	-	-	-	-	3 561	3 610	7 171
Uruguay	-	-	-	-	-	7 122	7 220	14 342
Total outstanding	3 271	6 201	7 011	18 195	26 282	339 704	492 485	893 149
Total paid	4 111 489	5 218 799	5 873 969	6 182 495	6 613 797	6 815 559	6 737 789	
Total assessed	4 114 760	5 225 000	5 880 980	6 200 690	6 640 079	7 155 263	7 230 274	
Percentage paid of assessment	99.92	99.88	99.88	99.71	99.60	95.25	93.19	

C. Contributions to the 1965 Regular Budget

Member	Assessed	Credits	Paid	Outstanding
	$	$	$	$
Afghanistan	3 857	-	-	3 857
Albania	3 085	-	144	2 941
Algeria	6 942	-	-	6 942
Argentina	71 731	-	3 682	68 049
Australia	118 009	5 956	56 027	56 026
Austria	31 623	1 444	4 579	25 600
Belgium	84 843	4 532	80 311	-
Bolivia	3 085	-	2 000	1 085
Brazil	73 273	3 393	69 880	-
Bulgaria	13 883	542	-	13 341
Burma	4 628	253	4 375	-
Byelorussian Soviet Socialist Republic	37 022	1 552	17 735	17 735
Cambodia	3 085	144	-	2 941
Cameroon	3 085	-	-	3 085
Canada	221 363	10 560	210 803	-
Ceylon	6 170	325	5 232	613
Chile	18 511	-	-	18 511
China	323 946	-	-	323 946
Colombia	18 511	-	-	18 511
Congo, Democratic Republic of	4 628	-	144	4 484
Cuba	15 426	-	-	15 426
Czechoslovak Socialist Republic	74 045	61	-	73 984
Denmark	40 879	1 985	38 894	-
Dominican Republic	3 857	-	-	3 857
Ecuador	4 628	-	-	4 628
El Salvador	3 085	-	3 085	-
Ethiopia	3 857	-	-	3 857
Finland	26 224	1 191	25 033	-
France	421 901	21 498	400 403	-
Gabon	3 085	-	3 085	-
Germany, Federal Republic of	404 161	18 125	193 018	193 018
Ghana	6 170	217	5 953	-
Greece	16 197	758	-	15 439
Guatemala	3 857	-	-	3 857
Haiti	3 085	-	-	3 085
Holy See	3 085	144	2 941	-
Honduras	3 085	-	-	3 085
Hungary	36 251	-	-	36 251
Iceland	3 085	144	81	2 860
India	144 233	8 194	136 039	-
Indonesia	31 623	1 552	-	30 071
Iran	13 883	686	-	13 197
Iraq	6 170	289	5 881	-
Israel	10 798	469	10 329	-
Italy	158 888	-	-	158 888

Member	Assessed	Credits	Paid	Outstanding
	$	$	$	$
Ivory Coast	3 085	-	-	3 085
Japan	161 202	7 292	153 910	-
Korea, Republic of	13 112	-	686	12 426
Lebanon	3 857	180	3 677	-
Liberia	3 085	-	-	3 085
Libya	3 085	-	3 085	-
Luxembourg	3 857	180	3 677	-
Mali	3 085	144	-	2 941
Mexico	52 448	2 346	50 102	-
Monaco	3 085	144	2 941	-
Morocco	10 027	469	9 558	-
Netherlands	71 731	3 357	68 374	-
New Zealand	29 309	1 408	27 901	-
Nicaragua	3 085	-	3 085	-
Nigeria	14 655	-	-	14 655
Norway	31 623	1 624	29 999	-
Pakistan	30 081	1 336	28 745	-
Paraguay	3 085	-	-	3 085
Peru	6 942	361	202	6 379
Philippines	28 538	1 444	27 094	-
Poland	91 013	4 548	41 000	45 465
Portugal	11 570	650	10 920	-
Romania	22 368	1 119	10 624	10 625
Saudi Arabia	4 628	180	-	4 448
Senegal	3 857	180	3 677	-
South Africa	37 794	1 877	35 917	-
Spain	60 933	3 104	57 829	-
Sudan	4 628	180	4 448	-
Sweden	92 556	4 621	-	87 935
Switzerland	67 103	3 413	63 690	-
Syrian Arab Republic	3 857	-	-	3 857
Thailand	11 570	542	11 028	-
Tunisia	3 857	180	-	3 677
Turkey	28 538	-	1 949	26 589
Ukrainian Soviet Socialist Republic	140 377	6 192	67 100	67 085
Union of Soviet Socialist Republics	1 062 080	46 266	507 900	507 914
United Arab Republic	17 740	1 083	-	16 657
United Kingdom of Great Britain and Northern Ireland	537 596	26 482	511 114	-
United States of America	2 455 819	118 285	-	2 337 534
Uruguay	7 713	-	-	7 713

Member	Assessed	Credits	Paid	Outstanding
	$	$	$	$
Venezuela	37 022	1 661	-	35 361
Viet-Nam	11 570	650	10 920	-
Yugoslavia	26 996	1 155	19 380	6 461
Sub-total	7 713 000	326 667	3 050 186	4 336 147
New Members				
Costa Rica	3 085	-	-	3 085
Cyprus	3 085	-	-	3 085
Kuwait	3 085	-	3 085	-
Madagascar	3 085	-	3 085	-
Sub-total	12 340	-	6 170	6 170
Total	7 725 340	326 667	3 056 356	4 342 317

D. Voluntary contributions to the General Fund for 1964 and 1965

Member	Contributions pledged (equivalent in United States dollars at Technical Assistance Board rates)		Paid	
	$		$	
	1964	1965	1964	1965
Argentina	15 000	15 000	15 000	-
Australia	20 000	20 000	20 000	20 000
Austria	5 000	8 200 a/	5 000	8 200
Belgium	10 000	-	10 000	-
Brazil	19 000 ab/	19 000 ab/	-	-
Burma	1 000	1 000	1 000	1 000
Canada	57 600 a/	57 400 a/	57 600	-
Ceylon	2 100 ab/	2 100 ab/	2 100	-
China	5 000	5 000	5 000	5 000
Congo, Democratic Republic of	333 b/	2 000 a/	-	-
Denmark	10 600 a/	10 600 a/	10 600	10 600
Ethiopia	-	1 000 a/	-	-
Finland	6 800	6 800 a/	6 800	6 800
France	30 612	30 000	30 612	-
Germany, Federal Republic of	105 200	104 800 a/	105 200	52 400
Ghana	-	1 600 a/	-	-
Greece	4 200 a/	4 200 a/	4 200	-
Holy See	2 000 a/	2 000 a/	2 000	2 000
India	25 000 b/	35 000 b/	25 000	35 000
Indonesia	2 000	2 000	-	-
Iran	-	2 000	-	2 000
Iraq	-	1 600 a/	-	-
Israel	2 800 ab/	2 800 ab/	2 800	-
Italy	41 400 a/	-	-	-
Japan	40 000	40 000	40 000	40 000
Korea, Republic of	3 000	3 000	3 000	-
Lebanon	1 000 a/	1 000 a/	1 000	1 000
Liberia	6 301 a/	-	-	-
Mexico	13 600 a/	13 600 a/	13 600	13 600
Monaco	2 000 a/	2 000 a/	2 000	-
Morocco	2 600 a/	-	2 600	-
Netherlands	18 600 a/	18 600 a/	18 600	18 600
Norway	8 200 a/	8 200 a/	-	-
Pakistan	6 000 b/	6 000 b/	6 000	6 000
Peru	-	c/	-	-
Philippines	4 000 b/	4 000 b/	4 000	4 000
Portugal	3 600 a/	3 600 a/	3 600	-
South Africa	9 800 a/	9 800 ab/	9 800	-
Spain	-	10 000	-	-
Sweden	24 000 a/	24 000 a/	24 000	-
Switzerland	17 600 ab/	17 600 ab/	17 600	17 600
Thailand	3 000 a/	3 000 a/	3 000	3 000
Tunisia	1 000 a/	-	1 000	-
Turkey	4 444 b/	4 444 b/	4 444	4 444
United Arab Republic	11 500 ab/	11 500 ab/	11 500	-

Member	Contributions pledged (equivalent in United States dollars at Technical Assistance Board rates)		Paid	
	$		$	
	1964	1965	1964	1965
United Kingdom of Great Britain and Northern Ireland	144 000 ab/	140 000 ab/	144 000	140 000
United States of America	500 000	d/	500 000	-
Uruguay	-	2 000 a/	-	-
Viet-Nam	-	2 449 b/	-	-
Yugoslavia	7 000 ab/	7 000 ab/	7 000	7 000
	1 196 890	665 893	1 119 656	398 244
United States of America (matching contribution)	196 890 e/	544 822 d/	-	-
Total	1 393 780	1 210 715	1 119 656	398 244

a/ Pledge based on a percentage equal to or higher than the Member's percentage assessment under the Regular Budget.

b/ Pledge announced in local currency.

c/ Peru is taking action to make a voluntary contribution.

d/ Total voluntary contribution of the United States equivalent to 45% of the total pledged by all Member States including the United States.

e/ In addition to the voluntary contribution of $500 000, a matching contribution of dollar for dollar of the total contributions above $1 million, until a total of $1.5 million is reached.