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Item 14 of the provisional agenda*

REPORT OF THE INTERNATIONAL ATOMIC ENERGY AGENCY

Note by the Secretary-General

1. The twenty-sixth report of the International Atomic Energy Agency for the calendar year 1981 (GC(XXVI)/664) is submitted herewith to the General Assembly. 1/ Major developments since this report was published will be covered by the annual statement of the Director General of the Agency to the General Assembly. This report has been transmitted in accordance with the provision of article III, paragraph 1 (a), of the Agreement governing the relationship between the United Nations and the International Atomic Energy Agency (General Assembly resolution 1145 (XII), annex).

2. As only a limited number of copies of this report is available, it has not been possible to make a full distribution. Delegations are therefore requested to have the copies transmitted to them available during the discussion of this item.

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* A/37/150.

1/ The International Atomic Energy Agency is solely responsible for the designations used in its annual report. Regarding the usage in the United Nations, it will be recalled that, by resolution 2758 (XXVI) of 25 October 1971, the General Assembly, inter alia, decided "... to restore all its rights to the People's Republic of China and to recognize the representatives of its Government as the only legitimate representatives of China to the United Nations, and to expel forthwith the representatives of Chiang Kai-shek from the place which they unlawfully occupy at the United Nations and in all the organizations related to it".

THE ANNUAL REPORT FOR 1981

INTERNATIONAL ATOMIC ENERGY AGENCY

International Atomic Energy Agency

GENERAL CONFERENCE

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Corrigenda

1. In Table 2, the figure "13" under "2000 (projected)" against the entry "b. CPE Europe" should read "17".

2. In Table 3, the figure "5800" under "2000[a/]" against the entry "3. Developing countries outside CPE Europe" should read "6800".

3. In paragraph 232, the third sentence should read:

> "Sixty-six such agreements, involving 70 non-nuclear-weapon States, were in force at the end of the year."

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INTERNATIONAL ATOMIC ENERGY AGENCY

THE ANNUAL REPORT FOR 1981

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LIST OF ABBREVIATIONS

Agency	International Atomic Energy Agency
AGRIS	Agricultural Information System
BICOT	Biological control of tsetse
CEC	Commission of the European Communities
CERN	European Organization for Nuclear Research
CINDA	Computer Index of Neutron Data
CMEA	Council for Mutual Economic Assistance
EURATOM	European Atomic Energy Community
FAO	Food and Agriculture Organization of the United Nations
FBR	Fast breeder reactor
GW(e)	Gigawatt (electrical)
HTR	High-temperature reactor
IAEA	International Atomic Energy Agency
IIASA	International Institute for Applied Systems Analysis
ILO	International Labour Organisation
IMCO	Inter-Governmental Maritime Consultative Organization
INTOR	International Tokamak Reactor
kGy	kilogray (=100 krad)
kV	kilovolt
LMFBR	Liquid-metal fast breeder reactor
London Dumping Convention	Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter
LWR	Light-water reactor
MW(e)	Megawatt (electrical)
MW(th)	Megawatt (thermal)
NEA	Nuclear Energy Agency of the Organisation for Economic Co-operation and Development
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NUSS	Nuclear Safety Standards (programme)
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of Petroleum Exporting Countries
PWR	Pressurized-water reactor
RCA	Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (INFCIRC/167)
SIDA	Swedish International Development Authority
Tlatelolco Treaty	Treaty for the Prohibition of Nuclear Weapons in Latin America
TW·h(e)	Terawatt-hour (electrical)
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme

UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
VIC	Vienna International Centre
WHO	World Health Organization

All sums of money are expressed in United States dollars.

General

1. In 1981, the Agency continued, within stringent budgetary limits, to give priority in its programmes to technical assistance (both through the Agency's programmes as a whole and through specific technical assistance projects), safeguards and nuclear safety. All these areas of activity are relevant to the peaceful application of nuclear energy and to a wider adoption of nuclear power, the need for which arises, despite current impediments, for many countries, especially those without indigenous resources of oil and coal.

Finance

2. The 1981 Regular Budget for the Agency's programmes, excluding "Cost of Work for Others", amounted to $85 614 000, which was $6 936 000, or 8.8%, higher than the 1980 Regular Budget. The 8.8% increase was accounted for entirely by price increases attributable to inflation, there being zero growth (actually a $24 000 reduction) in the Agency's programmes as a whole.

3. The 1981 assessment on Member States for contributions to the Regular Budget was $81 669 000 - an increase of $6 749 000 over the 1980 assessment.

4. The original budget estimates for 1981 were based on an exchange rate of 12.90 Austrian schillings to the United States dollar. Because of the substantial increase in the dollar/schilling exchange rate during 1981, however, the Director General informed the Board of Governors in September 1981 that he expected that funds amounting to $10 299 194 would be in excess of requirements.

5. Whereas the original amount appropriated for the Agency's programmes was $85 614 000, actual obligations amounted to $71 980 794, resulting in an unobligated balance of $13 633 206. The total provisional budgetary surplus, including additional income and savings on the liquidation of prior-year obligations, amounts to $17 710 800, compared with $10 720 392 in 1980.

Staff employed

6. During 1981 the Secretariat had an average of 585 staff members in the Professional and higher categories, 889 in the General Service category and 150 in the Maintenance and Operatives Service category - a total of 1624.

7. Compared with 1980, this represented an increase of 6.59% in the Professional and higher categories, an increase of 4.68% in the General Service category and a decrease of 1.57% in the Maintenance and Operatives Service category.

Director General

8. On 25 September, the Agency's General Conference unanimously approved the appointment of Dr. Hans Blix as successor to Dr. Sigvard Eklund as Director General. Also, it conferred upon Dr. Eklund the title of Director General Emeritus in recognition of his twenty years' service to the Agency as Director General.

9. Dr. Blix took up his appointment on 1 December 1981.

Nuclear power

10. During 1981, as in previous years, statesmen of many countries endorsed the need for nuclear power for meeting energy requirements and the need to overcome problems of public acceptance. For example, the representatives of the seven industrial countries meeting in Ottawa in July 1981 stated:

> "In most of our countries, progress in constructing new nuclear facilities is slow. We intend in each of our countries to encourage greater public acceptance of nuclear energy and to respond to public concerns about safety, health, nuclear waste management and non-proliferation (of nuclear weaponry). We will further our efforts in the development of advanced technologies, particularly in spent fuel management."

And the Prime Minister of India, at the United Nations Conference on New and Renewable Sources of Energy, held in August in Nairobi, said:

> "Nuclear energy is the only power source able to meet India's demands and, unless we have something positive to take its place, we cannot talk of replacing it."

11. Despite these and other statements on the important role of nuclear power, 1981 was not an encouraging year in general for new nuclear orders. Although the new French Government reaffirmed a continuing commitment to nuclear power, after parliamentary debate, and the Soviet Union and other CMEA countries remained committed to the expansion of nuclear power programmes, in most other industrialized countries, including those where the Governments support the development of nuclear power, progress in enlarging nuclear generating capacity tended to be slow. On a more positive note, Egypt and Mexico announced their intention of embarking on substantial nuclear power programmes.

12. There are several reasons for the widespread lack of new orders and the slow progress being made; low economic activity, falling demand for electricity and problems of financing and licensing still exercise a generally depressing influence on new ordering, and have led to the cancellation of eight orders. These problems lie outside the Agency's competence. In addition, public resistance to accepting nuclear power continues to be an inhibiting factor. It appears to be based on three main concerns - the safety of nuclear reactors, the disposal of radioactive waste and the risk of nuclear weapons proliferation. All these lie within the Agency's competence and form an important part of its programmes.

Nuclear fuel cycle

13. In the nuclear fuel cycle area, the emphasis with regard to nuclear materials has shifted (as a result of the present uranium market conditions) towards efforts to increase the efficiency and improve the economics of mining and milling operations.

Nuclear safety

14. Lessons from Three Mile Island continue to influence the development of nuclear safety measures and practices, both nationally and internationally, with particular attention being given to improving the qualifications and training of operating management and staff and to reducing the scope for human error.

15. Important features of the Agency's expanded safety programme were the substantial progress made towards completion of the codes and guides of the Nuclear Safety Standards (NUSS) programme and the revision of the Basic Safety Standards for Radiation Protection. Together with Member States, the Agency carried forward its work on plans for emergency preparedness and held important meetings directed towards international co-operation in the provision and exchange of information on abnormal operating experiences and on safety research.

16. Agency safety missions were sent to six developing countries to advise on radiation protection. Advice and training were directed primarily towards developing countries planning or starting nuclear power programmes.

17. No radiation-induced death and no serious radiation injury was identified at any nuclear power plant in 1981 - or in any year since the first commercial nuclear power reactor went critical.

Waste management

18. Concern persists about the management and disposal of radioactive waste, and this is an impediment to the development of nuclear power in some countries. The Agency continued to hold meetings and issue publications on many aspects of radioactive waste management and disposal, ranging through uranium mining to the decontamination of nuclear power plants. Also, the Agency continued to publish information and guidance on the underground disposal of radioactive waste.

19. Recognizing the importance of radioactive waste management, the Agency will be convening a major international conference on this subject in 1983.

Safeguards

20. 1981 was a year in which the Agency's safeguards system was frequently the subject of public and political discussion and comment, sometimes in the context of debate on wider issues. It was clear from some of the comments made that there are still misconceptions about the purpose and scope of Agency safeguards and, in particular, about what they can and cannot achieve. Increased attention is being given to explaining and clarifying the Agency's safeguarding role and responsibilities in terms that are intelligible to the interested layman as well as to the safeguards specialist - for example, through statements by Agency officials and special publications.

21. During 1981, the Agency's safeguards activities increased as more nuclear facilities and material came under safeguards. The number of nuclear installations under safeguards increased by 9%, to 844. The amount of plutonium contained in irradiated fuel rose by 22%, to 71 tonnes; that of separated plutonium remained at five tonnes; that of highly enriched uranium decreased from eleven tonnes to ten tonnes; that of low-enriched uranium rose by 11%, to 15 459 tonnes; and that of source material rose by 16%, to 22 183 tonnes. By the end of 1981, 98% of the nuclear installations known to the Agency outside the nuclear-weapon States were under Agency safeguards; also a few installations in nuclear-weapon States were under safeguards. In four States, in addition to the nuclear-weapon States, only some installations were under safeguards; these did not include certain facilities in operation or under construction with a capability of making weapons-grade material.

22. The Board of Governors was informed in September 1981 that a number of technical measures had been identified as being necessary for improving safeguards at certain on-load-refuelled reactors where independent verification of fresh fuel was not possible and that, until these measures had been adopted, the Agency was, with regard to these reactors, unable fully to discharge its verification responsibilities. In informing the Board of this situation, the Director General made it clear that he was not reporting any act of non-compliance. The Board recognized the urgency and seriousness of the matter and supported the efforts of the Director General to secure improvements. Discussions with the Member States concerned took place with a view to remedying the situation as soon as possible, and progress is being made in improving the safeguards arrangements [1].

23. In 1981, as in previous years, the Secretariat, in carrying out the safeguards programme of the Agency, did not detect any anomaly which would indicate the diversion of a significant amount of safeguarded nuclear material - or the misuse of facilities or equipment subject to safeguards under certain agreements - for the manufacture of any nuclear weapon, or to further any other military purpose, or for the manufacture of any other nuclear explosive device, or for purposes unknown. Furthermore, nuclear material to which safeguards were applied under voluntary-offer agreements with nuclear-weapon States was withdrawn from civil activities only in conformity with these agreements. However, in certain cases in non-nuclear-weapon States the Agency was not in a position, pending implementation of certain technical measures proposed by the Agency, to perform adequate verification (see paragraph 22). With the exception of these cases where the Agency was unable to draw conclusions, the Secretariat considers it reasonable to conclude that the nuclear material under Agency safeguards remained in peaceful nuclear activities or was otherwise adequately accounted for. This statement should be seen in the light of the following observations:

(a) The conclusions of the Secretariat are based on extensive inspection activities, which may be illustrated for 1981 as follows - figures for 1980 are given in parentheses. More than 1400 (1100) inspections were carried out using 132 (104) inspector man-years at about 500 (500) nuclear installations in 47 (44) non-nuclear-weapon States and three (three) nuclear-weapon States. About eight (six) million surveillance pictures were taken by about 160 (140) surveillance systems and evaluated. More than 4000 (3000) seals were applied and subsequently verified. The Safeguards Analytical Laboratory (SAL) analysed about 890 (780) plutonium and uranium samples collected at facilities under safeguards, with about 1810 (1862) analytical results for nuclear material measurements being statistically evaluated. Accounting reports concerning about 700 (700) installations were received. An additional 345 000 (400 000) data entries were processed and stored in the Agency's computer.

(b) The sensitivity of inspection and evaluation activities may be illustrated by the fact that about 230 (200), mostly minor, discrepancies or anomalies were found; all cases were satisfactorily explained upon subsequent appraisal or investigation.

(c) The level of assurance associated with the Secretariat's findings for a particular installation or State depends - inter alia - on the content of the safeguards agreement concluded with the State in question, on the co-operation of the State and of the facility operators in it, and on the funds, manpower and equipment available to the Agency.

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[1] Agreement in principle has been reached with one State on the improvements necessary. In the case of another State, some progress has been made but fully satisfactory agreement has still to be achieved.

(d) The findings of the Agency's Safeguards Implementation Report for 1981 refer for each facility to the latest available State report, Agency inspection, analysis, etc. related to that facility.

24. During the year, the Agency maintained its efforts to develop new techniques and methods for the improvement of safeguards. Much of the work was assisted considerably by financial and technical support from several Member States, in particular Australia, Canada, the Federal Republic of Germany, Japan, the Soviet Union, the United Kingdom and the United States.

25. On 7 May 1981 the Agency and the European Economic Community exchanged letters relating to the provision and exchange of research data and technical advice on safeguards techniques.

26. New safeguards agreements were concluded during 1981 with Argentina, Egypt, Spain, Turkey and Viet Nam.

The non-proliferation regime

27. The non-proliferation regime was strengthened in 1981 by the accession of Egypt to NPT. In addition, Antigua and Barbuda became a party to the Treaty. The total number of NPT parties, including nuclear-weapon States, rose to 116.[2]

28. In 1981 the United States ratified additional Protocol I to the Tlatelolco Treaty, which is for States that have de jure or de facto jurisdiction over territories within the limits of the Treaty zone; additional Protocol I had already been ratified by the Netherlands and the United Kingdom. France signed additional Protocol I in 1979, but has still to ratify it.

Experience of nuclear power

29. At the end of 1981, there were 272 nuclear power reactors operating in 23 countries with a total installed generating capacity of 152 603 MW(e), of which 72 477 MW(e) had been in operation for over five years. The total number of terawatt-hours generated by nuclear power plants in 1981 was approximately 800, compared with 410 in 1976. The average load factor over the past five years was 62.5%.

30. The present total installed nuclear capacity represents 7% of the world's total electricity generating capacity, producing approximately 9% of the world's electricity.

31. Nuclear capacity and operating experience will grow rapidly in the coming years as the 236 power reactors currently under construction come into service. It is estimated that 17% of the world's production capacity will be nuclear by 1985.

32. The already substantial and widespread operating experience, together with the work being done by the Agency and its Member States in such areas as safety, waste management and safeguards, will provide a solid factual background to the Agency's International Conference on Nuclear Power Experience to be held in Vienna in September 1982.

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[2] Papua New Guinea became a party to NPT on 25 January 1982 and Cape Verde's accession of 24 October 1979 was notified to the Agency on 7 May 1982. These bring the total to 117.

Technical co-operation and the application of nuclear techniques

33. Total resources available to support the Agency's technical co-operation activities rose in 1981 to $24.3 million, 15% above the 1980 level. Assistance provided from these resources increased by 11.3% to nearly $21 million, passing the $20 million mark for the first time.

34. Over half of the total resources were derived from voluntary contributions towards the 1981 target of $13 million. Implementation of activities financed from the Technical Assistance Fund rose sharply, so that earmarkings for approved assistance not yet delivered had declined by the end of the year - a welcome departure from the trend towards an increasing backlog of undelivered assistance noticeable in earlier years.

35. The Agency is now able to programme fully all its resources, and an imbalance between types of currency and their utilization no longer exists.

36. An important part of the Agency's technical assistance is provided from extrabudgetary funds and from assistance in kind. These resources made it possible to declare operational 73% of the footnote-a/ projects in the 1981 programme [3]; also, they provided over half of the amount needed for the Agency's fellowship programme.

37. The UNDP share in the total resources for the Agency's technical co-operation activities declined, but still accounts for 21% of them.

38. Besides multidisciplinary programming missions to Panama and Viet Nam and numerous technical missions in connection with ongoing projects, staff members of the Department of Technical Co-operation made programme monitoring visits to 22 countries. Efforts to assist Governments in identifying realistic development objectives in the nuclear field towards the achievement of which Agency inputs could make significant contributions have led to a rapid increase in multi-year projects.

39. Day-to-day monitoring of individual technical co-operation projects is now ensured through a computerized system. The first formal post-project evaluations were carried out in 1981.

40. In addition to the technical co-operation programme financed from voluntary contributions made by Member States, there are a number of other Agency activities related to the needs of the developing countries - for example, activities connected with the application of radiation and isotopes in such fields as medicine, food and agriculture, industry and hydrology and with nuclear power, radiological protection and nuclear safety.

41. By the end of 1981, the Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA) was in force for the Agency and for 13 Member States in Asia and the Pacific region. Within the framework of RCA the following programmes were under way:

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[3] A footnote-a/ project is a project that has been approved by the Agency's Board of Governors for implementation but for which assistance is provided only in substitution for other assistance which it is planned to provide to the Member State in question or if additional contributions from Member States of funds or services become available.

Funds obligated in 1981

Programme	Source of funds			Total
	Regular Budget	Extra-budgetary	UNDP	
Animal production	49 447	-	-	49 447
Food preservation	-	78 039[a/]	-	78 039
Plant breeding	49 970	-	-	49 970
Impact of mineral substances on man and the environment	23 707	-	-	23 707
Maintenance of medical instrumentation	44 172	16 000[a/]	-	60 172
Physics	6 166	-	-	6 166
Isotope hydrology	-	62 680[b/]	-	62 680
Industrial applications of isotopes and radiation technology	-	24 163[a/]	1 180 787	1 204 950
Total	173 462	180 882	1 180 787	1 535 131

a/ Met from a contribution of $165 000 made by the Government of Japan.

b/ Met from a contribution of $116 279 made by the Government of Australia.

42. The use of isotopic techniques in hydrological projects was expanded in 12 countries with the Agency's help.

43. The Agency continued to assist in manpower development for nuclear power programmes. Initiated in 1975, the Agency's activities in this field continued to attract great interest in developing countries.

Controlled thermonuclear fusion

44. The "Phase-One" INTOR Workshop ended in July 1981 and work has begun on the next phase ("Phase IIA"), which involves a cost-benefit analysis of design alternatives and an analysis of issues affecting design optimization.

Committee on Assurances of Supply (CAS)

45. The General Assembly, in its 36th session, reiterated its conviction that the work of CAS would greatly contribute to the success of the United Nations Conference for the Promotion of International Co-operation in the Peaceful Uses of Nuclear Energy (see paragraph 48).

46. CAS held three sessions in 1981, with some 50 countries participating as members [4] and four international or intergovernmental organizations attending as observers.

47. In November 1981, CAS established two working groups - one on "Principles of international co-operation in the field of nuclear energy in accordance with the mandate of the Committee on Assurances of Supply" and one on "Emergency and back-up mechanisms".

United Nations Conference for the Promotion of International Co-operation in the Peaceful Uses of Nuclear Energy

48. The Preparatory Committee for the United Nations Conference for the Promotion of International Co-operation in the Peaceful Uses of Nuclear Energy held its first meeting in August 1981, in Vienna, with the Agency's participation. The Preparatory Committee made recommendations to the United Nations General Assembly on the date, venue, duration and draft rules of procedure of the Conference, on the establishment of a conference secretariat and on the role of the Agency. In December, the General Assembly, in resolution 36/78, decided to convene the Conference from 29 August to 9 September 1983 in Geneva and invited the Agency to fulfil its appropriate role within the scope of its responsibilities at all stages of preparation of the Conference, and during the Conference itself, by contributing to the discussion of relevant issues, by providing technical data and documentation as needed, particularly in relation to the progress of the work of CAS, and by participating in the secretariat of the Conference.

United Nations Conference on New and Renewable Sources of Energy

49. The Agency participated in the United Nations Conference on New and Renewable Sources of Energy, which took place in August 1981, in Nairobi, and the Director General addressed the Conference. The Agency is participating in the relevant committees and working groups set up within the existing United Nations machinery to follow up the Action Plan resulting from the Conference.

Israeli attack on Iraqi reactor

50. On 7 June, Israel attacked the Tamuz research reactor at the Iraqi nuclear research centre, near Baghdad, and inflicted considerable damage on it. The attack was discussed by the Board of Governors and reported to the United Nations Security Council, which, in its resolution 487 of 19 June, strongly condemned the attack and called upon Israel urgently to place its nuclear facilities under Agency safeguards. It was subsequently debated in the Agency's General Conference and the United Nations General Assembly. In its Resolution GC(XXV)/RES/381, the General Conference decided - inter alia - to "suspend immediately the provision of any assistance to Israel under the Agency's technical assistance programme"; action to implement this part of the resolution was duly taken. Also, the Conference decided to consider at its twenty-sixth regular session the suspension of Israel from the exercise of the privileges and rights of Agency membership if by that time it had not complied with the provisions of Security Council resolution 487.

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[4] On 17 September 1981, the Board of Governors adopted a resolution prohibiting South Africa from participation in the meetings and work of CAS.

51. In the debate and comments which followed this attack, it was suggested that the Agency's safeguards arrangements for the Tamuz reactor complex were not adequate and would not have been able to detect misuse for non-peaceful purposes. In fact, the Agency demonstrated that the safeguards regime in force at the time of the attack, before the reactor became operational, was fully adequate and that the safeguards arrangements planned for the period after the reactor would have come into operation were such as to enable the Agency to detect any diversion or misuse.

Matters of special interest to the Agency discussed by the General Assembly of the United Nations

52. The General Assembly noted with satisfaction the Agency's efforts to strengthen its activities in the field of technical assistance to developing countries, the steady improvement of the Agency's safeguards system and the steps taken by the Agency to expand and strengthen its programme in nuclear safety and enhance its ability to deal with emergencies. It also noted with satisfaction that CAS had begun substantive work, which it hoped would greatly contribute to the success of the United Nations Conference for the Promotion of International Co-operation in the Peaceful Uses of Nuclear Energy. It urged all Agency Member States that had not already done so to ratify the Convention on the Physical Protection of Nuclear Material.

53. The General Assembly, adopting resolutions on the nuclear capability of South Africa and on the implementation of the Declaration on the Denuclearization of Africa, demanded that South Africa submit all its nuclear installations to inspection by the Agency. It called for the prohibition of all forms of co-operation and collaboration with South Africa in the nuclear field. Also, it called upon all States to "take effective measures to ensure that governmental and non-governmental organizations within their jurisdiction cease any relations with .... nuclear institutions in South Africa".

54. In resolution 36/121 D of 10 December 1981, the General Assembly invited the specialized agencies of the United Nations and the Agency to grant full membership to Namibia, represented by the United Nations Council for Namibia.[5]

55. In resolution 36/98, the Assembly requested the Security Council to prohibit all forms of co-operation with Israel in the nuclear field and to institute effective enforcement action against Israel so as to prevent it from endangering international peace and security by its nuclear weapons capability. Also, it demanded that Israel place all its nuclear activities under international safeguards.

56. In adopting resolution 36/27, "Armed Israeli aggression against the Iraqi nuclear installations and its grave consequences for the established international system concerning the peaceful uses of nuclear energy, the non-proliferation of nuclear weapons and international peace and security", the Assembly strongly condemned Israel for its action and requested the Security Council to investigate Israel's nuclear activities and the collaboration of other States and parties in those activities.

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[5] The United Nations Council for Namibia subsequently applied for membership of the Agency. On 11 June 1982 the Agency's Board of Governors recommended that the General Conference approve Namibia, represented by the United Nations Council for Namibia, for membership of the Agency (GC(XXVI)/663).

TECHNICAL CO-OPERATION

57. Agency technical assistance is provided from various sources. At the level of the recipient country, however, it is the volume and quality of the assistance that are of foremost importance, the source being rather a secondary consideration. Cash contributions and offers of assistance in kind represent building-blocks of the Agency's overall programme of technical co-operation, and it is necessary for the Secretariat to report on how they are used.

58. The categories of sources from which the Agency's technical assistance is provided are as follows:

(a) The Technical Assistance Fund, which consists primarily of the voluntary contributions of Member States in support of the regular programme of technical co-operation;

(b) Extrabudgetary funds, which are cash contributions made by Member States, over and above their contributions to the Technical Assistance Fund, in support of special projects and of projects for which funds would not otherwise be available (footnote a/ projects under the regular programme;

(c) Assistance in kind, which consists mainly of cost-free fellowships, the services of training course lecturers and experts, and - occasionally - equipment grants; and

(d) UNDP funds, which are made available for projects requested by individual recipient countries in cases where the Agency has been designated executing agency.

59. Overall, the resources at the Agency's disposal in 1981 were 15.8% higher than in 1980: $24 294 000 in 1981 and $20 971 000 in 1980 (the resources available for the years 1972-81 are shown in Figure 1). The volume of assistance actually provided was 11.3% higher in 1981 than in the previous year: $20 960 300 in 1981 and $18 834 300 in 1980. A comparison of the resources and expenditures for these two years, by source, is given in Figure 2.

FIGURE 1

RESOURCES AVAILABLE FOR
AGENCY TECHNICAL CO-OPERATION PROGRAMMES: 1972 - 1981

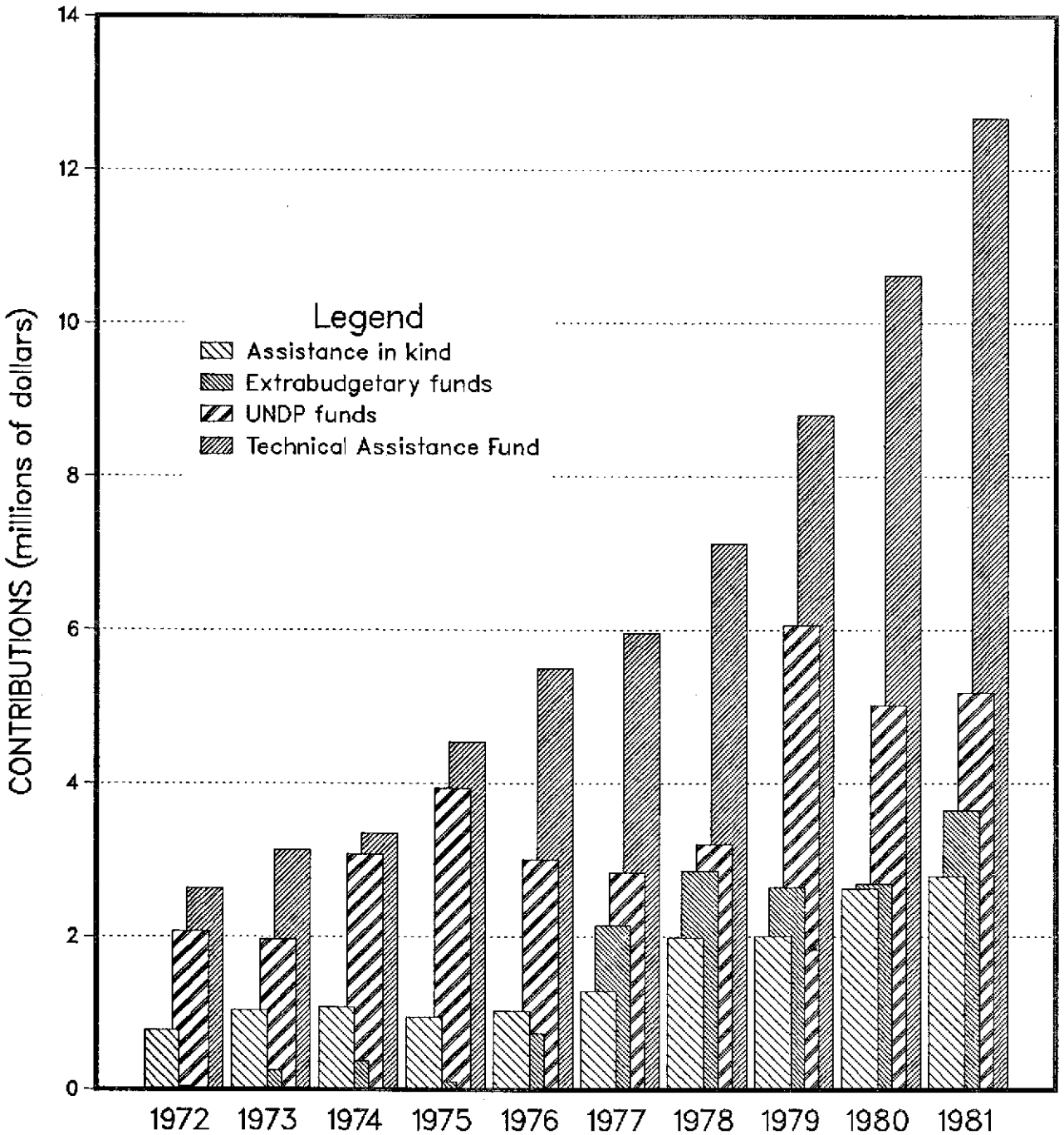
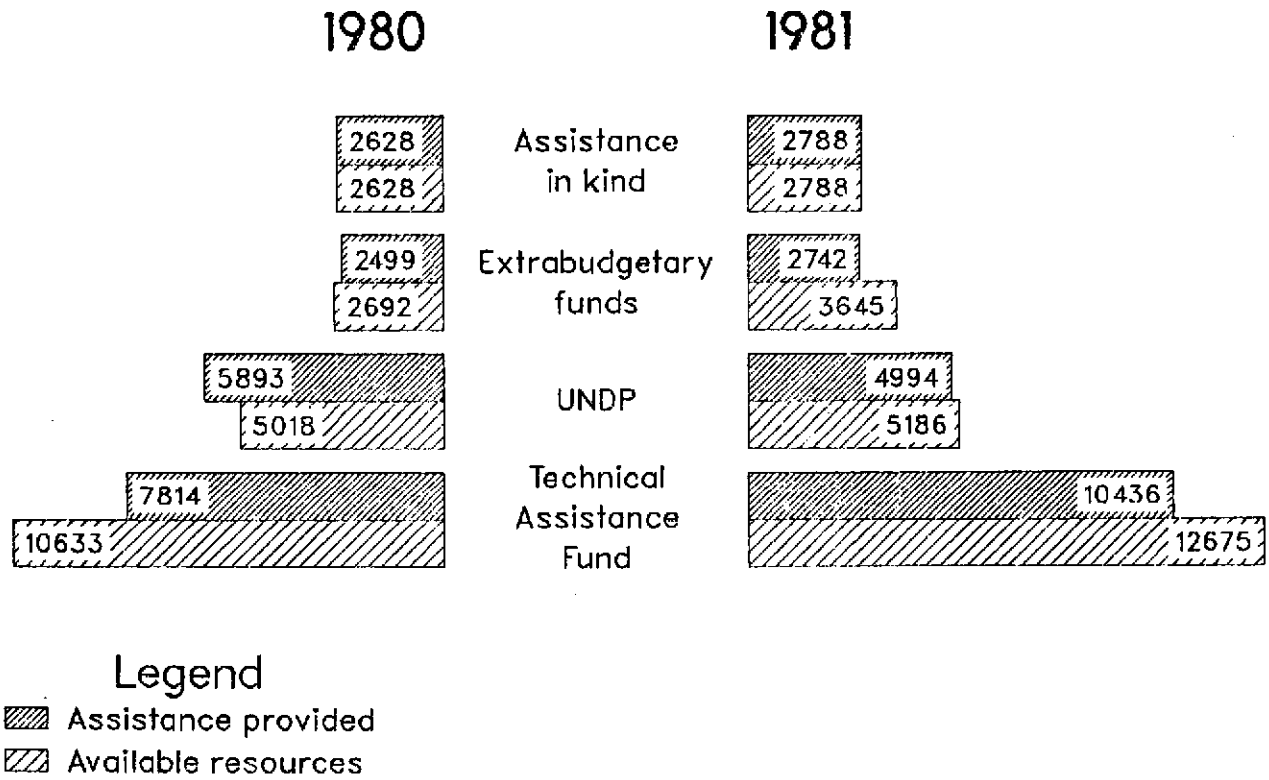


FIGURE 2

COMPOSITION OF AGENCY
TECHNICAL CO-OPERATION RESOURCES AND EXPENDITURES
(in thousands of dollars)



60. Information is given below, by category of source, on resources available and assistance provided.

1. Technical Assistance Fund

61(i) Resources: The voluntary contributions and miscellaneous income that make up the Fund rose by 19.2%, from $10 633 000 in 1980 to $12 675 000 in 1981; this corresponds approximately to the growth rate achieved in 1980. The target for voluntary contributions to the Fund was $10.5 million in 1980; contributions comprising 95.8% of the target amount were received, the shortfall being made up by miscellaneous income. Contributions to the Fund in 1981, however, reached only 90.6% of the $13 million target figure. Despite the receipt of $902 000 in the form of miscellaneous income, there was a shortfall of $325 000, part of which may be covered by late pledges for 1981.

61(ii) Expenditures: The largest increase in the delivery of assistance in 1981 was from this fund. Project expenditures ($7 813 700 in 1980) rose by 34% - to $10 436 500. Moreover, the amount of assistance under way - for example, in the form of equipment ordered but not yet delivered - at the end of 1981 ($9 553 100) was 40% higher than that under way at the end of 1980. As a result of the above-average increase in the rate of implementation in 1981, the earmarkings for approved assistance still to be implemented (i.e. the amount of funds not yet committed) declined from $7.8 million at the end of 1980 to $7.3 million at the end of 1981.

2. Extrabudgetary funds

62(i) Resources: The cash contributions which were received under this heading, and which have assumed considerable importance for the Agency's technical co-operation activities, rose by 35.4% - from $2 692 000 in 1980 to $3 645 000 in 1981. The major donors were the United States (34.5%), the Federal Republic of Germany (22.9%) and Sweden (22.3%); smaller shares were contributed by Italy, Finland, Japan, the United Kingdom, Denmark and Belgium. Also included under this heading are funds made available by developing countries to finance assistance for themselves (known as "funds in trust"). Not included in the above resources are extrabudgetary funds made available by Australia and Japan for RCA activities mentioned in paragraphs 168 and 196.

62(ii) Expenditures: The amount of assistance provided from these funds increased at a lower rate than the volume of resources, rising by 9.7% - from $2 499 500 in 1980 to $2 742 100 in 1981. This below-average growth was due mainly to the fact that substantial contributions received during the second half of 1981 had not been used by the end of the year. The growing importance of these funds can be gauged by the number of contributors: there were two in 1971, three in 1976 and 14 in 1981. This development has, of course, added to the complexity of managing the Agency's technical co-operation resources.

3. Assistance in kind

63. As the value of the assistance in kind offered depends on the use that can be made of the offers (in most cases, unused portions remaining at the end of a programme year cannot be carried forward into the next one), the value of the assistance in kind provided within a given year is considered by the Agency to constitute both the "resources" and the estimated value of "expenditures" for that year.

64. The value of the assistance in kind provided was about 6.1% higher in 1981 than in 1980, rising from $2 628 000 to $2 788 000. It accounted for 11.5% of the total resources for 1981; the corresponding figure for 1980 was 12.5%. In 1981 nearly 59% of the costs of fellowship training were met through assistance in kind, as compared with 48% in 1980, and the offer by Argentina to provide cost-free experts for two footnote a/ projects made it possible to declare them operational. It is hoped that donor countries will gradually increase the number of fellowships/man-months of training provided under this heading. Also, there is a continuing need for cost-free experts and training course lecturers.

65(i) Resources: Although the funds put at the Agency's disposal by UNDP represented 21% of total resources in 1981 as opposed to about 24% in 1980, the absolute amount made available increased by 3%, rising from $5 018 000 in 1980 to $5 186 000 in 1981; the latter amount includes $118 000 provided through the Interim Fund for Science and Technology for Development (IFSTD), which is being administered by UNDP. The financial difficulties in which UNDP currently finds itself, resulting from insufficient voluntary contributions, have obliged UNDP to impose strict limitations on budget levels for individual country programmes; this will mean cuts in project budgets, delays in commencing activities in respect of ongoing projects and the possible cancellation of projects where implementation has not yet begun. Recipient countries are having to review their priorities and, under such conditions, Agency-executed projects are often proving to be particularly vulnerable.

65(ii) Expenditures: The amount of assistance provided to UNDP projects fell by 15%, from $5 893 400 in 1980 to $4 993 700 in 1981, and the share of total Agency technical co-operation activities accounted for by such assistance fell from 31.2% to 23.8%. However, as the amount of assistance to UNDP projects contracted for but not yet delivered at the end of 1981 totalled $2.4 million (16% higher than at the end of 1980), there is good reason to hope that expenditures on behalf of UNDP in 1982 will not fall below the 1981 level. So far IFSTD has approved funds only for two training courses to be conducted by the Agency. A proposal for a regional project on non-destructive testing (for Latin America), made by the Agency in conjunction with UNIDO, has received a positive assessment; the approval of funds depends on the level of contributions pledged by donor countries to IFSTD.

Distribution of the assistance provided

66. The assistance provided by the Agency (in 1981, 1980 and 1972-81) is shown by field of activity and type in Figure 3; it is shown (for 1981) by field of activity and region in Figure 4.

67. Figure 5 also shows the distribution of the assistance provided (in 1981 and 1972-81) by region, but with a distinction made between the assistance funded by UNDP and that provided from Agency resources (the Technical Assistance Fund, extrabudgetary funds and assistance in kind).

68. Figure 6 shows the expert services, equipment and fellowships provided over the period 1972-81 from Agency and UNDP resources. It can be seen that fellowships have been of less importance in UNDP projects than in programmes supported entirely from Agency resources, where they represent the major component of assistance. The curves for equipment clearly indicate the traditional importance of equipment also, which now accounts for over 40% of total expenditures.

Currency utilization under the Technical Assistance Fund

69. Voluntary contributions to the Technical Assistance Fund can be made either in United States dollars or in the currency of the donor country. In the Agency's early years, when the target figure was relatively low, no great difficulty was experienced in utilizing all of the currencies received. However, by 1978, when the target was $7 million (compared to only $3 million in 1974), there had accumulated a surplus in certain non-convertible currencies that amounted to more than 150% of the voluntary contributions received in those currencies for 1978 and to one third of the total voluntary contributions received for that year; also, there was a deficit of the same order of magnitude in the convertible-currency portion of the Fund. Mainly through the introduction

of multi-year programming and of advance planning based on the currencies expected to be available in the Technical Assistance Fund, it has been possible to eliminate this imbalance over a three-year period.

Multi-year programming under the Technical Assistance Fund

70. There has been a considerable increase in multi-year projects. The regular programme for 1982 includes 63 operational multi-year projects in respect of which the future-year provisions for 1983-86 amounted to $8 325 900. In the 1982 regular programme, $2.5 million, or 22% of the 1982 resources for expert services and equipment, had already been earmarked in prior years; the comparable figure for 1983 is likely to exceed 30%. In the interest of maintaining a flexible programme responsive to the needs of requesting countries, it is felt that future-year commitments should not exceed 50% of the resources expected to be available in the years in which those commitments must be met.

General problems

71. The Agency is still experiencing difficulties in recruiting a sufficient number of experts. Of the 1154 man-months of expert services still to be implemented at the end of 1981, 28% related to projects in agriculture, 14% to projects in nuclear safety and 11% to projects in nuclear physics, the fields where the difficulties were greatest. There has been some improvement in these fields, but the situation still gives grounds for concern. The efforts of Governments in helping to obtain the release of expert candidates are appreciated, but even more must be done if the Agency's technical co-operation activities are to be as effective as they should be.

72. Another problem is the lack of on-the-job training opportunities for fellows, especially in the nuclear power and nuclear safety areas, for a country embarking on a major nuclear programme needs to train staff before it enters into commitments towards, for example, the supplier of a nuclear power reactor. Here the assistance of industrialized countries is urgently needed.

73. From paragraphs 64 and 65(i) above, it can be seen that the increases in assistance-in-kind resources and UNDP resources were small in 1981. There appear to be no prospects for major improvements in these two resource categories; in fact, UNDP resources may decline in absolute as well as in real terms. Thus, real growth in the resources for the Agency's technical co-operation activities would appear to depend on an increase in the resources of the Technical Assistance Fund and in extrabudgetary funds.

FIGURE 3
UTILIZATION OF RESOURCES: 1980, 1981 and 1972-1981
(in thousands of dollars)

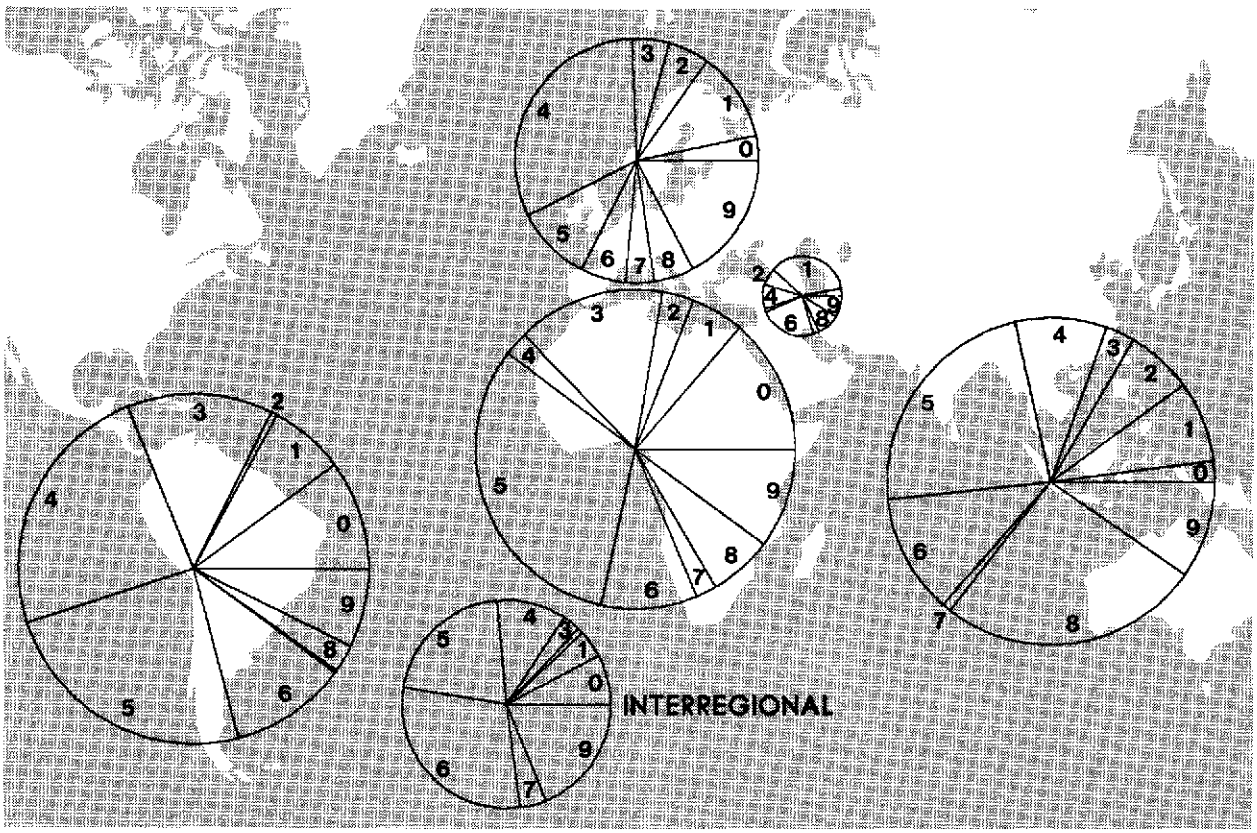
FIELD OF ACTIVITY		Year	Experts	Equipment	Fellow-ships	Share of total programme	
			$	$	$	$	%
General atomic energy development		1980	469.4	873.8	333.2	1 676.4	8.9
		1981	508.5	849.0	273.0	1 630.5	7.8
Nuclear physics		1980	246.5	826.2	443.9	1 516.6	8.1
		1981	304.7	993.4	308.8	1 606.9	7.7
Nuclear chemistry		1980	61.6	155.2	356.0	572.8	3.1
		1981	34.9	365.6	322.7	723.2	3.4
Prospecting, mining and processing of nuclear materials		1980	1 116.7	1 426.3	410.8	2 953.8	15.7
		1981	1 063.6	568.7	217.1	1 849.4	8.8
Nuclear engineering and technology		1980	735.7	1 315.1	1 548.4	3 599.2	19.1
		1981	673.7	1 544.1	893.5	3 111.3	14.8
Application of isotopes and radiation in	Agriculture	1980	919.9	1 697.6	1 036.1	3 653.6	19.4
		1981	1 095.4	2 315.2	1 450.0	4 860.6	23.2
	Medicine	1980	300.2	649.2	688.6	1 638.0	8.7
		1981	309.1	900.3	1 342.3	2 551.7	12.2
	Biology	1980	24.2	13.1	124.2	161.5	0.9
		1981	56.5	127.6	177.0	361.1	1.7
	Industry and Hydrology	1980	327.9	1 086.5	231.6	1 646.0	8.7
		1981	359.8	1 324.1	285.4	1 969.3	9.4
Safety in nuclear energy		1980	453.0	155.1	808.3	1 416.4	7.5
		1981	643.2	877.5	775.6	2296.3	11.0
Total assistance		1980	4 655.1	8 198.1	5 981.1	18 834.3	100.0
		1981	5 049.4	9 865.5	6 045.4	20 960.3	100.0
Ten-year total		1972-1981	32 534.4	46 826.8	33 554.0	112 915.2	100.0

Distribution of assistance by type

Type	1980 %	1981 %	1972-1981 %
Experts	24.7	24.1	28.8
Equipment	43.5	47.1	41.5
Fellowships	31.8	28.8	29.7
Total	100.0	100.0	100.0

FIGURE 4

DISTRIBUTION OF TECHNICAL CO-OPERATION INPUTS BY FIELD AND REGION



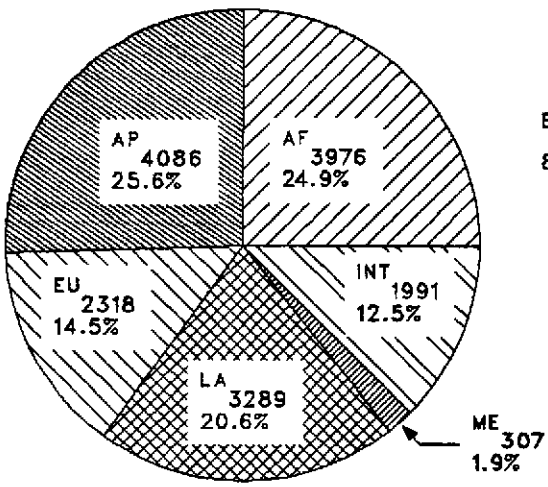
SUMMARY

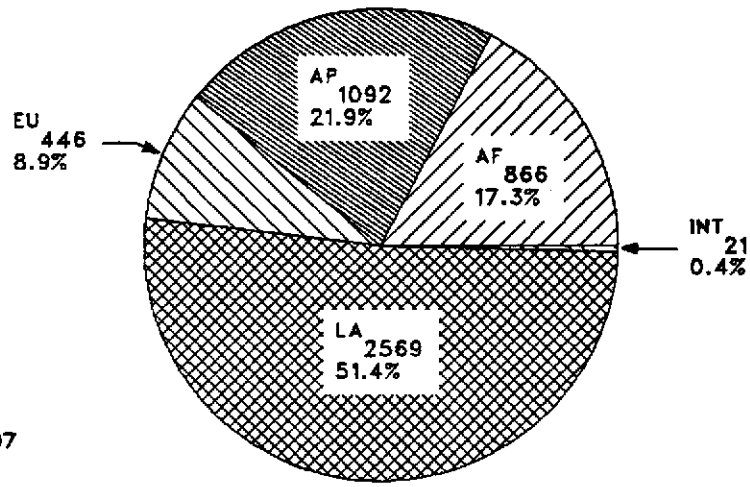
(in thousands of dollars)

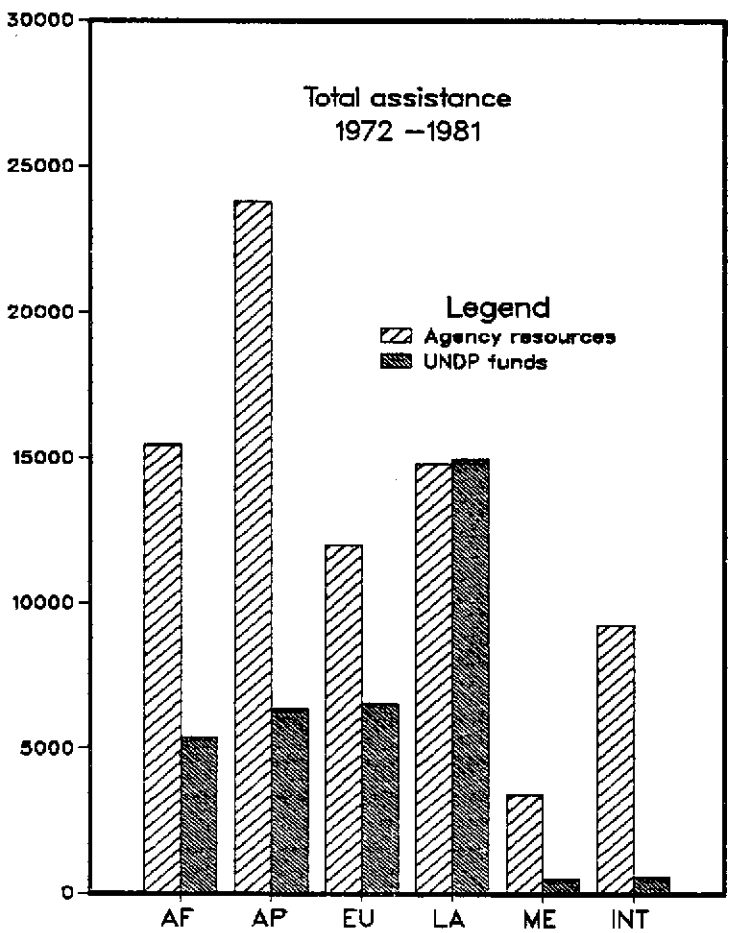
Field of activity	Africa $	Asia and the Pacific $	Europe $	Latin America $	Middle East $	Inter-regional $	All regions $
0 - General atomic energy development	668.7	106.0	91.3	597.4	9.9	157.2	1 630.5
1 - Nuclear physics	259.2	416.9	330.7	406.6	107.5	86.0	1 606.9
2 - Nuclear chemistry	155.1	340.1	150.7	37.8	21.6	17.9	723.2
3 - Prospecting, mining and processing of nuclear materials	724.0	147.6	138.0	784.7	-	55.1	1 849.4
4 - Nuclear engineering and technology	114.7	469.3	879.1	1 401.4	30.2	216.6	3 111.3
Application of isotopes and radiation in: 5 - Agriculture	1 545.7	1 201.8	277.0	1 409.1	4.0	423.0	4 860.6
Application of isotopes and radiation in: 6 - Medicine	470.7	614.0	167.7	631.2	71.2	596.9	2 551.7
Application of isotopes and radiation in: 7 - Biology	103.6	46.8	106.3	15.2	7.4	81.8	361.1
Application of isotopes and radiation in: 8 - Industry and Hydrology	311.4	1 333.9	145.3	150.4	28.3	-	1 969.3
9 - Safety in nuclear energy	488.9	501.2	478.1	423.9	26.7	377.5	2 296.3
Total	4 842.0	5 177.6	2 764.2	5 857.7	306.8	2 012.0	20 960.3

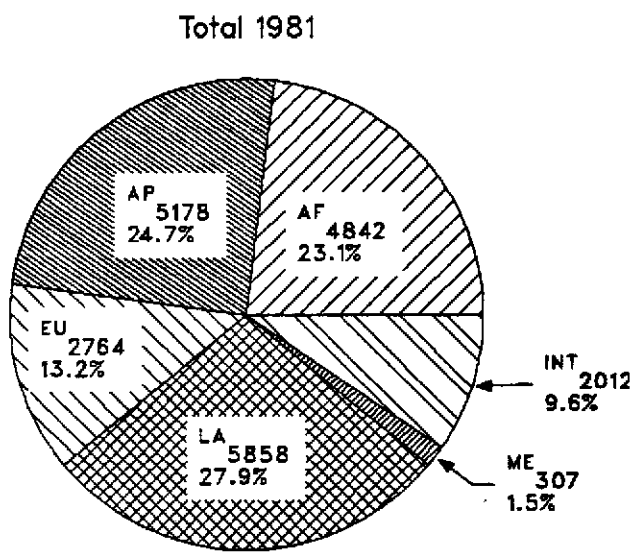
FIGURE 5

DISTRIBUTION OF TECHNICAL CO-OPERATION INPUTS BY REGION AND SOURCE
(in thousands of dollars)







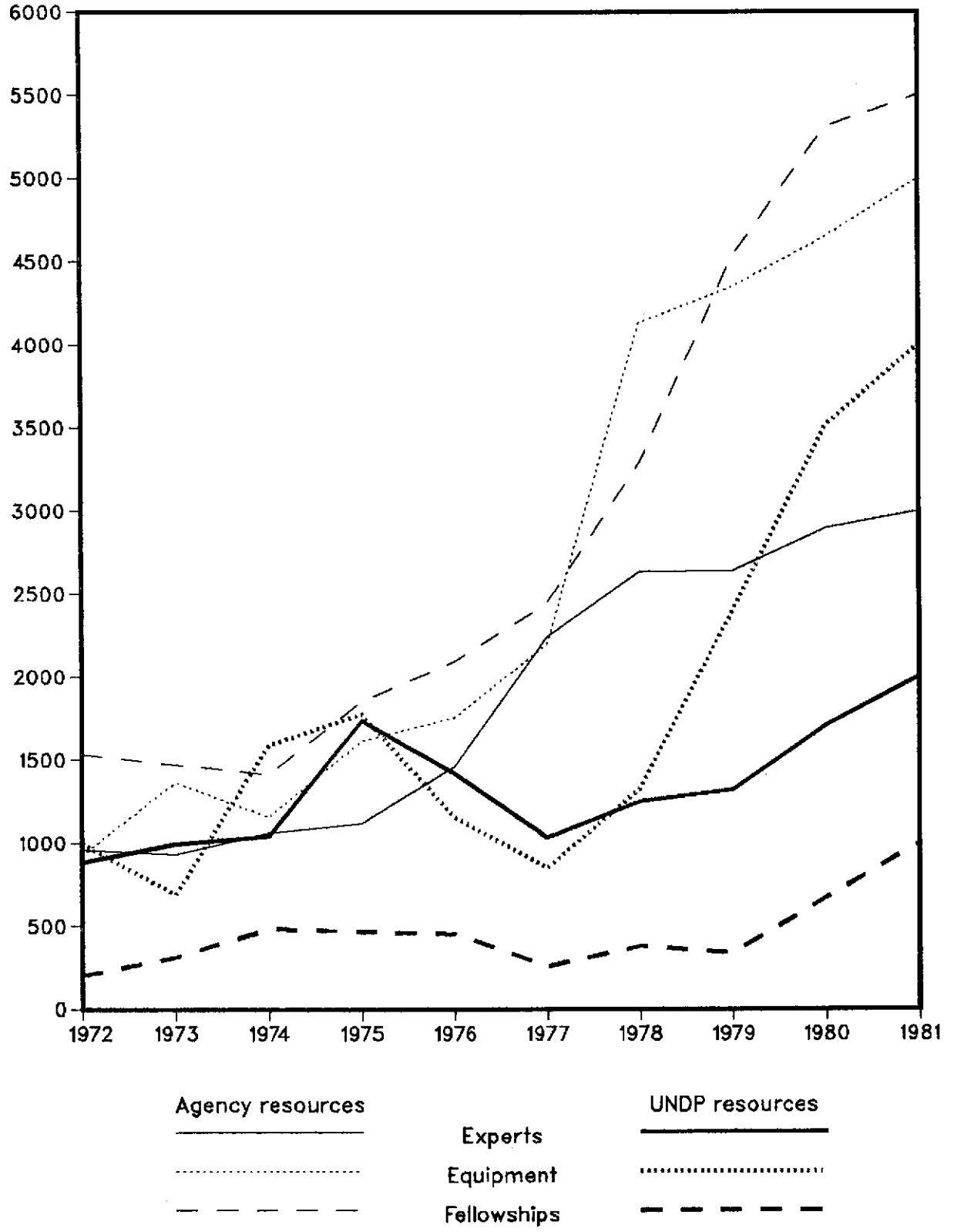


Abbreviations

AF = Africa
AP = Asia and the Pacific
EU = Europe
LA = Latin America
ME = Middle East
INT = Interregional

FIGURE 6

TRENDS IN THE TECHNICAL CO-OPERATION ACTIVITIES OF THE AGENCY
(in thousands of dollars)



General

74. Statistics collected by the Agency show that during 1981 the total installed nuclear power capacity in the world increased by 13%. This increase was due primarily to the entry into operation of nuclear power reactors in France, the Soviet Union and the United States, where there were growths of about 40%, 11% and 8% respectively. As shown in Table 1, at the end of last year 272 nuclear power reactors with a total capacity of 152 603 MW(e) were in operation in 23 countries, generating 9% of the world's total electricity; these reactors have accumulated 2600 reactor-years of operating experience. Also, 236 nuclear power reactors were under construction, which will bring the total installed nuclear capacity in the world to 373 GW(e). Present indications are that by 1985 nuclear power reactors will be generating 17% of the world's electricity.

75. However, there are wide differences within this overall picture. For example, in the United States cancellations and postponements of power reactors on order or even under construction have continued, and there is no certainty of any new power reactor orders in the coming years. In France, on the other hand, the new Government has confirmed the country's impressive nuclear power programme, and it is expected that by 1990 power reactors will be generating 70% of the electricity consumed there.

76. According to reports received by the Agency from Member States, last year seven reactors - with a total capacity of 7.4 GW(e) - were ordered in France, the Federal Republic of Germany, the Republic of Korea, Romania and Spain, and earlier orders for eight reactors - with a total capacity of 8 GW(e) - were either cancelled or postponed in the United States.

Table 1

Nuclear power reactors in operation and under construction at the end of 1981

Country[a/]	In operation		Under construction[b/]		Electricity supplied by nuclear power reactors in 1981	
	Number of units	Total MW(e)	Number of units	Total MW(e)	TW·h(e)	% share of total
Argentina	1	335	2	1 292	2.8	8.0
Belgium	3	1 664	4	3 807	12.2	25.3
Brazil			3	3 116		
Bulgaria	3	1 224	2	1 408	9.12	24.7
Canada	11	5 494	11	7 189	37.82	10.0
China, Republic of	3	2 159	3	2 765	12[c/]	n.a.[*/]
Cuba			1	408		
Czechoslovakia	2	800	6	2 520	5.13	7.0
Finland	4	2 160			14.0	35.8
France	30	21 595	26	28 585	99.5	37.7
German Democratic Republic	5	1 694	4	1 644	10[c/]	n.a.
Germany, Federal Republic of	14	8 606	10	10 636	50.7	14.6
Hungary			2	816		
India	4	809	4	880	2.89	n.a.
Italy	4	1 417	3	1 999	2.5	1.5
Japan	24	14 994	12	9 973	85.0	17.3
Korea, Republic of	1	564	8	6 869	2.90	7.2
Mexico			2	1 308		
Netherlands	2	501			3.5	5.7
Pakistan	1	125			0.2	5.5
Philippines			1	620		
Romania			1	660		
South Africa			2	1 842		
Spain	4	1 973	11	10 142	9.6	8.6
Sweden	9	6 415	3	3 025	34.10	35.3
Switzerland	4	1 940	1	942	14.46	28.1
Union of Soviet Socialist Republics	35	14 036	25	24 260	80[c/]	6.0[c/]
United Kingdom	32	6 458	10	6 480	33.2	12.7
United States of America	75	57 008	79	87 217	272.40	11.9
Yugoslavia	1	632			0[c/]	
World total	272	152 603	236	220 403	794	9

a/ An entry in this column does not imply the expression of any opinion whatsoever on the part of the Secretariat concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers.

b/ Construction in Austria and Iran has been interrupted and plants in these countries are not included.

c/ Except for the figures marked with this footnote reference, the last two columns contain nuclear electricity production figures received officially by the Agency.

*/ n.a. - not available.

77. At the end of 1981 there were nine developing countries with 34 nuclear power reactors in operation or under construction, with a total capacity of 21 GW(e).

78. It is expected that the number of developing countries with nuclear power programmes will increase to about 15-20 by the turn of the century, despite the difficulties of introducing a new and complex technology involving unprecedented infrastructure requirements. This represents a major challenge not only for the countries concerned but also for the Agency. In this connection, a major task of the Division of Nuclear Power in 1981 was to analyse the potential role of nuclear power in developing countries within the general energy supply situation and, where appropriate, to provide assistance, including infrastructure development assistance, with a view to the introduction of nuclear power.

Energy demand analysis and nuclear power planning

79. The Agency continued to co-operate with its developing Member States in the estimation of their future energy, electricity and nuclear power needs and in the planning of nuclear power programmes; for this purpose, the Energy and Economic Data Bank was further improved and the data required for the analysis of energy, electricity and nuclear power growth in Member States were updated. These data, together with some fairly simple energy growth models, were used in estimating the medium-term (1990-2000) prospects for nuclear power.

80. As shown in Table 2, it is expected that nuclear power will account for 430 GW(e), or nearly 12% of the world's electricity generating capacity, by 1990 (this estimate is based on figures for power reactors in operation and under construction or committed for a start of construction within the next two-three years). Current estimates for the year 2000 indicate a world-wide installed nuclear capacity of 740-1075 GW(e), or about 15% of world-wide installed electricity generating capacity.

81. Table 3 shows estimates of total electricity generation and the contribution of nuclear power to this total. As nuclear power generally provides base-load electricity, its share in the amount of electricity actually generated is likely to be higher than its proportion of installed capacity. It is estimated that its share of electricity generated will reach 18% in 1990 and about 23% in the year 2000; however, it should be borne in mind that longer-term estimates, particularly those for more than ten years ahead, are inevitably less reliable.

Table 2

Estimates of total and nuclear electricity generating capacity by main country groups (unit: GW(e))

Country group	1981			1990			2000 (projected)		
	Total	Nuclear	%	Total[c]	Nuclear[a]	%	Total[c]	Nuclear	%[c]
1. OECD North America	748	63	8	1063	145	14	1405	185-235	15
2. OECD Europe	468	53	12	734	150	20	1100	225-315	24
3. OECD Pacific	193	15	8	340	31	9	510	90-130	22
4. CPE Europe[b]	404	18	4	746	79	11	1200	160-240	17
5. Asia[d]	152	3.7	2	402	16	4	1040	45-80	6
6. Latin America	107	0.3	0.3	183	6.9	4	345	20-45	9
7. Africa and Middle East	67	-	-	122	3.3	2	270	15-30	8
World total[e]	2139	153	7	3600	430	12	5870	740-1075	15
a. Market-economy industrialized countries[e,f]	1410	131	9	2170	328	16	3060	500-680	20
b. CPE Europe[e]	404	18	4	750	79	11	1200	160-240	13
c. Developing countries outside CPE Europe[d,e]	325	4	1	680	24	4	1610	80-155	7

a/ Based on plants already in operation, under construction or committed for a start of construction within the next two-three years.

b/ CPE Europe = European countries with centrally planned economies, including Yugoslavia.

c/ Average of high and low estimates.

d/ Includes the "Republic of China".

e/ Capacity figures for 1990 and 2000 are rounded.

f/ Includes country groups 1, 2 and 3 plus Israel and South Africa.

Table 3

Estimates of total electricity generation and of the contribution of nuclear power by main country groups (unit: TW·h)

Country group	1981			1990			2000[a/]		
	Total	Nuclear	%	Total	Nuclear	%	Total	Nuclear	%
World total	8751	794	9	15 000	2600	18	24 600	5600	23
1. Market-economy industrialized countries	5662	668	12	8 600	2000	23	12 100	3600	30
2. CPE Europe	1955	104	5	3 600	485	13	5 700	1300	21
3. Developing countries outside CPE Europe	1134	22	2	2 800	150	5	5 800	700	10

a/ Average of high and low estimates.

82. These estimates reflect different degrees of reliance on nuclear power in different countries. Some - such as Argentina, Brazil, France, India, Japan, the Republic of Korea, Mexico, the Soviet Union and other CMEA countries, and Spain - have strong nuclear power development programmes; in others, more modest nuclear power development is foreseen; and in countries such as the Federal Republic of Germany, Italy, Sweden, Switzerland and the United States the nuclear power programmes have slowed down considerably, though in most of them the share of nuclear power in electricity generation is already high and will increase during the present decade. However, as the world energy supply situation worsens, which it is likely to do, there will probably have to be increased reliance on nuclear power for avoiding grave consequences for the world in general and developing countries in particular - as pointed out by, for example, the World Energy Conference.

83. During 1981 the Agency initiated work aimed at improving its methodologies for projecting future energy demands at the global, regional and country level, and thereby improving its estimates - such as those just described - of the role of nuclear power in meeting the energy needs of the world in general and the developing regions in particular. A consultants' meeting was held on this subject, with the participation of experts from a number of other international organizations.

84. A preliminary version of a model for the analysis of energy demand (MAED) was developed and used in a nuclear power planning study carried out in Algeria. The third version of the WASP (Wien Automatic System Planning Package) methodology for planning the expansion of electric power generation systems was completed and distributed on request to 40 Member States; it was used in the nuclear power planning study in Algeria and in an electric power system planning study for Morocco.

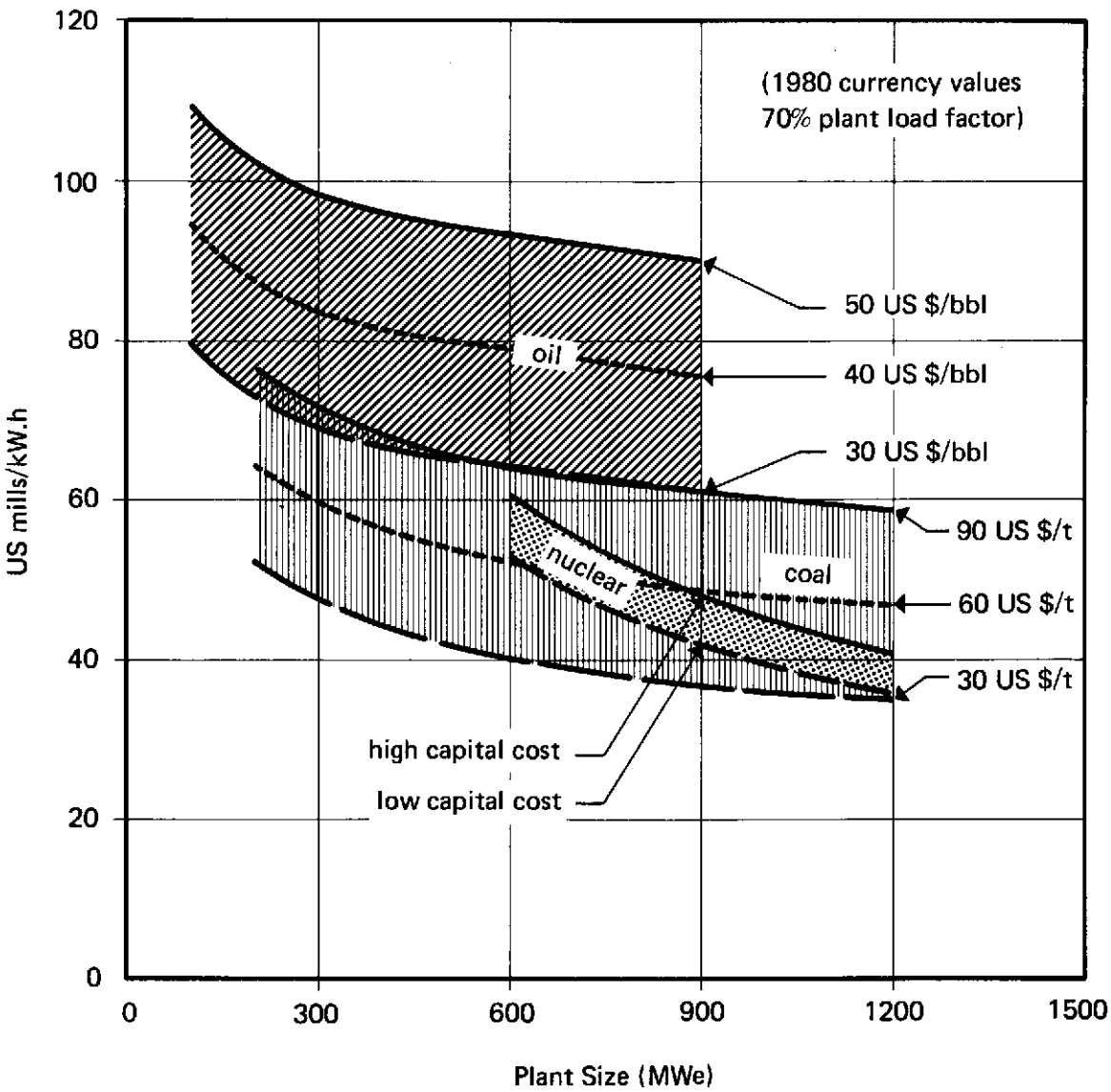
85. The fourth session of the interregional training course on "The Role of Nuclear Energy Within a National Energy Plan" was held in Madrid, Spain. A training manual on this subject was written for publication in 1982.

Economics of nuclear power

86. The economic competitiveness of nuclear power reactors in relation to conventional power plants was studied in detail with the help of consultants, and a draft report on capital cost experience in the United States was prepared for publication in 1982. On the basis of this work, Figure 7 presents the latest Agency estimates of the costs of electricity generated by nuclear, coal-fired and oil-fired power plants. These estimates support the conclusion that nuclear power plants of the sizes at present available on the market have and will continue to have electricity generation costs substantially lower than those of oil-fired plants, and that in many situations large nuclear power reactors can produce electricity at costs substantially below the costs of electricity from coal-fired power plants. In other situations (for example, when low-cost coal is available), coal-fired plants can produce electricity at costs competitive with or lower than the costs of electricity from nuclear power reactors.

FIGURE 7

Estimated cost of electricity generated by nuclear, coal- and oil-fired plants starting operation in 1990



87. The Agency held a consultants' meeting in 1981 as the initial step towards launching in 1982 a co-ordinated research programme on the broad economic implications of nuclear power programmes in developing countries, involving an analysis of the total economic effects of nuclear power programmes on energy and electricity supply markets and on national economic and industrial development.

Nuclear power programme implementation

88. In response to the need to strengthen infrastructures in developing countries, the Agency continued to assist in manpower development for nuclear power programmes; several advisory missions concerned with manpower and infrastructure development requirements visited developing Member States.

89. The Agency's nuclear power training programme, launched in 1975, continued to attract interest. By the end of 1981, more than 1000 trainees from 56 countries had participated in the courses organized under this programme. A first examination was made, with the help of experts, of ways in which the Agency could provide practical training for engineers and technicians in a more systematic manner - for example, through national technology centres.

90. Work continued on the series of guidebooks being developed by the Agency - a guidebook on "Technical Evaluation of Bids for Nuclear Power Plants" was published and guidebooks on "Introduction of Nuclear Power", "Interaction of Grid Characteristics with Design and Performance of Nuclear Power Plants" and "Nuclear Power Plant Instrumentation and Control" were prepared for publication in 1982.

91. A specialists' meeting addressed problems associated with the acquisition of nuclear power plant control and instrumentation technology in developing countries.

Nuclear power plant technology

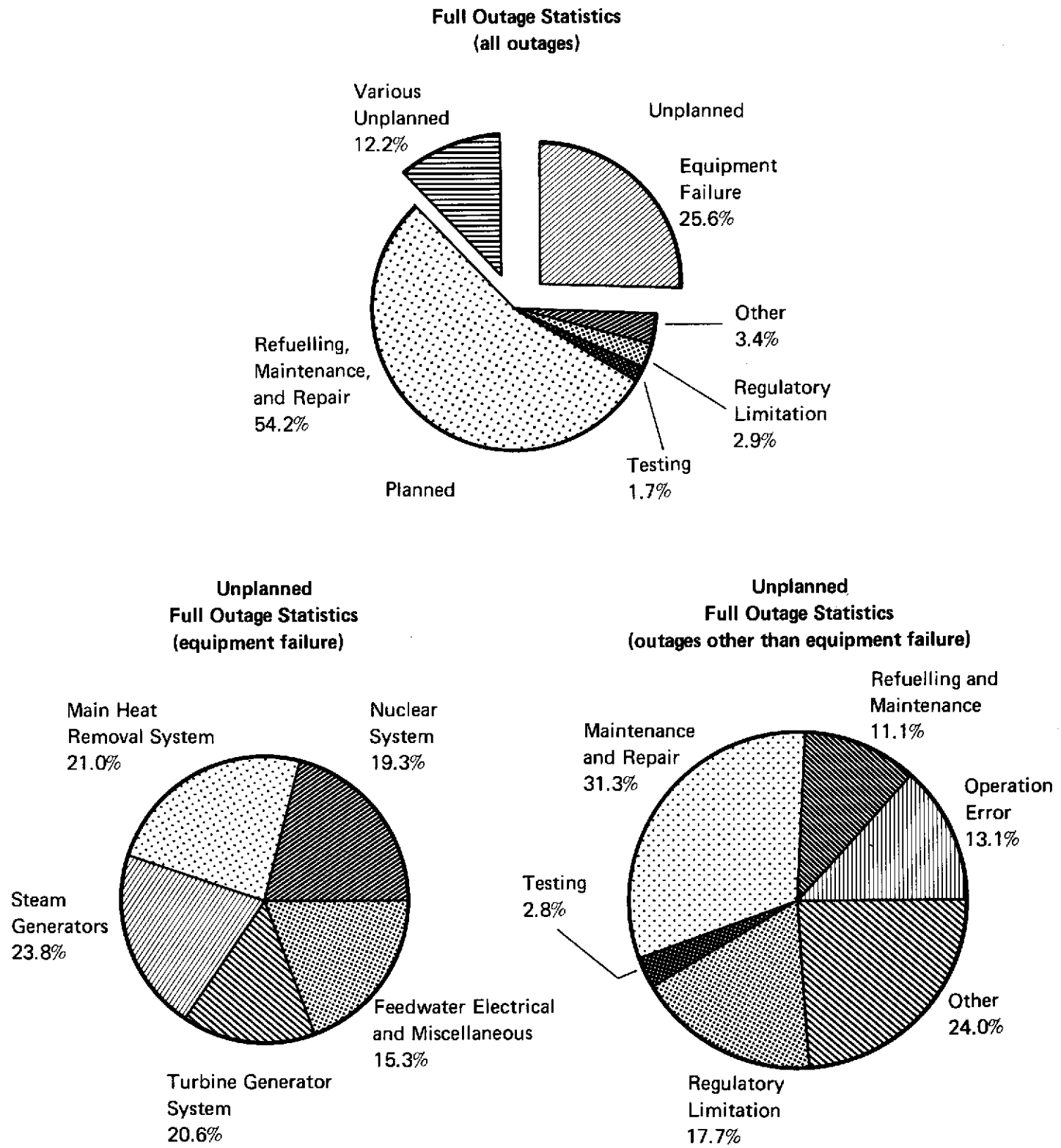
92. The code of practice and seven of the ten safety guides on quality assurance foreseen under the Nuclear Safety Standards (NUSS) programme have been published. A review symposium on quality assurance confirmed the importance which these guides have in assisting the establishment of national regulations and practices. Specialists' meetings focused on safety and reliability issues related to radiation embrittlement and defect propagation in pressure components - issues of considerable current significance.

93. On the basis of operating experience data collected by the Agency for most nuclear power plants since their start-ups, a statistical analysis was made of some 8000 outages; the preliminary results are shown in Figure 8.

94. A number of Member States displayed interest in small and medium power reactors, for which several updated design concepts have recently been developed by manufacturers. These concepts envisage reactors of greater simplicity and conservatism than large power reactors and, in some cases, with greater possibilities for shop fabrication. The economic competitiveness of small and medium power reactors is still uncertain, but they might compare favourably with oil-fired power plants from 200-300 MW(e) upwards. In this connection, there was a continuation of activities relating to special concepts of nuclear reactor suitable for the generation of low-temperature heat for use

in district heating and in industry: two such reactors are under construction in the Soviet Union and the SECURE concept, developed in Sweden, is being considered for use in Finland. These developments were presented at an information meeting held in conjunction with the 1981 session of the General Conference.

FIGURE 8



95. The progress of current LMFBR demonstration programmes, in which eight large LMFBRs are in operation or under construction (Table 4), was reviewed by the International Working Group on Fast Reactors (IWGFR) and work was initiated on a technical report summarizing the status of FBR development. The IWGFR assisted in programming three specialists' meetings on FBR technology topics relevant to the operational safety of fast reactors, including fuel failure detection and location in LMFBRs, design features affecting the dynamic behaviour of fast reactor cores and boiling noise detection in sodium.

Table 4

Large demonstration LMFBRs in operation or under construction

LMFBR	Country	Power	Start of operation
MONJU	Japan	280 MW(e)	1987
SNR-300	Germany, Federal Republic of[a/]	300 MW(e)	1985
Phénix	France	250 MW(e)	1974
Super-Phénix (commercial prototype)	France	1200 MW(e)	1983
PFR	UK	250 MW(e)	1979
BN-350	USSR	150 MW(e)[b/]	1973
BN-600	USSR	600 MW(e)	1980
CRBR	USA	375 MW(e)	

a/ In co-operation with Belgium and the Netherlands.

b/ In addition, 700 MW(th) is used for water desalination.

96. The International Working Group on Gas-Cooled Reactors (IWGGCR), which is preparing a report on the status and application potential of HTRs, reviewed the status of current HTR development programmes - including programmes relating to the application of high-temperature process heat. With the assistance of the IWGGCR, the development status of materials for the components of reactors designed to generate high-temperature process heat was reviewed; it was concluded that the materials data now existing are enough to serve as a basis for the design of a 950°C HTR for process heat production if replaceable high-temperature components and rigorous in-service inspection procedures are employed.

97. The development status of several other advanced gas-cooled reactor concepts - including gas-cooled breeders - was reviewed.

98. Fusion scientists and engineers evaluated recent progress made towards achieving practical fusion power and identified various outstanding technological issues, such as the important need to develop durable, radiation-resistant materials and the difficulty of simulating the radiation environments that will be encountered in fusion reactors. International co-operation in the development and testing of fusion reactor materials was urged.

Reactor physics

99. A co-ordinated research programme was started on computer codes that would be suitable for in-core fuel management analysis using computers typically available in developing countries. Basic codes for the leading commercial power reactor types have been selected for use as an integrated set, improved and adapted for use with the main types of computer.

General

100. The Department of Technical Operations was reorganized with effect from 1 January 1981 and the Nuclear Fuel Cycle Division formed, with two sub-programmes: "Nuclear materials and fuel cycle technology" and "Waste management". In addition, the Division provides technical support for the International Plutonium Storage and International Spent Fuel Management studies and for the Committee on Assurances of Supply.

101. The uranium industry is passing through a depressed phase, largely as a result of reductions in projections of nuclear power growth. The uranium price has gone down to \$23.5-\$25.0/lb U_3O_8 and operations at many uranium workings have been curtailed or totally stopped. For the time being, the emphasis in commercially oriented national programmes has shifted from finding new (often low-grade) resources to improving the economics and efficiency of production so as to maintain profitability. This shift will be reflected in the work of the Agency, but activities of a regular character and with long-term implications will remain unaffected. One such activity of importance is the continuance of the periodic NEA/IAEA reports on uranium resources, production and demand (the "Red Book").

102. In the area of fuel performance and technology, which is important from the point of view of reactor safety and economics, a guidebook was prepared on quality control in water reactor fuel fabrication technology. In the areas of spent fuel management, a co-ordinated research programme on the behaviour of spent fuel assemblies during extended storage was initiated.

103. The Agency continued to review and compile information on and to encourage research in the handling, treatment and disposal of radioactive waste; it provided a medium for the exchange of information among many Member States, whose waste management programmes it hopes to expedite by acting as a catalyst.

104. Among the major events of 1981 were a symposium on the migration of long-lived radionuclides in the terrestrial environment, organized by the Agency jointly with NEA, and a seminar on the management of wastes from nuclear power plants.

Nuclear materials and fuel cycle technology

Uranium resources and production

105. The joint NEA/IAEA Steering Group and Working Party on Uranium Resources continued their efforts to improve the definition of their data base and the methods used in collecting and evaluating information.[6] A new NEA/IAEA "Uranium Resources, Production and Demand" report was prepared for publication early in 1982. Table 5 gives uranium resource figures based on information available on 1 January 1981.

[6] GC(XXV)/642, para. 74.

Table 5

Reasonably assured and estimated additional uranium resources[a/]
(thousands tonnes U; data available on 1 January 1981)

	Reasonably assured		Estimated additional	
	$80/kg U ($30/lb U_3O_8)	$130/kg U[b/] ($50/lb U_3O_8)	$80/kg U ($30/lb U_3O_8)	$130/kg U[b/] ($50/lb U_3O_8)
North America	595	893	1043	1879
United States of America	362	605	681	1097
Canada	230	258	358	760
Mexico	3	3	4	6
Greenland (Denmark)	0	27	0	16
Africa	591	726	169	301
South Africa	247	356	84	175
Niger	160	160	53	53
Namibia	119	135	30	53
Algeria	26	26	0	0
Gabon	19	22	0	10
Central African Republic	18	18	0	0
Zaire	2	2	2	2
Somalia	0	7	0	3
Egypt	0	0	0	5
Australia	294	317	264	285
Europe	84	157	45	130
France	59	75	28	47
Spain	13	16	9	9
Portugal	7	8	3	3
Turkey	3	5	0	0
United Kingdom	0	0	0	7
Germany, Federal Republic of	1	5	2	9
Italy	0	2	0	2
Austria	0	0	1	2
Sweden	0	38	0	44
Finland	0	3	0	0
Greece	1	5	2	7
Asia	40	51	1	25
India	32	32	1	25
Japan	8	8	0	0
Korea, Republic of	0	11	0	0
South America	144	149	85	101
Brazil	119	119	81	81
Argentina	25	30	4	13
Chile	0	0	0	7
TOTAL (rounded)	1748	2293	1607	2721

a/ This table does not give figures for countries with centrally planned economies.
b/ Includes resources at $80/kg U level.

106. Significant progress was made by a working group on uranium geology, particularly in eight projects sponsored by the NEA/IAEA joint group of experts to improve the effectiveness of uranium exploration techniques. Two technical manuals on uranium prospecting and exploration were prepared for publication.

107. Significant progress was also made in developing the International Uranium Geology Information System (INTURGEO); computer software was developed and the data collection format was finalized.

108. A joint NEA/IAEA working group on uranium extraction reviewed world experience in the field of uranium milling technology.

Fuel performance and technology

109. Emphasis was placed by the Agency on studying improvements in fuel utilization, reliability and safety. The standing working group on fuel performance and technology reviewed work done in the past and recommended a programme for the future; in line with its recommendations, specialists' meetings were held on subjects such as the behaviour of fuel under high burn-up conditions, coolant/cladding interactions and the post-irradiation examination of nuclear fuel.

110. A guidebook on quality control in water reactor fuel fabrication technology was prepared for publication.

111. Co-ordinated research programmes on the computer modelling of fuel performance and on corrosion and water chemistry were initiated.

Spent fuel management

112. The Agency continued to collect and analyse information on experience in storing LWR spent fuel in water-filled pools. With the help of consultants, a world survey on the subject was prepared for publication.

113. Preparation of a guidebook on spent fuel storage and a co-ordinated research programme on the behaviour of spent fuel in wet storage for extended periods were started.

114. Data on the operational status of nuclear fuel cycle facilities including fuel fabrication plants and spent fuel storage and reprocessing facilities were collected and evaluated; a report is being published in 1982.

Waste management

Handling and treatment of radioactive wastes

115. The Agency held technical and advisory group meetings on many subjects in this field and issued publications on: (a) alpha-contaminated wastes; (b) tritium-bearing wastes; (c) wastes from the refining and conversion of uranium concentrates; (d) spent ion-exchange resins; and (e) solidified high-level waste forms. The Agency also issued publications on current practices and options for the confinement of uranium mill tailings and the decontamination of operational nuclear power plants.

116. Reports on the following subjects were prepared for publication:

- The evaluation of actinide partitioning and transmutation,
- The conditioning of low-intermediate level radioactive waste concentrates,
- The control of semi-volatile radionuclides in gaseous effluents at nuclear facilities,
- The treatment of low-intermediate level solid wastes.

117. In addition, the Agency completed work on a nuclear waste management glossary and co-operated with WHO in the preparation of a report on the health implications of high-level waste management.

118. Work continued on the preparation of reports on the treatment of low-intermediate level liquid waste, the testing and in-plant monitoring of off-gas cleaning systems, the handling and storage of conditioned high-level waste, and the retention of gaseous radionuclides from nuclear power plants under normal and accident conditions. Work on a code of practice for the management of radioactive waste from nuclear power plants was initiated. Also, new activities relating to the decommissioning of nuclear facilities and the conditioning of radioactive waste for storage and disposal were initiated.

119. A seminar was held on the management of radioactive waste from nuclear power plants.

120. Co-ordinated research programmes continued on the evaluation of high-level waste forms, the handling of tritium-contaminated effluents and wastes, the treatment of spent ion-exchange resins, and methods for testing particulate filters.

Underground disposal of radioactive waste

121. Within the framework of an integrated programme started in 1978, work on the preparation of Safety Series and Technical Reports Series documents giving guidance and information on all subjects of interest for the underground disposal of radioactive waste continued, with emphasis on shallow ground and rock cavity disposal and on the development of criteria; these documents cover generic, regulatory and safety aspects of the siting, design, construction, operation, shut-down and surveillance of repositories for different disposal options ranging from shallow ground to deep geological disposal.

122. Of the 20 documents to be issued in the first stage of the programme (up to 1984), seven were issued or completed for publication and four reached an advanced stage of preparation. Three Safety Series documents (one with basic guidance, one on shallow ground disposal and one on safety assessments) were published and two Technical Reports Series documents (on site investigations for deep geological and shallow ground disposal) were completed for publication.

Environmental aspects of nuclear energy

123. The Agency published the proceedings of a symposium (held in 1980) on impacts of radionuclide releases into the marine environment and technical documents on: (a) identifying transuranic speciation in aquatic environments; (b) environmental effects of cooling systems; (c) tritium in some ecosystems; (d) the packaging of radioactive waste for sea disposal; and (e) de minimis quantities of radioactive waste for dumping at sea under a general permit. Also, it prepared a Safety Series document on generic models and parameters for assessing the environmental transfer of radionuclides to man.

124. The Agency, jointly with NEA and CEC, held a symposium on the migration of long-lived radionuclides in the terrestrial environment. Advisory groups considered the pathways of radionuclides of regional and global concern from the nuclear fuel cycle and aspects of defining de minimis levels for the release of very low-level radioactive waste into the terrestrial environment as non-hazardous waste.

125. Co-ordinated research programmes on the migration in the terrestrial environment of radionuclides from waste storage facilities and on transuranic cycling in the marine environment were terminated; with regard to the latter programme, follow-up studies will be carried out by the International Laboratory of Marine Radioactivity, Monaco.

126. Work on reviewing the oceanographic model underlying the Agency's definition of radioactive waste unsuitable for dumping at sea under the London Dumping Convention was continued by a GESAMP (Group of Experts on the Scientific Aspects of Marine Pollution) working group sponsored by UNESCO, IMCO, UNEP and the Agency.

General

127. Although world-wide nuclear safety activities are no longer dominated by detailed evaluations of the Three Mile Island accident of March 1979 or by discussions over the clean-up plans, the many lessons learned from it continue to have a major influence. The accident was the result of a complex of factors - equipment failures together with design and operator errors - but the primary lesson in reactor safety was the need for more attention by all parts of the nuclear industry to important aspects of safe operation. Particularly singled out in many of the evaluations was the importance of the human factor in the prevention of and response to accidents.

128. Thus, much attention is now being focused on upgrading the qualification and training of electrical utility management and technical support staff as well as of plant operating personnel, on the evaluation and feedback of plant operating experience, and on the man-machine interface. In the latter area, recognition has been given to the importance of reducing the probability of human error in plant operation. This is being achieved through control-room designs that provide for a better presentation of information, grouping of displays and layout of panels, and by ensuring more automation during emergency response periods.

129. Experience at Three Mile Island also showed the importance of adequate emergency preparedness and advance planning. National planning is essential, but bilateral and multilateral agreements for mutual assistance between Member States may also be important. Several such agreemnts have been concluded in the past few years and others are under discussion.

130. An additional item high on the nuclear safety agenda is the need for a better understanding and more accurate descriptions of possible accidents and of the range of consequences which might realistically be anticipated. To assist in meeting this need, probabilistic risk analysis techniques are being used increasingly in the study not only of specific safety systems but also of the functioning of entire power plants. Similar techniques are being used in the calculation of potential consequences.

131. At the Agency, the expanded nuclear safety activities established over the past few years are continuing. An important feature has been the emphasis on encouraging and assisting Member States to implement - inter alia - the codes and guides of the Nuclear Safety Standards (NUSS) programme, the recently revised Basic Safety Standards for Radiation Protection, the Regulations for the Safe Transport of Radioactive Materials and the guidance being developed for emergency planning and preparedness. These are drawn upon by the Agency's staff and provide a framework for disseminating information during Agency-sponsored missions, seminars and training courses.

132. Two significant meetings designed to foster international nuclear safety co-operation were held in 1981: one started the Agency's efforts towards the world-wide collection, analysis and dissemination of information concerning abnormal operating experience; the other was held to encourage international co-operation in safety research. Greater emphasis is now being given to the exchange of technical information on current safety issues; for example, a specialists' meeting was held to identify problem areas in arriving at more realistic predictions of the airborne fission products released during an accident in which the reactor core is severely damaged.

133. Developing countries embarking on or planning nuclear power programmes continued to receive nuclear safety assistance and advice directed to their particular needs. Also, the Agency sponsored three seminars, eight training courses, and 12 advisory missions covering radiation protection, safety standards, specific safety problems and emergency planning.

134. The continuing emphasis on nuclear safety in the international community should help to keep intact the nuclear industry's notable record of having avoided any identifiable radiation-induced death or serious radiation-induced injury at any nuclear power plant.

Radiological safety

Radiation protection

135. A highlight of 1981 was the approval by the Board of Governors of the Agency's revised Basic Safety Standards for Radiation Protection (Safety Series No. 9). These standards, first issued in 1962 and revised in 1967, are based on recommendations of the International Commission on Radiological Protection (ICRP); they were developed by the Agency jointly with WHO, ILO and NEA. They are intended to serve as guidelines for Member States and are written in a form that can serve as a regulatory basis for the radiation protection of workers and of members of the general public. It is hoped that the latest revision, directed towards controlling risks from the use of ionizing radiation, will enhance the protection of workers and of the general public. The Agency believes that the basic safety philosophy and the sophisticated techniques of radiation protection based on these standards could serve as an example in industrial activities involving other hazards to man.

136. An important aspect of the revised Basic Safety Standards is the emphasis now being given to the requirement that all radiation exposures be "as low as reasonably achievable" - the first example of a system of protection which, although it already provides adequate safety to all individuals, still requires consideration of a further decrease in the remaining potential hazard. This aspect featured prominently at an Agency symposium on application of the ICRP dose limitation system at nuclear fuel cycle facilities, organized in co-sponsorship with WHO, NEA and ICRP and attended by almost 300 participants from 37 countries and eight international organizations.

137. During the year, additional documents on various aspects of radiation protection were completed and/or published; the subjects covered were safety aspects of the design and equipment of hot laboratories, estimation of the environmental transfer of plutonium and the dose to man, neutron monitoring for radiological protection, dosimetry for criticality accidents, and fusion safety.

138. Safety missions were sent to six developing Member States to advise on radiation protection practices. Five training courses were held at which staff members served as lecturers.

139. Research in Member States continued to be supported through co-ordinated research programmes on the following subjects: radioecology of the River Danube; radioactivity monitoring in the Baltic Sea; chromosome aberration analysis; carbon-14 from nuclear facilities; and lung monitoring for plutonium. The Danube study is nearing completion, while the others will continue for several years.

Emergency assistance

140. Early in 1981 the Agency began to implement recommendations contained in a programme plan on emergency preparedness proposed by a technical committee. The programme activities, which will increase significantly with time, resulted in the publication of a document on planning for off-site response to radiation accidents in nuclear facilities (Safety Series No. 55) and the completion of an emergency planning guide for transportation accidents involving radioactive material.

141. A seminar for Asian and Pacific-region countries was held on the health physics and medical aspects of emergency preparedness, and missions were sent to two Member States to assist in the evaluation and further development of emergency plans for their new nuclear power plants. The Agency prepared a new training course on emergency planning and preparedness - to be given for the first time during 1982, in the United States.

Safe transport

142. The Standing Advisory Group on the Safe Transport of Radioactive Materials (SAGSTRAM) reviewed the Agency's programme on transport safety. Work continued on a comprehensive review of the Regulations for the Safe Transport of Radioactive Materials (Safety Series No. 6), an updated version of which is planned for 1984; in the interests of uniformity and compatibility, most national and international organizations base their regulations on those of the Agency. An explanatory document on the Agency's Regulations and a quality assurance guide for radioactive materials packaging were produced for the purpose of assisting Member States in implementing the Regulations and ensuring compliance with them. An advisory mission visited Hungary and a training course for personnel from developing countries on transport regulations, to be held in the United Kingdom in 1982, was prepared.

143. An expanded programme was initiated for collecting data on types and quantities of radioactive materials shipments and on the approved transport package designs in Member States. The data collection will be a major source of information for Member States wishing to control and expedite the transport of radioactive materials.

Safety of nuclear installations

NUSS programme

144. In 1974 the Agency initiated an ambitious programme - NUSS - to develop internationally agreed safety standards for nuclear power plants. Preparation of the basic NUSS documents is now nearing completion; all five codes of practice have been published in the Agency's four working languages and 37 of 57 planned safety guides have been completed (26 of them have already been published in English and many in the other working languages). Considerable effort - through advisory missions, seminars and training courses - is now being devoted to helping Member States to use these documents; in 1981, Greece and Indonesia became the third and fourth countries to receive special NUSS missions.

Advisory services and training

145. Advisory services and training courses are directed primarily towards developing countries that are embarking on or planning nuclear power programmes. In 1981, the Agency examined and advised on the structure of Mexico's nuclear regulatory body; an Agency mission visited Yugoslavia to advise on the initial start-up phase of the Krško power reactor; reactor centres in Austria, Hungary and Yugoslavia were given assistance with the use of the highly complex computer codes frequently needed in safety evaluations.

146. Various aspects of nuclear safety were covered at five international training courses (two in France, two in the United States and one in the Federal Republic of Germany) and three national training courses (one each in Argentina, Egypt and the German Democratic Republic). In addition, seminars on the safety of two-loop PWRs and on safety reviews and inspections were held in Vienna. Such courses and seminars continue to be well attended.

Risk assessment

147. As part of the Agency's risk assessment activities, which are gaining greater recognition, presentations were made at five international meetings and eight scientific papers were published. A study completed in 1981 showed that the risks of nuclear power compare favourably with those of the total fuel cycle of coal, natural gas and solar systems.

148. The attitudes towards nuclear power and other energy systems of various groups within the general public in Austria, Brazil, the Federal Republic of Germany and the Philippines were elicited using a questionnaire developed by the Agency; the results are being analysed and interpreted in order to gain a better understanding of the structure of public attitudes.

Exchange of information

149. The Agency continued to provide a forum for the exchange of technical information in the field of nuclear safety and to work for the wider dissemination of available results and the identification of areas of major interest for possible co-operation. A meeting in Vienna initiated efforts to make the Agency a focal point for the worldwide collection, analysis and dissemination of information concerning significant abnormal operating experience, with a view to the feedback of this information to regulators, designers and operators. A meeting in Moscow was held to encourage the exchange of safety research information.

General

150. The joint FAO/IAEA programme has continued to help developing Member States solve economically important agricultural problems by the application of isotope and radiation techniques. The activities embrace: soil fertility, irrigation and crop production; plant breeding and genetics; the control of insects and other pests; studies of agro-chemicals and residues; research aimed at improving the health and productivity of animals; and food preservation.

151. During 1981, support was given to 86 technical co-operation projects in 46 developing Member States. More than 300 laboratories and other institutes took part in 25 co-ordinated research programmes financed by the Agency, and in several cases also supported by the Federal Republic of Germany and Sweden. In addition, eight training courses and study tours were held and programming missions visited Egypt, Sudan, Uruguay and Viet Nam.

Improving crop production

152. Isotopic techniques developed by participants in the co-ordinated research programme on the biological fixation of nitrogen [7] showed that the proportion of atmosphere-derived nitrogen in a legume crop increased when the plants were supplied with adequate phosphorus. Certain types and varieties of legumes were more capable than others of obtaining a high proportion of their nitrogen from the atmosphere even in the presence of available soil nitrogen. It may thus be possible to develop legumes which will utilize atmospheric nitrogen while leaving the soil nitrogen for an intercropped cereal or a subsequent crop.

153. FAO/IAEA/SIDA training courses on the use of isotope and radiation techniques in studies of soil-plant relationships were held at the Agency's Laboratory at Seibersdorf, near Vienna, and in Mexico. An FAO/IAEA course in Leipzig, German Democratic Republic, provided training in the use of nitrogen-15 in soil and crop research, and one at Cadarache, France, focused on the use of nuclear techniques in soil water studies. A study tour on the application of nuclear techniques in agriculture visited several research institutes in the Soviet Union.

154. In the field of plant breeding and genetics, six co-ordinated research programmes aimed at improving the yield and economic value of major crop plants through the induction, selection and direct and/or indirect use of mutants continued, with 70 institutes in 34 Member States participating. Encouraging results were obtained and new varieties of rice, wheat, barley, groundnut, pea, bean, sugar cane, castor bean and other crop plants were released.

155. An FAO/IAEA symposium reviewed the potential for using induced mutants in various fields of plant research. Also, four research co-ordination meetings reviewed developments in:

(a) The evaluation of semi-dwarf cereal mutants as cross-breeding material;

(b) Mutation induction for improving grain legume production;

(c) Mutation induction for increasing the disease resistance of crop plants; and

(d) Mutation induction for increasing the disease resistance of grain legumes.

[7] GC(XXV)/642, para. 112.

156. A consultants' meeting on the induction of mutations in extra-nuclear hereditary cell elements prepared the basis for future work on the manipulation of cytoplasmic inherited traits.

157. The Agency maintains a computerized list (published in the "Mutation Breeding Newsletter") of officially released mutant varieties of seed-propagated and vegetatively propagated crops (including ornamentals). By the end of 1981, more than 450 such mutant varieties had been released.

Insect control

158. The Agency continued to advise the Mexican authorities in their large-scale campaign against the Mediterranean fruit fly (medfly).[8] Also, assistance was provided to Egypt and Peru in planning and initiating a programme for the release of sterile medflies.

159. A co-ordinated research programme on the development of a method for the genetic sexing of medflies was started in order to reduce rearing, sterilization and release costs and to prevent the stinging of fruit and vegetables by sterile females.

160. The BICOT project[9] on the Vom plateau, Nigeria[10], which is supported by Belgium, the Federal Republic of Germany, Italy, Sweden and the United Kingdom, is now mass rearing tsetse flies and conducting ecological studies.

161. Institutes in nine Member States participated in a co-ordinated research programme on the use of isotopes and radiation in integrated pest management (i.e. pest management involving the combined use of various methods of pest control) with emphasis on rice insects.

Animal production and health[11]

162. The Agency continued the co-ordinated research programmes on animal reproduction using radioimmunoassay techniques, on the nutrient value and use of low-quality roughages and agro-industrial by-products (for example, bagasse and molasses) as potential feedstuffs, and on the use and productivity of domestic buffalo in Asia. This latter programme is being carried out within the framework of RCA.

163. A programme was initiated on the control of parasitic diseases.

Protection of the environment

164. The Agency continued co-ordinated isotope-aided research programmes on pesticide residues in soil and water, with emphasis on the development of a standard technique for detecting the extent of contamination by agro-chemicals. It also continued the co-ordinated research programmes on bound pesticide residues in soil, plants and food and on pesticide residues in the milk and meat of livestock.

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[8] GC(XXV)/642, para. 117.

[9] IAEA/Government of Nigeria Project on the Biological Control of Tsetse Flies by the Sterile Insect Technique.

[10] GC(XXV)/642, para. 118.

[11] Ibid., para. 121.

165. Institutes in ten Member States took part in a co-ordinated research programme on the development, employing nuclear techniques, of better methods for the rural production of methane from biomass (with the residual slurry being used as fertilizer material).

Food preservation

166. Following the conclusion reached in 1980 by a joint FAO/IAEA/WHO expert committee that no toxicological hazard is caused by irradiating any food up to 10 kGy[12], the Agency completed a co-ordinated research programme on the wholesomeness of the food irradiation process and terminated its participation in the International Project in the Field of Food Irradiation. In the light of the same conclusion, a group convened by WHO, FAO and the Agency prepared amendments to the Recommended International General Standard for Irradiated Foods. The revised Standard was distributed by the Codex Alimentarius Commission to the countries party to the Joint FAO/WHO Food Standard Programme.

167. A co-ordinated research programme on the technological and economic feasibility of food irradiation, which has contributed to the expansion of food irradiation studies in many developing Member States, was completed. Co-ordinated research programmes were started on the pre-commercial-scale radiation treatment of food, on factors influencing the use of food irradiation processes, and on the disinfestation of food and agricultural products by irradiation.

168. The Government of Japan continued its sponsorship of the RCA project on food irradiation (see paragraph 41); the project committee met in Tokyo in November to evaluate the results obtained so far and to plan for future regional studies.

169. The International Facility for Food Irradiation Technology at Wageningen, Netherlands, provided training for 40 scientists from developing Member States.

170. An FAO/IAEA seminar on food irradiation for developing Member States in Asia and the Pacific region, held in Tokyo, provided a forum for discussion on the latest developments in food irradiation technology.

[12] GC(XXV)/642, para. 125.

General

171. In the field of life sciences, the Agency is supporting the development of nuclear techniques for use in medicine (diagnostic and therapeutic), biology and health-related environmental research and promoting greater reliability and accuracy in radiation dosimetry for medical and industrial purposes, with emphasis on the needs of developing Member States.

Medical applications

172. The Agency continued to assist developing countries in the maintenance of nuclear instruments (e.g. well scintillation counters, scanners and gamma cameras) by:

(a) Encouraging and assisting in the introduction of devices to improve the quality of the electrical power supply at laboratories;

(b) Assisting in the establishment of laboratory maintenance plans and in gaining easier access to spare parts; and

(c) Helping to organize training courses for maintenance technicians and instructors.

173. The reliability achievable in the radioimmunoassay of thyroid-related hormones was assessed in a co-ordinated research programme. Calculator programs for processing assay data were completed and about 40 laboratories were provided with calculators.

174. Under a regional technical co-operation programme in Latin America for the quality control of instruments used in nuclear medicine, a seminar was held in Bogotá; also, equipment was supplied to the countries participating in the programme.

175. The Agency continued its work on the use of nuclear techniques in studying essential and toxic trace elements, with reference to human nutrition. Also, it reviewed the applicability of nuclear techniques in the in vivo study of human body composition (mainly in relation to bone mineral mass, body protein, and organ contents of cadmium and lead).

Dosimetry[13]

176. Of the 43 laboratories constituting the IAEA/WHO network of Secondary Standard Dosimetry Laboratories (SSDLs), which has obtained wide recognition, particularly from the International Organization of Legal Metrology, 25 were in full operation during 1981, eight were partly operative and ten were in various stages of development. The 22 laboratories that participated in the postal dose intercomparison for SSDLs performed well.

177. Dose calibration comparisons were undertaken by visiting experts at six SSDLs in Eastern Europe and the Near East under an interregional technical co-operation programme. The Agency assisted in setting up SSDLs in Ecuador, Indonesia, Malaysia, Pakistan, Thailand and Venezuela. A training course for SSDL staff on the calibration of dosemeters for radiation therapy and radiation protection was conducted in the Federal Republic of Germany.

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[13] GC(XXV)/642, para. 135.

178. The dosimetry laboratory in the new premises at Seibersdorf went into full operation. Its equipment now includes a 320-kV X-ray generator donated by the Federal Republic of Germany. New fast-shutter systems were constructed for this unit and the laboratory's 250-kV X-ray generator.

179. The laboratory continued to run a postal cobalt-60 gamma dose intercomparison service for radiotherapy centres, and preparations were made for extending the service to include orthovoltage X-rays. Further studies were carried out on the application of the thermoluminescent dose (TLD) method in high-energy electron and photon dosimetry. The calibrations performed at the laboratory were confirmed in a Fricke dosimetry intercomparison conducted by the International Bureau of Weights and Measures.

180. High-dose intercomparison studies were carried out in collaboration with 14 other laboratories prior to the launching of an international dose assurance service for irradiation facilities in Member States. The co-ordinated research programme on high-dose standardization and intercomparison for industrial radiation processing made good progress; the interim results were evaluated in November by an advisory group.

Radiation biology

181. Research directed towards the development of safe practices for the radiation sterilization of medical items manufactured in developing countries was carried out under RCA, with the participation of nine institutes in Asian and Pacific-region countries.

182. Within the framework of continued Agency support for studies on the immunological control of malaria and schistosomiasis, a symposium reviewed the available nuclear techniques and recommended the development of others which would facilitate the control of parasitic infections.

183. The results of the co-ordinated research programme on improvements in cancer radiotherapy through the use of radiosensitivity modifiers were reviewed at a final research co-ordination meeting. Some of the results were presented at a seminar on prospective radiotherapy methods for use in developing countries.

184. A symposium on health impacts of different sources of energy, organized jointly by WHO, UNEP and the Agency, reviewed current methodological approaches in the evaluation of health risks due to chemical and physical pollutants from the development and use of different energy sources.

Health-related environmental research

185. The use of nuclear techniques in studying the impact of mineral substances on man and the environment continued to receive support under a co-ordinated research programme, with 13 laboratories in 13 Member States applying such techniques in the assessment of human exposure to environmental mineral elements - especially heavy metals. A related research project continued to be implemented under RCA in 11 Member States.

Physics

186. The "Phase One" INTOR Workshop[14] ended in July 1981 as scheduled, with completion of the conceptual design of an INTOR device; work began on the next phase, "Phase IIA", which involves a cost-benefit analysis of design alternatives and an analysis of issues affecting design optimization (three sessions of the "Phase IIA" INTOR Workshop were held in the second half of the year); and a group met to discuss possible administrative arrangements for the INTOR project beyond "Phase IIA".

187. Four technical committees met to consider: alternative fusion concepts; divertors and impurity control in tokamaks; advances in open confinement systems; and radiofrequency plasma heating in large fusion experiments.

188. In nuclear and solid-state physics, the research programmes of developing countries were supported through:

(a) A study tour on low-energy accelerators and their utilization;

(b) An interregional and a regional training course on nuclear electronics; and

(c) A consultants' meeting on the use of nuclear techniques in radiation damage studies (the appropriateness of small laboratories conducting such studies was discussed).

Research reactor support programme

189. Under the research reactor support programme[15], work started on two documents designed to supplement a guidebook published in 1980 on the technical aspects of converting reactor cores to use low-enriched uranium (LEU); one deals with safety and licensing aspects of core conversion and the other with the conversion of heavy-water-moderated research reactor cores. The Agency sent missions to three developing Member States for the purpose of providing technical information on and assisting with core conversions.

190. An international seminar on research reactor operation and use was held in Jülich, Federal Republic of Germany; the topics included reactor modification, reactor up-grading, fuel development and reactor operating experience.

191. Other, related activities included:

(a) A consultants' meeting on the production of technetium-99^{m} generators using low-power research reactors;

(b) A consultants' meeting on the use of small, low-cost computers in research reactor operations; and

(c) A meeting (under a co-ordinated research programme) on the use of neutron scattering techniques in applied research.

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[14] GC(XXV)/642, para. 141.

[15] Ibid., para. 144.

Industrial applications and chemistry

192. Within the framework of RCA, the "Project Document" for a UNDP-supported large-scale industrial demonstration programme on the use of nuclear techniques in the rubber, wood, paper, steel and mining industries[16] was completed and submitted, together with a workplan, to the participating countries for approval. Cobalt-60 irradiation facilities for a rubber vulcanization demonstration plant were designed and ordered, and a nucleonic control system for demonstration and training was installed at a paper mill.

193. At a conference on industrial applications of radioisotopes and radiation technology, considerable emphasis was placed on the economic benefits achievable in - inter alia - mineral exploration, industrial process control, energy and resource saving, and pollution control. A group of consultants convened to review uses of nuclear techniques in mineral exploration concluded that it was too early to use such techniques in sea-bed mineral exploration.

194. Work continued on the series of Agency publications "Chemical thermodynamics of actinide elements and their compounds", with a view to its completion during 1983.

195. Co-ordinated research programmes relating to the production of radioisotopes for medical purposes using particle accelerators and to the development of new, more specific radiopharmaceuticals were supported. Also, consultants' meetings reviewed methods for the quality control of radionuclides and radiopharmaceuticals, the use of stable isotopes in the life sciences and optimization of the production of radionuclide (especially technetium-99^{m}) generators using low-power reactors (see paragraph 191(a) above).

Isotope hydrology

196. Isotope techniques were used in hydrological projects in 12 countries. The scope of an isotope hydrology project being implemented under RCA and supported by the Government of Australia (see paragraph 41) was broadened to include the application of caesium-137 measurements to problems of erosion.

197. In the field of training, which continued to be a major activity, series of lectures were given at international post-graduate courses in Graz, Austria, and Padua and Pisa, Italy.

198. A regional seminar on the potential and scope of isotope hydrology techniques was held in Sri Lanka and a symposium on methods of low-level counting and spectrometry in Berlin (West). An advisory group reviewed isotope techniques for the hydrological investigation of fractured and fissured rocks, and the status of isotopic geochemical techniques in geothermal exploration was examined at a consultants' meeting.

Nuclear data

199. Programme emphasis was shifted towards meeting nuclear and atomic data needs in the fields of radiation damage, nuclear safety, nuclear materials safeguards and nuclear fusion.

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[16] GC(XXV)/642, para. 146.

200. The Agency continued to provide nuclear data services to Member States, responding to approximately 640 requests (over 50% more than in 1980). The nuclear data needs of scientists in developing countries continued to grow and to receive increasing attention.

201. The nuclear data accuracy requirements associated with important uranium and plutonium parameters and the nuclear data requirements associated with the assessment of radiation damage were reviewed in the light of the demand for greater design accuracy and greater operational reliability and safety in the field of nuclear technology.

202. The requirements for nuclear data in the production of radioisotopes for medical application and those for atomic data pertinent to plasma-wall interaction processes in fusion reactors were also reviewed.

Seibersdorf Laboratory

Agricultural laboratory

203. The laboratory carried out research and provided routine services and training in support of the Agency's research contract and technical co-operation programmes. Particular attention was given to:

(a) The efficient use of fertilizers in mixed cropping systems and optimization of the symbiotic fixation of nitrogen by legume crops;

(b) The training of Agency fellows in, and the holding of an inter-regional course on, the use of isotopes and radiation in fertilizer efficiency studies;

(c) The mutation breeding of wheat and field beans (with a view to achieving higher protein content, yield and quality) and the creation of mutant stocks (for use in training and research); and

(d) The developing of, and provision of training in, more reliable, efficient and economical methods for rearing and releasing sterile Mediterranean fruit flies and tsetse flies (in support of eradication programmes in Mexico and Nigeria respectively).

Chemistry laboratory

204. The laboratory conducted four intercomparison determinations, for either trace elements or radionuclides; institutes in 38 Member States took part in one or more of them. The average number of institutes participating in the individual intercomparisons was 38.

205. About 600 samples of reference materials were supplied to institutes in 50 Member States; the ratio of certified to uncertified reference materials increased.

206. Services to technical co-operation, safeguards and other Agency activities involved 1746 determinations on 714 samples.

Electronics and measurement

207. Over 120 calibrated solid radioactive sources and 30 calibrated radioactive solutions were prepared and over 30 calibrated liquid samples from eight institutes were measured.

Medical applications and dosimetry laboratories

208. The medical applications and dosimetry laboratories, which went into full operation in their new, larger premises, continued to carry out routine analyses, undertake research and provide in-service training in support of the research contracts, technical co-operation and analytical quality control programmes.

209. An intercomparison of trace elements in human hair reference material was completed and an intercomparison of trace elements in animal bone reference material started (both with more than 100 participants). The postal dose service for radiotherapy centres throughout the world continued (see paragraph 179 above) and the laboratory helped to organize and took part in a number of international dosimetry intercomparisons.

Safeguards Analytical Laboratory (SAL)

210. With the agreement of the Austrian authorities, the Agency took over full responsibility for the operation of SAL on 12 October 1981.

211. In 1981, SAL analysed 658 samples of uranium and 122 samples containing plutonium or mixtures of uranium and plutonium; also, 166 samples of spent fuel solutions were analysed by isotopic dilution mass spectrometry.

212. Optimum use of SAL's capacity was practically reached with this analytical workload, which was 24% higher than the 1980 workload; more than 90% of SAL's manpower was used in providing the services requested by the Department of Safeguards.

International Laboratory of Marine Radioactivity

213. The Laboratory continued its investigations of:

(a) The uptake, distribution and loss of transuranic and fission-product nuclides in marine organisms;

(b) The behaviour of natural radioactive elements in marine organisms; and

(c) The chemical behaviour of transuranic and fission-product nuclides in the marine environment.

214. Work started on the environmental problems involved in the disposal of radioactive wastes in the deep oceans.

215. Several trainees from developing countries received instruction in radiochemical and radiobiological procedures, and some Member States were given advice on their marine environmental monitoring programmes. Joint exercises were carried out with Member States to improve the quality of data on environmental radioactivity.

216. Investigations of non-nuclear pollutants were undertaken with the co-operation and financial support of UNEP, UNESCO, the Mediterranean Action Plan, the Kuwait Action Plan, the International Oceanographic Commission and the United States National Science Foundation.

217. At the International Centre for Theoretical Physics, in Trieste, the main fields of research and training-for-research in 1981 were:

(a) Physics and energy (nuclear physics, solar energy and fusion energy);

(b) Physics and the frontiers of knowledge (elementary particles and fundamental theory);

(c) Physics and technology (atomic, molecular, laser and condensed-matter physics); and

(d) Applicable mathematics (variational methods and microprocessors).

Also, regional activities and science teaching were supported.

218. Some 1900 physicists, about half of them from developing countries, visited the Centre in order to attend scientific meetings or to conduct independent research.

Physics and energy

219. Work under this programme started, in May and June, with a college on fusion energy dealing with the latest developments in theoretical and experimental plasma research, with physics problems of fusion reactors and with plasma research in developing countries. In the summer, a second symposium on non-conventional energy (a follow-up to a symposium held in 1979) took place. A nuclear physics workshop was held in October.

Physics and the frontiers of knowledge

220. The research group on elementary particle physics and fundamental theory held a workshop in July and August. Over 130 elementary particle physicists participated in a spring school on supergravity in April and May.

221. Over 120 scientists took part in a meeting on monopoles in quantum field theory in December.

222. A conference on differential geometric methods in theoretical physics was held in June and July in collaboration with the University of Clausthal, Federal Republic of Germany, and the International School for Advanced Scientific Studies (SISSA), Trieste. A workshop on non-linear evolution equations, solitons and spectral methods was held in August as a follow-up to the one held in 1979.

Physics and technology

223. The year began with a winter college on lasers in atomic and molecular physics. The annual research workshop was highlighted by two topical conferences, one on nuclear level excitation in atoms, molecules and solids and the other, co-sponsored by the Italian National Research Council and SISSA, on the physics of intercalation compounds. The solid-state physics group was active throughout the year.

Applicable mathematics

224. A college on the technology and applications of microprocessors took place in September and October, with the collaboration of a microprocessor group from CERN. An eight-week course on variational methods in analysis and mathematical physics was held towards the end of the year.

Regional activities

225. The Centre co-sponsored the following activities in 1981:

(a) Sixth international summer college on physics and contemporary needs (Nathiagali, Pakistan);

(b) Regional college on solid-state physics (Accra, Ghana);

(c) Summer school on physics teaching (Louvain-la-Neuve, Belgium);

(d) Fifteenth Central American course in physics (Honduras);

(e) First East African symposium on pure and applied mathematics (Nairobi, Kenya);

(f) "Multiciencias 1981" (Cuzco, Peru);

(g) Workshop on problems of physics in the less-developed regions of Europe (Istanbul, Turkey);

(h) Symposium on international dimensions of the energy problem (Siguenza, Spain);

(i) Group representation summer school (Ibadan, Nigeria);

(j) Twentieth international Schladming school (Schladming, Austria);

(k) All-India seminar on finite-element methods in biology (Ludhiana, India);

(l) Seminar on estuaries, on their physics, chemistry, biology, geology and geophysics and on engineering aspects (Goa, India); and

(m) Workshop on phase transitions in living organisms (New Delhi, India).

Support received

226. In addition to the regular support of the Agency, UNESCO and the Government of Italy, the Centre received special grants from the Swedish Agency for Research Co-operation, the Italian Department of Co-operation for Development, OPEC, the UNDP Interim Fund, the Governments of Denmark, the Federal Republic of Germany, Japan, the Netherlands and the United States of America, and the Kuwait Foundation for the Advancement of Science.

227. There was close collaboration throughout the year with SISSA and the Institute of Physics, Trieste University.

General

228. In 1981, as in previous years, the Secretariat, in carrying out the safeguards programme of the Agency, did not detect any anomaly which would indicate the diversion of a significant amount of safeguarded nuclear material - or the misuse of facilities or equipment subject to safeguards under certain agreements - for the manufacture of any nuclear weapon, or to further any other military purpose, or for the manufacture of any other nuclear explosive device, or for purposes unknown. Furthermore, nuclear material to which safeguards were applied under voluntary-offer agreements with nuclear-weapon States was withdrawn from civil activities only in conformity with these agreements. However, in certain cases in non-nuclear-weapon States the Agency was not in a position, pending implementation of certain technical measures proposed by the Agency, to perform adequate verification (see paragraph 22). With the exception of these cases where the Agency was unable to draw conclusions, the Secretariat considers it reasonable to conclude that the nuclear material under Agency safeguards remained in peaceful nuclear activities or was otherwise adequately accounted for. This statement should be seen in the light of the following observations:

(a) The conclusions of the Secretariat are based on extensive inspection activities, which may be illustrated for 1981 as follows - figures for 1980 are given in parentheses. More than 1400 (1100) inspections were carried out using 132 (104) inspector man-years at about 500 (500) nuclear installations in 47 (44) non-nuclear-weapon States and three (three) nuclear-weapon States. About eight (six) million surveillance pictures were taken by about 160 (140) surveillance systems and evaluated. More than 4000 (3000) seals were applied and subsequently verified. The Safeguards Analytical Laboratory (SAL) analysed about 890 (780) plutonium and uranium samples collected at facilities under safeguards, with about 1810 (1862) analytical results for nuclear material measurements being statistically evaluated. Accounting reports concerning about 700 (700) installations were received. An additional 345 000 (400 000) data entries were processed and stored in the Agency's computer.

(b) The sensitivity of inspection and evaluation activities may be illustrated by the fact that about 230 (200), mostly minor, discrepancies or anomalies were found; all cases were satisfactorily explained upon subsequent appraisal or investigation.

(c) The level of assurance associated with the Secretariat's findings for a particular installation or State depends - inter alia - on the content of the safeguards agreement concluded with the State in question, on the co-operation of the State and of the facility operators in it, and on the funds, manpower and equipment available to the Agency.

(d) The findings of the Agency's Safeguards Implementation Report for 1981 refer for each facility to the latest available State report, Agency inspection, analysis, etc. related to that facility.

Special safeguards implementation issues

229. Following the Israeli attack of 7 June 1981 on the Tamuz reactor complex at the Iraqi nuclear research centre, near Baghdad, the extent of the damage and the danger from unexploded bombs prevented full inspection of the reactor and its fuel until November 1981, when the site had been sufficiently cleared. In November the facility was inspected and all the nuclear material accounted for. Regular inspections of the other nuclear material in Iraq were satisfactorily carried out during the whole year.

230. The Board of Governors was informed in September 1981 that a number of technical measures had been identified as being necessary for improving safeguards at certain on-load-refuelled reactors where independent verification of fresh fuel was not possible and that, until these measures had been adopted, the Agency was, with regard to these reactors, unable fully to discharge its verification responsibilities. Since then, discussions with the Member States concerned on the measures proposed by the Agency have taken place with a view to remedying the situation as soon as possible.[17]

Increased safeguards coverage

231. As in 1980, by far the major part of the nuclear material under safeguards was in States that had submitted all their peaceful nuclear activities to safeguards as a consequence of their being party to NPT or to NPT and the Tlatelolco Treaty.

232. During 1981, Antigua and Barbuda and Egypt became parties to NPT - the latter State twelve years after signing it - bringing the total number of States party to the Treaty to 116, including three nuclear-weapon States. One non-nuclear-weapon State (Turkey) brought its NPT safeguards agreement into force. The total number of States with such agreements in force at the end of the year was 66. On 17 December 1981 Greece acceded to the safeguards agreement of 5 April 1973 concluded between the non-nuclear-weapon States of EURATOM, EURATOM itself and the Agency.[18]

233. Of the remaining 43 non-nuclear-weapon States party to NPT, three had significant nuclear activities. Of these, two (Egypt and Venezuela[19]) had begun, but not yet completed, the procedures for bringing their agreements with the Agency into force[20]. The nuclear activities of which the Agency is aware in

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[17] Agreement in principle has been reached with one State on the improvements necessary. In the case of another State, some progress has been made but fully satisfactory agreement has still to be achieved.

[18] Papua New Guinea became a party to NPT on 25 January 1982 (Cape Verde's accession of 24 October 1979 was notified to the Agency on 7 May 1982). The NPT/Tlatelolco safeguards agreement concluded with Guatemala entered into force on 1 February 1982.

[19] The safeguards agreement concluded with Venezuela entered into force on 11 March 1982 and the one concluded with Egypt entered into force on 30 June 1982.

[20] The third party was the "Republic of China" (nothing in paragraph 233 implies the expression of any opinion whatsoever on the part of the Secretariat concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers).

two of these three countries (Venezuela and the "Republic of China") were covered by safeguards under non-NPT safeguards agreements. The nuclear activities of the third country (Egypt) were not covered by Agency safeguards since no safeguards agreement had been concluded with Egypt prior to its adherence to NPT.

234. In 1981 safeguards agreements were in force with 12 non-nuclear-weapon States which were not party to NPT - namely, Argentina, Brazil, Chile, Colombia, Cuba, the Democratic People's Republic of Korea, India, Israel, Pakistan, South Africa, Spain and Viet Nam. New safeguards agreements were concluded during 1981 with three of these States (Argentina, Spain and Viet Nam). The agreement with Spain had the effect of bringing all Spain's nuclear activities under Agency safeguards.

235. In eight of the States referred to in the previous paragraph, all substantial nuclear activities known to the Agency from published information were covered by provisions of existing safeguards agreements. In the remaining four States, unsafeguarded nuclear facilities were in operation or under construction. In these States, as in nuclear-weapon States, the unsafeguarded facilities were capable of producing weapons-grade material.

236. In 1981, the agreement with France and EURATOM under which the Agency may apply safeguards to certain nuclear material in civil nuclear facilities in France entered into force. Thus, the voluntary offer agreements negotiated with France, the United Kingdom and the United States have all now been brought into force.

237. By the end of 1981, safeguards agreements were in force with 87 States. Safeguards were actually being applied in 51 States, the nuclear activities of the remainder not yet having reached the stage at which reports and verification activities are required under the relevant agreements.

238. The number of installations and the amounts of nuclear material under Agency safeguards can be seen from Tables 6 and 7.

239. Thirty-nine of the non-nuclear-weapon States party to NPT have failed to comply with their obligations under Article III.4 of the Treaty regarding the conclusion of the relevant safeguards agreements with the Agency. The Agency has again drawn this to the attention of the States concerned, with a view to beginning negotiations for the conclusion of the relevant agreements as soon as possible.

Safeguards information treatment

240. The Agency implemented the International Safeguards Information System (ISIS), which replaced the PSI-2 data processing system in use from 1974 to 1980.[21] Guidelines for the short- and long-term development of ISIS, including the integrated use of computers at all levels of safeguards operation, were established.

241. A new version of the data base management system, ADABAS 4.1, which allows several user queries to be processed concurrently, became operational. This, together with an upgrading of computer capabilities, led to a considerable increase in operational effectiveness through faster and more flexible data input and output, distributed data processing and compatibility with the computing devices used in the field.

[21] GC(XXV)/642, para. 185.

242. During 1981, the ISIS data base increased to about 1.4 million records with accounting, design, inspection and other data; about 25 000 queries were run. All units within the Department of Safeguards had access, under strict security procedures, to the data base through computer terminals. A co-ordination committee was established in order to help ensure the smooth operation of ISIS.

243. In support of inspection planning and post-inspection data evaluation, improved computer programs were made available on computer terminals for use in the preparation of inspection sampling plans and in determining the verification measurement accuracies and detection probabilities achieved. Work continued on creating computer files of measurement data from 27 bulk-handling facilities and on the development of computer-based methods for facilitating the evaluation of those data.

244. To determine the quality and accuracy of destructive measurements made on inspection samples shipped to the Safeguards Analytical Laboratory, the results of about 900 analyses were evaluated. Work continued on the development, with a view to their use in the field, of computer-based methods for comparing the results of non-destructive measurements performed by inspectors with those of measurements (both destructive and non-destructive) performed by operators. Considerable success was achieved in using isotope correlation methods for independent verification of the input (uranium and plutonium) to reprocessing plants.

245. At the invitation of the USSR State Committee on the Utilization of Atomic Energy, a basic training course on States' systems of accounting for and control of nuclear materials and a workshop seminar on safeguards information processing were held in Yalta and Moscow for personnel from Member States, in particular from developing countries; 20 Member States sent participants.

Safeguards development and technical support

246. The Agency continued to give special attention to developing and improving safeguards approaches for heavy-water production plants and for "sensitive" facilities such as reprocessing, highly enriched uranium and mixed-oxide fuel fabrication, and enrichment plants.

247. A safeguards effectiveness evaluation methodology for light-water reactors, whose development was completed in 1980,[22] was successfully tested at several light-water reactors. Further progress was made in the application of the methodology to other types of plants.

248. The standardization of procedures for the application of safeguards at light-water reactors and other types of facilities continued. The safeguards procedures for large research reactors were reviewed and further improved.

249. The development of guidelines for designing facilities in such a way as to make safeguards easier and more effective made definite progress.

250. The Agency continued to assist Member States in establishing and maintaining national systems of accounting for and control of nuclear material. Considerable work was done on formulating detailed guidelines for the maintenance and implementation of such systems in the case of certain specific facilities.

251. The development of a computer-based methodology for the long-term forecasting of nuclear material and facilities under safeguards and of safeguards manpower requirements was completed. The development of a methodology for optimizing inspection effort allocation was started.

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[22] GC(XXV)/642, para. 191.

252. The International Working Group on the Application of Safeguards to Reprocessing Plants finished its work[23] and produced a comprehensive report.

253. There was a general improvement in the performance and availability of equipment (including equipment for non-destructive analysis - NDA - and for containment and surveillance - C/S), but certain problem areas remained. Despite some improvement in the reliability of photo and video surveillance equipment, the overall performance level was still lower than desired.

254. Various underwater surveillance devices for the verification of spent fuel stores were field-tested; they included underwater television units, a periscope, a simple surface viewing tray to facilitate the use of binoculars and a special Cerenkov glow measurement device.

255. Equipment and procedures for the independent weighing of UF_6 shipping cylinders (2½ tonnes) were developed and field-tested.

256. Laboratory testing and demonstrations of equipment developed specifically for on-load-refuelled reactor safeguards were completed; this equipment includes an 8-camera closed-circuit television system, film cameras triggered by motion or radiation as well as on a time sequence, irradiated bundle counters and fresh fuel bundle counters.

257. A programme for the testing and demonstration of advanced safeguards techniques applied in reprocessing plants was completed (TASTEX). Five of the 13 approaches covered by the programme were identified as being sufficiently proven for early implementation; they involved - inter alia - the use of certain surveillance techniques in spent fuel storage facilities, the concentration and isotopic measurement of plutonium product solutions, and the use of electromanometers to monitor accountability tank levels accurately and continuously.

258. Research and development work was accelerated significantly by the comprehensive assistance received from Australia, Canada, the Federal Republic of Germany, Japan, the Soviet Union, the United Kingdom and the United States, and through the International Working Group on Reprocessing Plant Safeguards, the hexapartite safeguards project related to ultracentrifuge uranium-235 enrichment plants, and TASTEX.

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[23] GC(XXV)/642, para. 196.

Table 6

Nuclear installations under Agency safeguards or containing safeguarded nuclear material, except those covered by agreements implementing the voluntary offers of two nuclear-weapon States[a/]

Nuclear installations	End of 1981[b/]		
	NPT	Non-NPT	Total
Facilities			
Power reactors	106 (103)	24 (23)	130 (126)
Research reactors and critical assemblies	149 (147)	27 (28)	176 (175)
Conversion plants	3 (3)	1 (1)	4 (4)
Fuel fabrication plants	31 (31)	7 (7)	38 (38)
Reprocessing plants	4 (4)	2 (2)	6 (6)
Enrichment plants	4 (4)	0 (0)	4 (4)
Separate storage facilities	18 (15)	6 (6)	24 (21)
Other facilities	40 (40)	0 (0)	40 (40)
	355 (347)	67 (67)	422 (414)
Other locations	402 (340)	20 (18)	422 (358)
Total	757 (687)	87 (85)	844 (772)

a/ The Agency was applying its safeguards at the following facilities in the United Kingdom and the United States pursuant to agreements concluded on the basis of voluntary offers: one demonstration fast reactor and one reprocessing plant in the United Kingdom; two power reactors and one fuel fabrication plant in the United States.

b/ The figures in brackets indicate the status at the end of 1980. They have been corrected by the deletion of the two United Kingdom facilities mentioned in footnote a/.

Table 7

Quantities (in tonnes) of nuclear material under Agency safeguards, except that covered by agreements implementing the voluntary offers of two nuclear-weapon States[a/]

	1977	1978	1979	1980	1981
Plutonium					
(a) Separated	6	7	8	5	5
(b) Contained in irradiated fuel[b/]	28	41	49	58	71
Total	34	48	57	63	76
Uranium enriched to 20% or more	11	11	11	11	10
Uranium enriched to less than 20%	7 849	10 495	11 714	13 872	15 459
Source materials (natural or depleted uranium and thorium)	12 234	13 150	15 399	19 097	22 183

a/ Apart from this exception, the table includes all nuclear material safeguarded under agreements concluded pursuant to NPT (other than material referred to in sub-paragraphs 34(a) and (b) of INFCIRC/153) and all nuclear material safeguarded under agreements concluded pursuant to INFCIRC/66/Rev.2.

b/ The figures for this entry represent the sum of the amount of plutonium contained in irradiated fuel which has been reported by the Member States and of the calculated amount of plutonium contained in some reactor cores and cooling ponds which has not yet been reported to the Agency or which is not required to be reported to the Agency (the plutonium not required to be reported is contained in fuel elements to which item accountancy and containment and surveillance measures are applied). In previous years the amount of non-reported plutonium was roughly estimated on the basis of published figures for total energy production. In 1981 it was possible to make some improvements in the Agency's procedures for estimating the amount of plutonium contained in the fuel assemblies being safeguarded. The total amount of plutonium under safeguards at the end of 1981 was calculated using the latest information and procedures. The values for previous years have been adjusted accordingly.

Table 8

Agency safeguards agreements in connection with NPT and the Tlatelolco Treaty (status at the end of 1981)[a]

Safeguards agreements in force in connection with:		
NPT	53	(52)
NPT and Tlatelolco Treaty	12	(12)
NPT and Additional Protocol I of Tlatelolco Treaty	1	(1)
Tlatelolco Treaty	1	(1)[b]
Non-nuclear-weapon States party to NPT that had not met the deadline for the entry into force of their NPT agreement	40	(37)[c]
Non-nuclear-weapon States with significant nuclear activities to which NPT safeguards were being applied	36	(35)[d]

Table 9

Agency safeguards agreements other than those covered in Table 8 (status at the end of 1981)[a]

Safeguards agreements in force:		
Project agreements	25	(25)[b]
Unilateral submissions	21	(15)[b]
Agreements concluded with nuclear-weapon States on the basis of voluntary offers	3	(2)
Other agreements	30	(31)[b]
Non-nuclear-weapon States in which all substantial nuclear activities known to the Agency from published information were covered by provisions of existing safeguards agreements	8	(6)[e]
Non-nuclear-weapon States in which part of the nuclear activities was covered by safeguards	4	(5)[f]
Non-nuclear-weapon States whose nuclear activities were not covered by safeguards	1	(1)[g]
Nuclear-weapon States in which safeguards were being applied to certain activities	3	(3)[h]

a/ Figures in brackets indicate the status at the end of 1980.

b/ In States party to the agreements in question which had brought into force agreements in connection with NPT or with both NPT and the Tlatelolco Treaty, the Agency was applying safeguards under the latter agreements.

c/ Bahamas, Bangladesh, Barbados, Benin, Bolivia, Botswana, Burundi, Cape Verde, Central African Republic, Chad, Congo, Democratic Kampuchea, Democratic Yemen, Gabon, Grenada, Guatemala (the NPT/Tlatelolco safeguards agreement concluded with Guatemala entered into force on 1 February 1982), Guinea Bissau, Haiti, Ivory Coast, Kenya, Lao People's Democratic Republic, Liberia, Mali, Malta, Nigeria, Panama, Rwanda, St. Lucia, San Marino, Sierra Leone, Somalia, Sri Lanka, Syrian Arab Republic, Togo, Tonga, Tunisia, Tuvalu, United Republic of Cameroon, Upper Volta, Venezuela (the NPT/Tlatelolco safeguards agreement concluded with Venezuela entered into force on 11 March 1982).

d/ Australia, Austria, Belgium, Bulgaria, Canada, Czechoslovakia, Denmark, Finland, German Democratic Republic, Federal Republic of Germany, Greece, Hungary, Indonesia, Iran, Iraq, Ireland, Italy, Japan, Republic of Korea, Libyan Arab Jamahiriya, Luxembourg, Mexico, Netherlands, Norway, Peru, Philippines, Poland, Portugal, Romania, Sweden, Switzerland, Thailand, Turkey, Uruguay, Yugoslavia, Zaire.

e/ Argentina, Brazil, Chile, Colombia, Cuba, Democratic People's Republic of Korea, Spain, Viet Nam.

f/ India, Israel, Pakistan, South Africa.

g/ Egypt (a safeguards agreement in connection with NPT between Egypt and the Agency entered into force on 30 June 1982).

h/ France, United Kingdom, United States of America.

Table 10

Situation on 31 December 1981 with respect to the signing of, the ratification of, or accession or succession to NPT by non-nuclear-weapon States and to the conclusion of safeguards agreements between the Agency and these States in connection with NPT

Non-nuclear-weapon States which have signed, ratified, acceded to or succeeded to NPT[a] (1)	Date of ratification, accession or succession[a] (2)	Safeguards agreement with the Agency (3)		INFCIRC (4)
Afghanistan	4 February 1970	In force:	20 February 1978	257
Antigua and Barbuda	1 November 1981			
Australia	23 January 1973	In force:	10 July 1974	217
Austria	27 June 1969	In force:	23 July 1972	156
Bahamas	10 July 1973			
Bangladesh[g]	27 September 1979			
Barbados	21 February 1980			
Belgium	2 May 1975	In force:	21 February 1977	193
Benin	31 October 1972			
Bolivia[b]	26 May 1970	Signed:	23 August 1974	
Botswana	28 April 1969			
Bulgaria	5 September 1969	In force:	29 February 1972	178
Burundi	19 March 1971			
Canada	8 January 1969	In force:	21 February 1972	164
Cape Verde[h]	24 October 1979			
Central African Republic	25 October 1970			
Chad	10 March 1971			
China, Republic of	27 January 1970			
Colombia[e]				
Congo	23 October 1978			
Costa Rica[b]	3 March 1970	In force:	22 November 1979	278
Cyprus	10 February 1970	In force:	26 January 1973	189
Czechoslovakia	22 July 1969	In force:	3 March 1972	173
Democratic Kampuchea	2 June 1972			
Democratic Yemen	1 June 1979			
Denmark[c]	3 January 1969	In force:	21 February 1977	193
Dominican Republic[b]	24 July 1971	In force:	11 October 1973	201
Ecuador[b]	7 March 1969	In force:	10 March 1975	231
Egypt[g]	26 February 1981	Signed:	7 October 1981	
El Salvador[b]	11 July 1972	In force:	22 April 1975	232
Ethiopia	5 February 1970	In force:	2 December 1977	261
Fiji	14 July 1972	In force:	22 March 1973	192
Finland	5 February 1969	In force:	9 February 1972	155
Gabon	19 February 1974	Signed:	3 December 1979	
Gambia	12 May 1975	In force:	8 August 1978	277
German Democratic Republic	31 October 1969	In force:	7 March 1972	181
Germany, Federal Republic of	2 May 1975	In force:	21 February 1977	193
Ghana	5 May 1970	In force:	17 February 1975	226
Greece[f]	11 March 1970	Accession:	17 December 1981	193
Grenada	19 August 1974			
Guatemala[b,g]	22 September 1970	Signed:	20 July 1978	
Guinea-Bissau	20 August 1976			
Haiti[b]	2 June 1970	Signed:	6 January 1975	
Holy See	25 February 1971	In force:	1 August 1972	187
Honduras[b]	16 May 1973	In force:	18 April 1975	235
Hungary	27 May 1969	In force:	30 March 1972	174
Iceland	18 July 1969	In force:	16 October 1974	215
Indonesia	12 July 1979	In force:	14 July 1980	283
Iran	2 February 1970	In force:	15 May 1974	214
Iraq	29 October 1969	In force:	29 February 1972	172
Ireland	1 July 1968	In force:	21 February 1977	193
Italy	2 May 1975	In force:	21 February 1977	193
Ivory Coast	6 March 1973			
Jamaica[b]	5 March 1970	In force:	6 November 1978	265
Japan	8 June 1976	In force:	2 December 1977	255

(1)	(2)	(3)	(4)
Jordan	11 February 1970	In force: 21 February 1978	258
Kenya	11 June 1970		
Korea, Republic of	23 April 1975	In force: 14 November 1975	236
Kuwait[e/]			
Lao People's Democratic Republic	20 February 1970		
Lebanon	15 July 1970	In force: 5 March 1973	191
Lesotho	20 May 1970	In force: 12 June 1973	199
Liberia	5 March 1970		
Libyan Arab Jamahiriya	26 May 1975	In force: 8 July 1980	282
Liechtenstein	20 April 1978	In force: 4 October 1979	275
Luxembourg	2 May 1975	In force: 21 February 1977	193
Madagascar	8 October 1970	In force: 14 June 1973	200
Malaysia	5 March 1970	In force: 29 February 1972	182
Maldives	7 April 1970	In force: 2 October 1977	253
Mali	10 February 1970		
Malta	6 February 1970		
Mauritius	25 April 1969	In force: 31 January 1973	190
Mexico[b/]	21 January 1969	In force: 14 September 1973	197
Mongolia	14 May 1969	In force: 5 September 1972	188
Morocco	27 November 1970	In force: 18 February 1975	228
Nepal	5 January 1970	In force: 22 June 1972	186
Netherlands[d/]	2 May 1975	In force: 21 February 1977	193
New Zealand	10 September 1969	In force: 29 February 1972	185
Nicaragua[b/]	6 March 1973	In force: 29 December 1976	246
Nigeria	27 September 1968		
Norway	5 February 1969	In force: 1 March 1972	177
Panama	13 January 1977		
Paraguay[b/]	4 February 1970	In force: 20 March 1979	279
Peru[b/]	3 March 1970	In force: 1 August 1979	273
Philippines	5 October 1972	In force: 16 October 1974	216
Poland	12 June 1969	In force: 11 October 1972	179
Portugal	15 December 1977	In force: 14 June 1979	272
Romania	4 February 1970	In force: 27 October 1972	180
Rwanda	20 May 1975		
St.Lucia	28 December 1979		
Samoa	17 March 1975	In force: 22 January 1979	268
San Marino	10 August 1970	Approved by the Board, Feb.1977	
Senegal	17 December 1970	In force: 14 January 1980	276
Sierra Leone	26 February 1975	Signed: 10 November 1977	
Singapore	10 March 1976	In force: 18 October 1977	259
Somalia	5 March 1970		
Sri Lanka	5 March 1979	Signed: 5 July 1980	
Sudan	31 October 1973	In force: 7 January 1977	245
Suriname[b/]	30 June 1976	In force: 2 February 1979	269
Swaziland	11 December 1969	In force: 28 July 1975	227
Sweden	9 January 1970	In force: 14 April 1975	234
Switzerland	9 March 1977	In force: 6 September 1978	264
Syrian Arab Republic	24 September 1969		
Thailand	7 December 1972	In force: 16 May 1974	241
Togo	26 February 1970		
Tonga	7 July 1971	Approved by the Board, Feb.1975	
Trinidad and Tobago[e/]			
Tunisia	26 February 1970		
Turkey	17 April 1980	In force: 1 September 1981	295
Tuvalu	19 January 1979		

(1)	(2)	(3)		(4)
United Republic of Cameroon	8 January 1969			
Upper Volta	3 March 1970			
Uruguay[b/]	31 August 1970	In force:	17 September 1976	157
Venezuela[b,g/]	26 September 1975	Signed:	23 June 1978	
Yemen Arab Republic[e/]				
Yugoslavia	3 March 1970	In force:	28 December 1973	204
Zaire	4 August 1970	In force:	9 November 1972	183

a/ The information reproduced in columns (1) and (2) was provided to the Agency by the depositary Governments of NPT, and an entry in column (1) does not imply the expression of any opinion on the part of the Secretariat concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers.

b/ The relevant safeguards agreement was concluded in connection with both NPT and the Tlatelolco Treaty.

c/ The NPT safeguards agreement with Denmark (INFCIRC/176), in force since 1 March 1972, has been replaced by the agreement of 5 April 1973 between the non-nuclear-weapon States of EURATOM, EURATOM and the Agency (INFCIRC/193) but still applies to the Faroe Islands.

d/ An agreement had also been concluded in respect of the Netherlands Antilles (INFCIRC/229). This agreement entered into force on 5 June 1975.

e/ The following States had signed NPT but not yet ratified it: Colombia, on 1 July 1968; Kuwait, on 15 August 1968; Trinidad and Tobago, on 22 August 1968; and the Yemen Arab Republic, on 23 September 1968.

f/ The application of Agency safeguards in Greece under the agreement INFCIRC/166, provisionally in force since 1 March 1972, was suspended on 17 December 1981, at which date Greece acceded to the agreement of 5 April 1973 (INFCIRC/193) between the non-nuclear-weapon States of EURATOM, EURATOM and the Agency.

g/ The safeguards agreements with Bangladesh, Egypt, Guatemala and Venezuela entered into force on 11 June, 30 June, 1 February and 11 March 1982 respectively.

h/ Cape Verde's accession of 24 October 1979 was notified to the Agency on 7 May 1982.

Table 11

Agreements providing for safeguards, other than those in connection with NPT, approved by the Board as of 31 December 1981

Party(ies)[a]	Subject	Entry into force	INFCIRC
(While the Agency is a party to each of the following agreements, only the State(s) party to them is (are) listed.)			
(a) Project Agreements			
Argentina	Siemens SUR-100	13 March 1970	143
	RAEP Reactor	2 December 1964	62
Chile	Herald Reactor	19 December 1969	137
Finland[b]	FiR-1 Reactor	30 December 1960	24
	FINN sub-critical assembly	30 July 1963	53
Greece[b]	GRR-1 Reactor	1 March 1972	163
Indonesia[b]	Additional core-load for TRIGA Reactor	19 December 1969	136
Iran[b]	UTRR Reactor	10 May 1967	97
Japan[b]	JRR-3	24 March 1959	3
Malaysia[c]/United States	TRIGA-II Reactor	22 September 1980	287
Mexico[b]	TRIGA-III Reactor	18 December 1963	52
	Siemens SUR-100	21 December 1971	162
	Laguna Verde Nuclear Power Plant	12 February 1974	203
Pakistan	PRR Reactor	5 March 1962	34
	Booster rods for KANUPP	17 June 1968	116
Peru[c]	Research Reactor and fuel therefor	9 May 1978	266
Philippines[b]	PRR-1 Reactor	28 September 1966	88
Romania[b]	TRIGA Reactor	30 March 1973	206
Spain	Coral-I Reactor	23 June 1967	99
Turkey[b]	Sub-critical assembly	17 May 1974	212
Uruguay[b]	URR Reactor	24 September 1965	67
Venezuela	RV-1 Reactor	7 November 1975	238
Yugoslavia[b]	TRIGA-II Reactor	4 October 1961	32
	Krško Nuclear Power Plant	14 June 1974	213
Zaire[b]	TRICO Reactor	27 June 1962	37
(b) Unilateral submissions			
Argentina	Atucha Power Reactor Facility	3 October 1972	168
	Nuclear material	23 October 1973	202
	Embalse Power Reactor Facility	6 December 1974	224
	Equipment	22 July 1977	250
	Nuclear material, material, equipment and facilities	22 July 1977	251
	Atucha II Nuclear Power Plant	15 July 1981	294
	Heavy water plant	14 October 1981	296
	Heavy water	14 October 1981	297
Chile	Nuclear material	31 December 1974	256
China, Republic of	Taiwan Research Reactor Facility	13 October 1969	133
Cuba	Nuclear research reactor and fuel therefor	25 September 1980	
	Nuclear power plant and nuclear material	5 May 1980	281
Democratic People's Republic of Korea	Research Reactor and nuclear material for this reactor	20 July 1977	252
India	Nuclear material, material and facilities	17 November 1977	260
Pakistan	Nuclear material	2 March 1977	248
Spain	Nuclear material	19 November 1974	218
	Nuclear material	18 June 1975	221
	Vandellos Nuclear Power Plant	11 May 1981	292
	Four nuclear facilities	11 May 1981	291
United Kingdom	Nuclear material	14 December 1972	175
Viet Nam	Research reactor and fuel therefor	12 June 1981	293
(c) Tlatelolco Treaty			

Party(ies)[a]	Subject	Entry into force	INFCIRC
Colombia	All nuclear material		
Mexico[b]	All nuclear material, equipment and facilities	6 September 1968	118
Panama	All nuclear material		
(d) Agreements concluded with nuclear-weapon States on the basis of voluntary offers			
France	Nuclear material in facilities submitted to safeguards	12 September 1981	290
United Kingdom	Nuclear material in facilities designated by the Agency	14 August 1978	263
United States	Nuclear material in facilities designated by the Agency	9 December 1980	288
(e) Other agreements			
Argentina/United States of America		25 July 1969	130
Australia[b]/United States of America		26 September 1966	91
Austria[b]/United States of America		24 January 1970	152
Brazil/Germany, Federal Republic of[b]		26 February 1976	237
Brazil/United States of America		31 October 1968	110
China, Republic of/United States of America		6 December 1971	158
Colombia/United States of America		9 December 1970	144
India/Canada[b]		30 September 1971	211
India/United States of America		27 January 1971	154
Iran[b]/United States of America		20 August 1969	127
Israel/United States of America		4 April 1975	249
Japan[b]/Canada[b]		20 June 1966	85
Japan[b]/France		22 September 1972	171
Japan/United States of America		10 July 1968	119
Japan[b]/United Kingdom		15 October 1968	125
Japan[b]/Australia[b]		28 July 1972	170
Korea, Republic of/United States of America		5 January 1968	111
Korea, Republic of[b]/France		22 September 1975	233
Pakistan/Canada		17 October 1969	135
Pakistan/France		18 March 1976	239
Philippines[b]/United States of America		19 July 1968	120
Portugal[b]/United States of America[b]		19 July 1969	131
South Africa/United States of America		26 July 1967	98
South Africa/France		5 January 1977	244
Spain/United States of America		9 December 1966	92
Spain/Canada[b]		10 February 1977	247
Sweden[b]/United States of America		1 March 1972	165
Switzerland[b]/United States of America[b]		28 February 1972	161
Turkey/United States of America		5 June 1969	123
Venezuela/United States of America		27 March 1968	122

a/ An entry in this column does not imply the expression of any opinion whatsoever on the part of the Secretariat concerning the legal status of any country or territory or of its authorities or concerning the delimitation of its frontiers.

b/ Application of Agency safeguards under this agreement has been suspended in the State indicated as the State has concluded an agreement in connection with NPT.

c/ The requirement for the application of safeguards under this agreement was satisfied by the application of safeguards pursuant to the agreement concluded by the State in connection with NPT.

Table 12

Nuclear facilities under Agency safeguards or containing safeguarded material under agreements in force as of 31 December 1981

A. Research reactors and critical assemblies

State[a/]	Abbreviated name	Location	Type	Capacity MW(th)	In operation	Subsidiary arrangements in force
Argentina	RA-1	Constituyentes	Tank	0.07	x	x
	RA-2	Constituyentes	MTR	0.00	x	x
	RA-3	Ezeiza	MTR	5.00	x	x
	RA-4	Rosario	SUR-100	0.00	x	x
	RA-6	Bariloche	MTR	5.00	-	- f/
Australia[b/]	HIFAR	Lucas Heights, N.S.W.	Tank	11.00	x	x
	MOATA	Lucas Heights, N.S.W.	Argonaut	0.01	x	x
	CF	Lucas Heights, N.S.W.	Critical assembly	0.00	x	x
Austria[b/]	SAR	Graz	Argonaut	0.01	x	x
	Triga II	Vienna	Pool	0.25	x	x
	ASTRA	Seibersdorf	Pool	12.00	x	x
Belgium[b/]	BR1-CEN	Mol	Tank	4.00	x	x
	BR2-CEN	Mol	Tank	100.00	x	x
	Thetis	Gent	Pool	0.15	x	x
	BR02	Mol	Tank	0.00	x	x
	CEN-Venus	Mol	Tank	0.00	x	x
Brazil	IEAR-1	São Paulo	Pool	5.00	x	x
	UMG	Belo Horizonte	Triga I	0.10	x	x
	RIEN-1	Rio de Janeiro	Argonaut	0.01	x	x
Bulgaria[b/]	IRT-2000	Sofia	Pool	2.00	x	x
Canada[b/]	NRX	Chalk River, Ont.	NRX	30.00	x	x
	NRU	Chalk River, Ont.	NRU	125.00	x	x
	WR-1	Pinawa, Manitoba	Organic-cooled	60.00	x	x
	McMaster	Hamilton, Ont.	Pool	2.5	x	x
	Slowpoke-Toronto	Univ. of Toronto	Pool	0.02	x	x
	AECL. Chem. Comp.	Ottawa, Ont.	Pool	0.02	x	x
	PTR	Chalk River, Ont.	Pool	0.00	x	x
	ZED-2	Chalk River, Ont.	Pool	0.00	x	x
	ZEEP	Chalk River, Ont.	Tank	0.00	-	x
	Slowpoke - Halifax	Dalhousie Univ.	Pool	0.02	x	- f/
	Ecole Polytechnique	Montreal	Pool	0.02	x	x
	Slowpoke - Edmonton	Univ. of Alberta	Pool	0.02	x	- f/
	Slowpoke - Saskatchewan	Saskatoon	Pool	0.02	x	- f/
Chile	La Reina	Santiago	Herald	5.00	x	x
	Lo Aguirre	Santiago	MTR	10.00	x	x
China, Republic of	THOR	Hsin-chu	Pool	1.00	x	x
	TRR	Huaitzupu	NRX	40.00	x	x
	ZPRL	Lung-Tan	Pool	0.01	x	x
	THAR	Hsin-chu	Argonaut	0.01	x	x
	MER	Hsin-chu	Mobile Educational Reactor	0.00	x	x
	WBRL	Lung-Tan	Tank	0.1	-	x

State[a]	Abbreviated name	Location	Type	Capacity MW(th)	In operation	Subsidiary arrangements in force
Colombia	IAN-R1	Bogotá	Pool	0.02	x	x
Czecho-slovakia[b]	SR-OD	Vochov	Critical assembly	0.00	x	x
	SR-OB	Vochov	Exponential assembly	0.00	x	x
	VVR-S	Rez	Tank	4.5	x	x
	TR-O	Rez	Critical assembly	0.00	x	x
Democratic People's Republic of Korea	IRT-DPRK	Nyonpyon	Pool	4.00	x	x
	Critical assembly	Nyonpyon	Pool	0.10	x	x
Denmark[c]	DR-1	Roskilde	Homogeneous	0.00	x	x
	DR-3	Roskilde	Tank	10.00	x	x
Finland[b]	Triga II	Otaniemi	Tank	0.25	x	x
German Democratic Republic[b]	WWR-S(M)	Rossendorf	Tank	10.00	x	x
	RRR	Rossendorf	Argonaut	0.00	x	x
	RAKE	Rossendorf	Tank	0.00	x	x
	Training Reactor AKR	Dresden	Tank	0.00	x	x
	Training and reseach reactor	Zittau	Tank	0.00	x	x
Germany, Federal Republic of[b]	FRM	Garching	Pool	4.00	x	x
	GKSS-FRG1	Geesthacht	Pool	5.00	x	x
	GKSS-FRG2	Geesthacht	Pool	15.00	x	x
	GFK-FR-2	Karlsruhe	Tank	45.00	x	x
	KFA-FRJ1	Jülich	Pool	10.00	x	x
	KFA-FRJ2	Jülich	Tank	43.00	x	x
	Triga	Mainz	Triga I	0.10	x	x
	Triga II	Heidelberg	Triga II	0.25	x	x
	FMRB	Braunschweig	Tank	1.00	x	x
	Triga	Hanover	Triga II	0.25	x	x
	Triga	Neuherberg	Triga II	1.00	x	x
	GFK-SNEAK	Karlsruhe	Critical assembly	0.00	x	x
	SUR 100	Garching	Solid-homogeneous	0.10	x	x
	SUR 100	Darmstadt	Solid-homogeneous	0.10	x	x
	SUR 100	Stuttgart	Solid-homogeneous	0.10	x	x
	SUR 100	Hamburg	Solid-homogeneous	0.10	x	x
	SUR 100	Kiel	Solid-homogeneous	0.10	x	x
	SUR 100	Ulm	Solid-homogeneous	0.10	x	x
	SUR 100	Karlsruhe	Solid-homogeneous	0.10	x	x
	SUR 100	Bremen	Solid-homogeneous	0.10	x	x
	SUR 100	Furtwang	Solid-homogeneous	0.10	x	x
	SUR 100	Aachen	Solid-homogeneous	0.10	x	x
	KFA-ITR	Jülich	Critical assembly	0.00	x	x
	FRF-2	Frankfurt	Triga	1.0	x	x
	SUR 100	Hanover	Solid-homogeneous	0.1	x	x
	KFA-NEA	Jülich	Critical assembly	0.00	x	x
	BER-2	Berlin (West)	Aqueous Homogeneous	5.00	x	x
	SUR 100	Berlin (West)	Solid-homogeneous	0.10	x	x
Greece[d]	GRR-1	Athens	Pool	5.00	x	x
	N.T.U.	Athens	Graphite	0.00	x	x

State[a]	Abbreviated name	Location	Type	Capacity MW(th)	In operation	Subsidiary arrangements in force
Hungary[b]	WWR-S(M)	Budapest	Tank	5.00	x	x
	ZR-4	Budapest	Critical assembly	0.00	x	x
	ZR-6	Budapest	Critical assembly	0.00	x	x
	Training reactor	Budapest	Tank	0.01	x	x
Indonesia[b]	PPTN	Bandung	Triga II	1.00	x	x
	Gama	Yogyakarta	Triga II	0.25	x	x
Iran[b]	TSPRR	Teheran	Pool	5.00	x	x
Iraq[b]	IRT-2000	Baghdad Tuwaitha	Pool	2.00	x	x
	Tamuz	Baghdad Tuwaitha	Pool	0.5	x	- [f]
Israel	IRR-1	Soreq	Pool	5.00	x	x
Italy[b]	Triga 1-RCl	Cassaccia	Triga I	1.00	x	x
	AGN-201	Palermo	Solid-homogeneous	0.00	x	x
	CESNEF-L54	Milan	Aqueous Homogeneous	0.01	x	x
	ESSOR	Ispra	Tank	40.00	x	x
	RTS-1-S.	Pisa	Pool	5.00	x	x
	RANA	Casaccia	Pool	0.01	x	x
	RITMO	Casaccia	Pool	0.00	x	x
	TAPIRO	Casaccia	Fast neutron	0.00	x	x
	Triga-2	Pavia	Triga II	0.25	x	x
	RB-1	Montecuccolino	Graphite	0.00	x	x
	RB-2	Montecuccolino	Argonaut	0.01	x	x
	RB-3	Montecuccolino	Tank (D_2O)	0.01	x	x
Japan[b]	DCA	Oarai-Machi	Critical assembly	0.00	x	x
	FCA	Tokai-Mura	Critical assembly	0.00	x	x
	HTR	Kawasaki-shi	Pool	0.10	x	x
	JMTR	Oarai-Machi	Tank	50.00	x	x
	JMTR-CA	Oarai-Machi	Critical assembly	0.00	x	x
	JOYO	Oarai-Machi	EBR	50.00	x	x
	JRR-2	Tokai-Mura	Tank	10.00	x	x
	JRR-3	Tokai-Mura	Tank	10.00	x	x
	JRR-4	Tokai-Mura	Pool	3.50	x	x
	Kinki University	Kowake	UTR-B	0.00	x	x
	KUR	Kumatori-cho	Pool	5.00	x	x
	NSRR	Tokai-Mura	Triga (pulse)	0.30	x	x
	Musashi College of Technology	Kawasaki	Triga II	0.10	x	x
	NAIG-CA	Kawasaki-ku	Critical assembly	0.00	x	x
	Rikkyo University	Nagasaka	Triga II	0.10	x	x
	SHE	Tokai-Mura	Critical assembly	0.00	x	x
	TCA	Tokai-Mura	Critical assembly	0.00	x	x
	TODAI	Tokai-Mura	Fast Neutron Source Reactor	0.00	x	x
	TTR	Kawasaki-shi	Pool	0.10	x	x
	KUCA	Kumatori-cho	Critical assembly	0.00	x	x
	KUCA	Kumatori-cho	Critical assembly	0.00	x	x
	KUCA	Kumatori-cho	Critical assembly	0.00	x	x
Korea, Republic of[b]	KRR - TRIGA II	Seoul	Triga II	0.10	x	x
	KRR - TRIGA III	Seoul	Triga III	2.00	x	x
	Kyung-Hee Univ.	Seoul	Tank	0.00	x	x
Libyan Arab Jamahiriya[b]	IRT-TAJURA	Tajura	IRT	10.00	-	x
Mexico[e]	Centro Nuclear de Mexico	Ocoyoacac	Triga III	1.00	x	x
	Training reactor facility	Mexico City	SUR 100	0.00	x	x

State[a/]	Abbreviated name	Location	Type	Capacity MW(th)	In operation	Subsidiary arrangements in force
Netherlands[b/]	LFR	Petten	Argonaut	0.01	x	x
	HOR-THS	Delft	Pool	2.00	x	x
	BARN	Wageningen	Graphite	0.10	x	x
	HFR	Petten	Tank	45.00	x	x
Norway[b/]	JEEP-II	Kjeller	Tank	2.00	x	x
	HBWR	Halden	HBWR	25.00	x	x
Pakistan	PARR	Rawalpindi	Pool	5.00	x	x
Peru[e/]	RP-0	Lima	Tank	0.00	x	x
Philippines[b/]	PRR-1	Diliman, Quezon City	Pool	1.00	x	x
Poland[b/]	EWA	Świerk	Tank	8.00	x	x
	Maryla	Świerk	Critical assembly	0.00	x	x
	Anna	Świerk	Critical assembly	0.00	x	x
	Agata	Świerk	Critical assembly	0.00	x	x
	Maria	Świerk	Tank	30.00	x	x
Portugal[b/]	RPI	Sacavem	Tank	1.00	x	x
Romania[b/]	VVR-S	Margurele	Tank	10.00	x	x
	Triga II	Pitesti-Colibasi	Tank	14.00	x	x
	RP-01	Margurele	Tank	0.00	-	x
South Africa	SAFARI-1	Pelindaba	Tank	20.00	x	x
Spain	JEN-1 and JEN-2	Madrid	Pool	3.00	x	x
	CORAL-1	Madrid	Fast cricical assembly	0.00	x	x
	ARBI	Bilbao	Argonaut	0.01	x	x
	ARGOS	Barcelona	Argonaut	0.01	x	x
Sweden[b/]	R2	Studsvik	Tank	50.00	x	x
	R2-0	Studsvik	Pool	0.00	x	x
	R-0	Studsvik	Pool	0.00	x	x
Switzerland[b/]	Proteus	Würenlingen	Fast thermal critical assembly	0.00	x	x
	Saphir	Würenlingen	Pool	5.00	x	x
	Crocus	Lausanne	Pool	0.00	x	x
	AGN201P	Geneva	Solid-homogeneous	0.00	x	x
	AGN211P	Basel	Pool	0.00	x	x
Thailand[b/]	TRR-1	Bangkok	Pool	2.00	x	x
Turkey[b/]	TR-1	Istanbul	Pool	1.00	x	x
	TR-2	Istanbul	Triga II	0.25	x	x
Uruguay[e/]	RU-1	Montevideo	Lockheed	0.10	x	x
Venezuela	RVI	Altos de Pipe	Pool	3.00	x	x
Yugoslavia[b/]	Triga II	Ljubljana	Triga II	0.25	x	x
	Boris Kidric R.	Vinča	Tank	6.50	x	x
	RB	Vinča	Critical assembly	0.00	x	x
Zaire[b/]	Triga-Zaire	Kinshasa	Triga II	1.00	x	x

B. Nuclear power reactors

State[a]	Name of power reactor	Location	Type	Capacity MW(e)	In operation	Subsidiary arrangements in force
Argentina	Atucha NPS	Atucha	PHWR	319	x	x
	Embalse PR	Cordoba	Candu	600	-	x
Austria[b]	Tullnerfeld	Zwentendorf	PWR	700	-	x
Belgium[b]	BR-3-CEN	Mol	PWR	11	x	x
	DOEL-1	Antwerp	PWR	412	x	x
	DOEL-2	Antwerp	PWR	412	x	x
	SEMO-1	Tihange	PWR	920	x	x
	SEMO-2	Tihange	PWR	934	x	- [f]
	Kernzentrale DOEL-3	Beveren	PWR	900	x	- [f]
Brazil	Angra-1	Angra dos Reis	PWR	626	-	x
Bulgaria[b]	Kozloduy-1	Kozloduy	PWR	440	x	x
	Kozloduy-2	Kozloduy	PWR	440	x	x
	Kozloduy-3	Kozloduy	PWR	440	x	x
	Kozloduy-4	Kozloduy	PWR	440	-	x
Canada[b]	Bruce-1	Tiverton, Ontario	Candu	788	x	x
	Bruce-2	Tiverton, Ontario	Candu	788	x	x
	Bruce-3	Tiverton, Ontario	Candu	788	x	x
	Bruce-4	Tiverton, Ontario	Candu	788	x	x
	DPGS	Kincardine, Ontario	Candu	208	x	x
	Gentilly-1	Gentilly, Quebec	Candu	250	-	x
	Gentilly-2	Gentilly, Quebec	Candu	600	-	x
	NPD	Rolphton, Ontario	Candu	22	x	x
	Pickering-1	Pickering, Ontario	Candu	540	x	x
	Pickering-2	Pickering, Ontario	Candu	540	x	x
	Pickering-3	Pickering, Ontario	Candu	540	x	x
	Pickering-4	Pickering, Ontario	Candu	540	x	x
	Point Lepreau	New Brunswick	Candu	600	-	x
China, Republic of	FNPS-1	Ching-San	BWR	636	x	x
	FNPS-2	Ching-San	BWR	636	x	x
	SNPS-1	Kuosheng Tsun	BWR	985	x	x
	SNPS-2	Kuosheng Tsun	BWR	985	-	x
Czecho-slovakia[b]	A1	Bohunice	HWGC	143	-	x
	V.1 Bohunice-1	Bohunice	PWR	440	x	x
	V.1 Bohunice-2	Bohunice	PWR	440	x	x
Finland[b]	Loviisa-1	Loviisa	PWR	420	x	x
	Loviisa-2	Loviisa	PWR	420	x	x
	TVO-1	Olkiluoto	BWR	660	x	x
	TVO-2	Olkiluoto	BWR	660	x	x
German Democratic Republic[b]	Rheinsberg PWR	Rheinsberg	PWR	80	x	x
	Bruno Leuschner-1	Greifswald	PWR	440	x	x
	Bruno Leuschner-2	Greifswald	PWR	440	x	x
	Bruno Leuschner-3	Greifswald	PWR	440	x	x
	Bruno Leuschner-4	Greifswald	PWR	440	x	x
Germany, Federal Republic of[b]	KRB-1	Gundremmingen	BWR	250	-	x
	GFK-MZFR	Karlsruhe	HWR	58	x	x
	VAK-KAHL	Grosswelzheim	BWR	16	x	x
	AVR	Jülich	HTGR	15	x	- [f]
	KWL-1	Lingen	BWR	267	-	x
	KNK	Karlsruhe	SZR	21	x	x
	KWW	Würgassen	BWR	670	x	x
	KKS-1-HAM	Stade	PWR	662	x	x

State[a]	Name of power reactor	Location	Type	Capacity MW(e)	In operation	Subsidiary arrangements in force
	KWO	Obrigheim	PWR	345	x	x
	KKB	Brunsbüttel	BWR	805	x	x
	RWE-BIBLIS-A	Biblis	PWR	1204	x	x
	RWE-BIBLIS-B	Biblis	PWR	1300	x	x
	GKN	Neckarwestheim	PWR	805	x	x
	KKU	Unterweser	PWR	1300	x	x
	KKI-ISAR	Ohu	BWR	907	x	x
	KKP	Philippsburg	BWR	907	x	x
	KKG	Grafenrheinfeld	LWR	1200	x	- f/
Hungary[b]	PAKS I	Paks	PWR	440	-	x
India	Tarapur-1	Tarapur	BWR	190	x	x
	Tarapur-2	Tarapur	BWR	190	x	x
	Rajasthan-1	Rajasthan	Candu	200	x	x
	Rajasthan-2	Rajasthan	Candu	200	x	x
Italy[b]	E.N.E.L.	Latina	GCR	160	x	x
	E.N.E.L.	Garigliano	BWR	160	-	x
	FERMI	Turin	PWR	256	-	x
	E.N.E.L.	Caorso	BWR	920	x	x
Japan[b]	Fugen	Tsuruga-Fukui	ATR	165	x	x
	Fukushima-1	Okuma-Fukushima	BWR	460	x	x
	Fukushima-2	Okuma-Fukushima	BWR	784	x	x
	Fukushima-3	Okuma-Fukushima	BWR	784	x	x
	Fukushima-4	Okuma-Fukushima	BWR	784	x	x
	Fukushima-5	Okuma-Fukushima	BWR	784	x	x
	Fukushima-6	Okuma-Fukushima	BWR	1100	x	x
	Fukushima Dai-ni-1	Naraha-Fukushima	BWR	1100	x	x
	Genkai-1	Kyushu	PWR	559	x	x
	Genkai-2	Kyushu	PWR	559	x	x
	Hamaoka-1	Hamaoka-cho	BWR	540	x	x
	Hamaoka-2	Hamaoka-cho	BWR	840	x	x
	Ikata-1	Nishiuwagun	PWR	566	x	x
	Ikata-2	Nishiuwagun	PWR	566	-	- f/
	Mihama-1	Mihama-Fukui	PWR	340	x	x
	Mihama-2	Mihama-Fukui	PWR	500	x	x
	Mihama-3	Mihama-Fukui	PWR	826	x	x
	Ohi-1	Ohi-cho, Fukai-ken	PWR	1175	x	x
	Ohi-2	Ohi-cho, Fukai-ken	PWR	1175	x	x
	Shimane	Kashima-cho	BWR	460	x	x
	Takahama-1	Takahama	PWR	826	x	x
	Takahama-2	Takahama	PWR	826	x	x
	Tokai-1	Tokai-Mura	Magnox	166	x	x
	Tokai-2	Tokai-Mura	BWR	1100	x	x
	Tsuruga	Tsuruga	BWR	357	x	x
	JPDR	Tokai-Mura	BWR	90	-	x
	Mutsu nuclear ship	Minato-Machi Mutsu	PWR	36	-	x
Korea, Republic of[b]	Kori-1	Pusan	PWR	564	x	x
	Kori-2	Pusan	PWR	605	-	- f/
	Wolsung-1	Yangnam-Myon	Candu	633	-	- f/
Mexico[e]	Laguna Verde PS	Laguna Verde, Vera Cruz	BWR	650	-	- f/
Netherlands[b]	GKN	Dodewaard	BWR	54	x	x
	PZEM	Borssele	PWR	468	x	x

State[a]	Name of power reactor	Location	Type	Capacity MW(e)	In operation	Subsidiary arrangements in force
Pakistan	KANUPP	Karachi	Candu	125	x	x
South Africa	Koeberg-1	Cape Town	PWR	922	-	x
	Koeberg-2	Cape Town	PWR	922	-	x
Spain	Almaraz-1	Province of Caceres	PWR	930	x	x
	Almaraz-2	Province of Caceres	PWR	930	-	x
	Asco-1	Province of Tarragona	PWR	930	-	x
	Asco-2	Province of Tarragona	PWR	930	-	x
	Cofrentes	Province of Valencia	BWR	975	-	x
	José Cabrera	Almonacid de Zorita	PWR	153	x	x
	Lemoniz-1	Province of Viscaya	PWR	930	-	x
	Lemoniz-2	Province of Viscaya	PWR	930	-	x
	Santa María de Garona	Province of Burgos	BWR	440	x	x
	Vandellos	Vandellos	GCR	480	x	- f/
Sweden[b]	Barsebäck-1	Near Malmö	BWR	580	x	x
	Barsebäck-2	Near Malmö	BWR	580	x	- f/
	Forsmark-1	Near Uppsala	BWR	900	x	- f/
	Forsmark-2	Uppsala	BWR	900	x	- f/
	Oskarshamn-1	Oskarshamn	BWR	440	x	x
	Oskarshamn-2	Oskarshamn	BWR	580	x	x
	Ringhals-1	Near Göteborg	BWR	760	x	x
	Ringhals-2	Near Göteborg	PWR	830	x	x
	Ringhals-3	Near Göteborg	PWR	912	x	- f/
	Ringhals-4	Near Göteborg	PWR	912	-	- f/
Switzerland[b]	KKM	Mühleberg	BWR	320	x	x
	KKB-1	Beznau	PWR	350	x	x
	KKB-2	Beznau	PWR	350	x	x
	KKG	Gösgen-Däniken	PWR	970	x	x
United Kingdom	PFR and storage capacity*/	Dounreay	FBR	250	x	x
United States	Trojan nuclear plant	Rainier, Oregon	PWR	1178	x	- f/
	Rancho Seco nuclear generating station	Herald, California	PWR	963	x	- f/
Yugoslavia[b]	Krško	Krško	PWR	632	x	x

*/ This facility is used for research and development.

C. Conversion plants, fuel fabrication plants, enrichment plants and chemical reprocessing plants including pilot plants with an annual throughput or inventory exceeding one effective kilogram

State[a]	Abbreviated name	Location	Type	Subsidiary arrangements in force
Argentina	Pilot Fuel Fabrication Plant (natural uranium)	Constituyentes	Fuel fabrication	- f/
	Pilot Fuel Fabrication Plant (HEU)	Constituyentes	Fuel fabrication	x
	Atucha Fuel Fabrication Plant	Ezeiza	Fuel fabrication	- f/
Belgium[b]	FBFC	Dessel	Fuel fabrication	x
	Belgonucléaire-BN-MOX	Dessel	Fuel fabrication	x
Brazil	Resende Fuel Fabrication Plant	Resende	Fuel fabrication	- f/
Canada[b]	ENL Port Hope	Port Hope	Conversion	x
	ENL Port Hope	Port Hope	Conversion	x
	CGE Peterborough	Peterborough	Fuel fabrication	x
	WCL	Varennes	Fuel fabrication	x
	Combustion Engineering Superheat	Moncton, New Brunswick	Fuel fabrication	x
	WCL Port Hope	Port Hope	Fuel fabrication	x
	CGE Toronto	Toronto	Fuel fabrication	x
	Noranda Met. Ind. Ltd.	Montreal	Fuel fabrication	x
	ENL Port Hope	Port Hope	Fuel fabrication	x
	CRNL Fuel Fabrication Plant	Chalk River	Fuel fabrication	x
	Metallurgy	Chalk River	Fuel fabrication	x
China, Republic of	INER Fuel Fabrication Plant	Lung Tan	Fuel fabrication	x
	INER Uranium Conversion Pilot Plant	Lung Tan	Conversion	- f/
Denmark[c]	Metallurgy Department	Risø	Fuel fabrication	x
Germany, Federal Republic of[b]	ALKEM	Wolfgang, Hanau	Fuel fabrication	- f/
	NUKEM	Wolfgang, Hanau	Fuel fabrication	x
	RBU-1	Wolfgang, Hanau	Fuel fabrication	x
	RBU-2	Karlstein	Fuel fabrication	x
	GWK-WAK	Leopoldshafen, Karlsruhe	Reprocessing	x
	Exxon	Lingen	Fuel fabrication	x
	Uranit	Jülich	Enrichment	- f/
India	Nuclear Fuel Complex	Hyderabad	Fuel fabrication	x
	PREFRE	Tarapur	Reprocessing	x
Italy[b]	Fabnuc-Bosco Marengo	Alessandria	Fuel fabrication	x
	COREN	Saluggia	Fuel fabrication	x
	EUREX	Saluggia	Reprocessing	x
	IFEC	Saluggia	Fuel fabrication	x
	ITREC-Trisaia	Rotondella	Reprocessing	x
	Comb. Nuc.	Rotondella	Fuel fabrication	x
Japan[b]	PNC Reprocessing Plant	Tokai-Mura	Reprocessing	x
	NFI (Kumatori-1)	Kumatori, Osaka	Fuel fabrication	x
	SMM (Tokai-1)	Tokai-Mura	Conversion	x
	JNF	Yokosuka	Fuel fabrication	x
	MNF	Tokai-Mura	Fuel fabrication	x
	NFI (Tokai R&D)	Tokai-Mura	Fuel fabrication	- f/
	NFI (Tokai-1)	Tokai-Mura	Fuel fabrication	- f/
	PPFF	Tokai-Mura	Fuel fabrication	x
	MAPI	Ohmiya	Fuel fabrication	x
	NFI (Kumatori-2)	Kumatori, Osaka	Fuel fabrication	x
	NFI (Takayama-R&D)	Takayama	Fuel fabrication	x
	PNC Pilot Enrichment Plant	Ningyo	Enrichment	- f/

State[a/]	Abbreviated name	Location	Type	Subsidiary arrangements in force
Netherlands[b/]	URENCO	Almelo	Enrichment	- f/
	Ultra-Centrifuge	Almelo	Enrichment	- f/
Spain	Metallurgical Plant Juan Vigon Research Centre	Madrid	Fuel fabrication	x
	Juan Vigon Research Centre	Madrid	Reprocessing	x
Sweden[b/]	ASEA - ATOM	Västeras	Fuel fabrication	x
United Kingdom	PFR Reprocessing Plant	Dounreay	Reprocessing	x
United States	Exxon Fuel Fabrication Plant	Richland, Washington	Fuel fabrication	- g/

D. Separate storage facilities and other facilities

State[a/]	Abbreviated name	Location	Type	Subsidiary arrangements in force
Argentina	Store of Embalse fuel at Atucha	Atucha	Separate storage	- f/
Australia[b/]	Research Laboratory	Lucas Heights	Other facilities	x
Belgium[b/]	CEN-Labo	Mol	Other facilities	x
	BCMN	Geel	Other facilities	x
	Overpelt	Olen	Separate storage	x
	Eurochemic	Mol	Separate storage	x
	BN-Mol	Mol	Other facilities	- f/
	PULAB	Mol	Other facilities	x
	Belgonucléaire - UF_6 store	Dessel	Separate storage	- f/
Canada[b/]	Fuel Engineering	Chalk River	Other facilities	x
	WNRE	Pinawa, Manitoba	Other facilities	x
	Workshops	Chalk River	Other facilities	x
	WNRE	Pinawa, Manitoba	Separate storage	x
	Pickering G.S.	Pickering	Separate storage	x
	CRNL	Chalk River	Separate storage	x
	Bruce G.S.	Tiverton	Separate storage	x
Czecho-slovakia[b/]	Research Laboratories	Rez	Other facilities	x
	Nuclear Fuel Inst. (UJB)	Prague	Other facilities	x
	Al	Bohunice	Separate storage	x
Denmark[c/]	FAB.STO.	Risø	Separate storage	x
	Hotcell Plant	Roskilde	Other facilities	x
France	COGEMA	Cap de la Hague	Separate storage	x
German Democratic Republic[b/]	Staatl. Amt f. Atomsicherheit	Berlin-Karlshorst	Other facilities	x
	VEB Geophysik Leipzig	Gommern	Other facilities	x
	Uran Technikum	Rossendorf	Other facilities	- f/
Germany, Federal Republic of[b/]	Urananlage	Ellweiler	Separate storage	x
	Braunkohle	Wesseling	Separage storage	x
	KWU-Hotcell	Karlsruhe	Other facilities	x
	KFA-Lab	Jülich	Other facilities	- f/
	Transuran	Karlsruhe	Other facilities	x
	GFK-Hotcell	Karlsruhe	Other facilities	x
	GFK/IHCH	Karlsruhe	Other facilities	x
	GFK/IMF3	Karlsruhe	Other facilities	x
	PTB-Spaltstofflager/ALKEM	Wolfgang, Hanau	Separate storage	- f/
Hungary[b/]	Institute of Isotopes	Budapest	Other facilities	x
Iraq[b/]	Separate storage	Baghdad, Tuwaitha	Separate storage	- f/
Italy[b/]	CNEN-LAB. TEC	Casaccia	Other facilities	x
	CNEN. LAB.PU.	Casaccia	Other facilities	x
	CCRM-Ispra	Ispra	Separate storage	x
	Research Centre	Ispra	Other facilities	- f/
	AGIP Bosco-Marengo	Alessandria	Separate storage	x
Japan[b/]	JAERI-Oarai R&D	Oarai-Machi	Other facilities	x
	JAERI-Tokai R&D	Tokai-Mura	Other facilities	x
	NERL, University of Tokyo	Tokai-Mura	Other facilities	x
	NFD	Oarai-Machi	Other facilities	x
	PNC Tokai R&D (development facility)	Tokai-Mura	Other facilities	x
	PNC-Oarai R&D	Oarai-Machi	Other facilities	x
	NRF Neutron Radiation Facility	Sakura-Mura	Other facilities	x
	Fukushima Dai-ni	Fukushima	Separate storage	- f/

State[a]	Abbreviated name	Location	Type	Subsidiary arrangements in force
Netherlands[b]	ECN+JRC	Petten	Other facilities	x
	Kema Lab.	Arnheim	Other facilities	x
Norway[b]	Research laboratories	Kjeller	Other facilities	x
Pakistan	Storage at Government depot	Karachi	Separate storage	x
Poland[b]	Institute of Nuclear Research	Świerk	Other facilities	x
	Miscellaneous locations combined in one material balance area	Various	Other facilities	x
Portugal[b]	Instalacao de Armazenagem	Sacavem	Separate storage	x
Romania[b]	Demfuel	Pitesti, Colibasi	Other facilities	x
Sweden[b]	Central storage fresh fuel	Studsvik	Other facilities	x
	Central Hot Laboratory	Studsvik	Other facilities	x
Switzerland[b]	Diorit	Würenlingen	Separate storage	x
	Federal Institute of Reactor Research	Würenlingen	Other facilities	x
United Kingdom	Windscale PU-storage	Windscale	Separate storage	x
	Windscale Storage Pond	Windscale	Separate storage	x
USA	Argonne National Laboratory	Argonne	Separate storage	x

a/ An entry in this column does not imply the expression of any opinion whatsoever on the part of the Secretariat concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of its frontiers.

b/ NPT safeguards agreement.

c/ Prior to the entry into force on 21 February 1977 of the safeguards agreement between the seven non-nuclear-weapon States of EURATOM, EURATOM and the Agency, NPT safeguards were applied in Denmark under the NPT agreement with Denmark which entered into force on 1 March 1972.

d/ Prior to the accession by Greece on 17 December 1981 to the safeguards agreement of 5 April 1973 between the non-nuclear-weapon States of EURATOM, EURATOM and the Agency, NPT safeguards were applied in Greece under the NPT agreement with Greece which provisionally entered into force on 1 March 1972.

e/ Safeguards agreement in connection with the Treaty for the Prohibition of Nuclear Weapons in Latin America (Tlatelolco Treaty) and NPT.

f/ Under negotiation.

g/ In force on 10 February 1982.

Scientific journals

259. Twelve regular issues of "Nuclear Fusion" were published with slightly higher sales than in 1980. Compilation of the fourth edition of the "Nuclear Fusion" supplement "World Survey of Major Activities in Controlled Fusion Research", covering all aspects of plasma physics and fusion research, was completed.

International Nuclear Information System (INIS)

260. Four countries (Cuba, the Libyan Arab Jamahiriya, the Syrian Arab Republic and Paraguay) and one international organization (the International Institute for Applied Systems Analysis) joined INIS during 1981, bringing the total number of active participants to eighty. The combined input to the data base exceeded 70 000 documents for the year. By the end of 1981, the INIS bibliographic file contained more than 640 000 items and the file of non-commercial documents available for sale as microfiche (technical reports, theses, etc.) contained almost 160 000 items. At the end of the year, 33 Member States were taking advantage of the service providing direct on-line access to the INIS data base and other searchable files stored on the Agency's computer. Connect time for external users during 1981 totalled 1418 hours, an increase of about 28% over the previous year's figure. The format of the on-line data base was thoroughly restructured in order to increase the flexibility and efficiency of on-line searching.

261. A new edition of the introductory publication "INIS Today" was issued in December. Revised editions of several volumes in the INIS Reference Series were prepared, including "Terminology and Codes for Countries and International Organizations" (IAEA-INIS-5), "Authority List for Corporate Entries and Report Number Prefixes" (IAEA-INIS-6), "Authority List for Journal Titles" (IAEA-INIS-11) and the "Thesaurus" (IAEA-INIS-13). A new volume in the series OCR Input Instructions was also published. Considerable progress was made with the compilation of a new multilingual subject-indexing dictionary based on the "Thesaurus". Machine-readable versions of the "Thesaurus" in Russian, German and French prepared by various national centres are being merged into a single file with the standard English version so as to produce printed reference manuals for subject indexers and retrieval specialists; a Spanish version will be added soon. A thorough study of the INIS character set and of methods of representing special characters was completed; the results will be incorporated in a new edition of "Magnetic and Punched Paper Tape Codes and Character Sets" (IAEA-INIS-7).

262. A consultative meeting of INIS Liaison Officers was held in Rio de Janeiro, Brazil, in conjunction with a regional training seminar for Latin America. This seminar, together with Agency assistance to Venezuela in the installation of on-line searching software, has stimulated more active participation in INIS by Member States in Latin America.

Library services

263. Improvements in the services provided to the organizations located at the Vienna International Centre were brought about by the further computerization of library procedures. The book and journal order files were computerized and work began on automation of the loan system.

Computer services

264. Computer usage was 60% higher in 1981 than in 1980; the seven years up to and including 1981 saw an elevenfold increase in computer usage. To accommodate the increased work-load, a second central processing unit (IBM 3033S) was installed in December. Word processor applications continued to increase.

Publishing and printing services

265. The net income to the Agency from the sale of Agency publications (including INIS and CINDA publications) was $1.08 million in 1981, compared with $1.26 million in 1980 and $970 000 in 1979.

266. The printing services provided to the United Nations and UNIDO yielded an income of approximately $895 197 in 1981.

Legal affairs

Regional co-operation

267. In March, the Government of Viet Nam notified the Director General of its acceptance of RCA. By the end of 1981, RCA was in force for the Agency and the following Member States: Australia, Bangladesh, India, Indonesia, Japan, the Republic of Korea, Malaysia, Pakistan, the Philippines, Singapore, Sri Lanka, Thailand and Viet Nam.

268. In June, the Government of India notified the Director General of its acceptance of the agreement of 23 May 1980 establishing the Asian regional co-operative project on food irradiation[24] within the framework of RCA. By the end of 1981, the agreement was in force for the Agency and the following Member States: Bangladesh, India, Indonesia, Japan, the Republic of Korea, Malaysia, Pakistan, the Philippines, Sri Lanka and Thailand.

Advisory services

269. Advice on the framing of legislation on radiation protection, nuclear safety and third-party liability for nuclear damage were provided to Chile and Ghana at the request of the national authorities concerned.

Physical protection

270. By 31 December 1981, 33 States and one regional organization had signed the Convention on the Physical Protection of Nuclear Material[25] and three States had ratified it; the Convention, which was opened for signature on 3 March 1980, will enter into force on the thirtieth day after the deposit with the Director General of the twenty-first instrument of ratification.

International spent fuel management

271. The Expert Group on International Spent Fuel Management continued its examination of the potential for international co-operation in the management of spent fuel; three meetings of the Expert Group and its sub-groups were held. Work on technical and economic aspects was completed and a summary report drafted. Also, good progress was made in the examination of institutional issues.

International plutonium storage

272. The Expert Group on International Plutonium Storage and its technical sub-groups, which held six meetings, made further progress in examining the technical, operational and legal aspects of implementing Article XII.A.5 of the Agency's Statute, as an extension of the safeguards system.

Host country arrangements

273. Agreements regarding occupancy of the Agency's seat at the VIC[26] were signed in January by the Agency, the Austrian Government and the United Nations. They entered into force on 1 October 1981, except for the agreement

[24] Reproduced in document INFCIRC/285.

[25] Reproduced in document INFCIRC/274/Rev.1.

[26] GC(XXV)/642, para. 215.

establishing a common fund for financing major repairs and replacements, which entered into force retroactively on 1 January 1981.

274. Negotiations between the Agency and the Austrian Government on a draft agreement for inclusion of the Agency's laboratories at Seibersdorf in the Headquarters of the Agency were concluded late in 1981.[27]

275. The agreement with Monaco regarding the International Laboratory of Marine Radioactivity was extended through exchanges of letters between the Agency, the Monegasque Government and the Oceanographic Institute at Monaco until 30 June 1984 subject to termination upon nine months' notice.

Vienna International Centre

276. The operation of common services with the United Nations and UNIDO was in general satisfactory.

277. The international organizations agreed to transfer from a private contractor to UNIDO, as of 1982, the responsibility for the operation and maintenance of the heating and air-conditioning functions of the Vienna International Centre.

Personnel

278. In 1981, 192 staff members left the Agency and 256 were appointed. Of the new staff members, 104 were in the Professional category.

279. At the end of 1981, the Secretariat had 596 staff members in the Professional and higher categories, 914 in the General Service category and 150 in the Maintenance and Operatives Service category.[28]

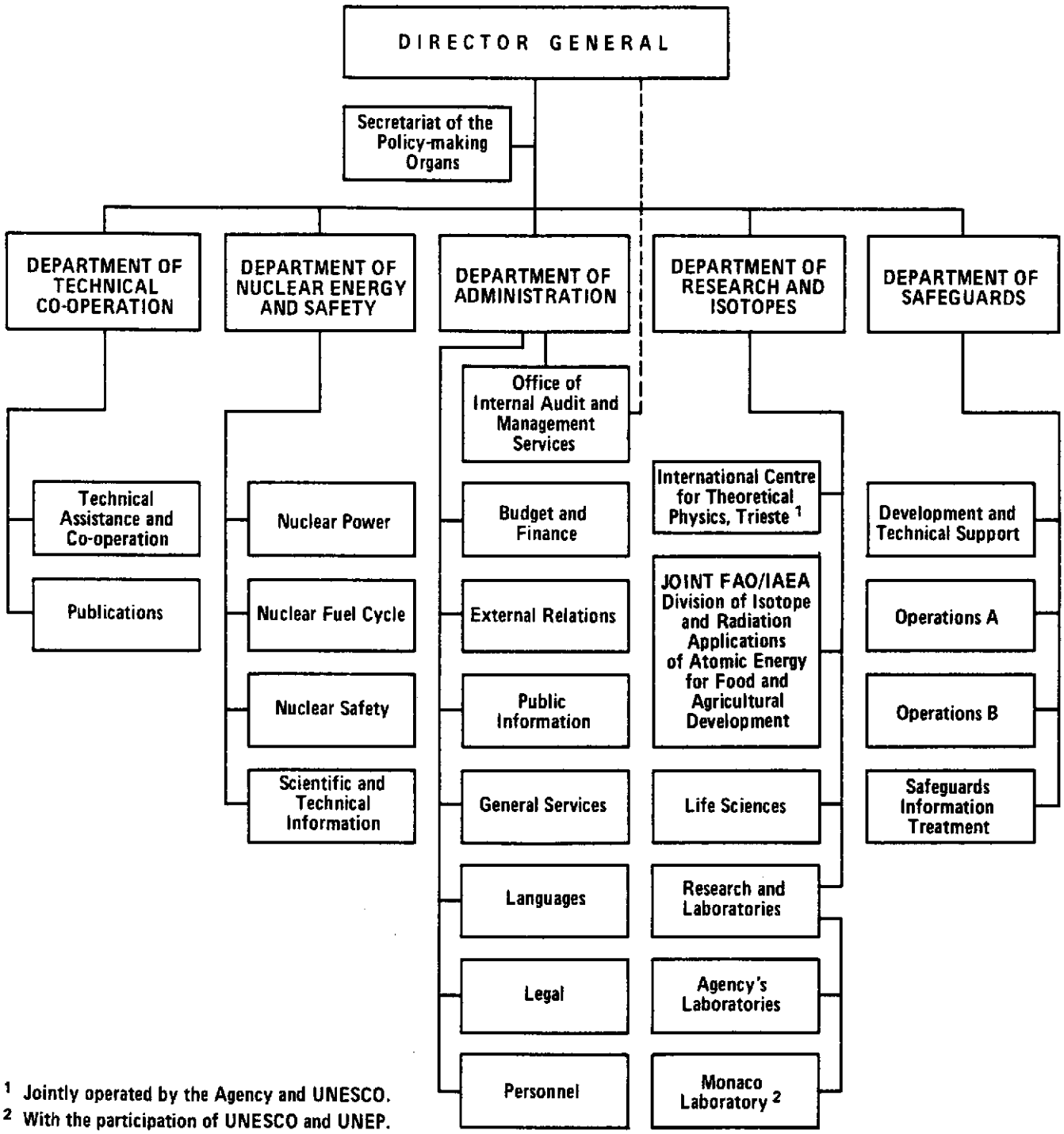
280. Among the staff in posts subject to geographical distribution, 66 nationalities were represented on 31 December 1981.

281. The following organizational chart shows the structure of the Secretariat.

[27] The agreement was signed on 1 March 1982.

[28] These figures include staff members funded from extrabudgetary resources.

ORGANIZATIONAL CHART*



[1] Jointly operated by the Agency and UNESCO.
[2] With the participation of UNESCO and UNEP.

* This organizational chart became effective on 2 April 1982.