



General Assembly

Distr.
GENERAL

A/39/458/Add.1
20 September 1984
ENGLISH
ORIGINAL: ARABIC/ENGLISH/
FRENCH/RUSSIAN/
SPANISH

Thirty-ninth session
Item 14 of the provisional agenda*

REPORT OF THE INTERNATIONAL ATOMIC ENERGY AGENCY

Note by the Secretary-General

Addendum

The Secretary-General has the honour to submit herewith to the General Assembly Addendum 1 and Addendum 2 to the twenty-eighth report of the International Atomic Energy Agency (GC(XXVIII)/713).

* A/39/150

THE ANNUAL REPORT FOR 1983

GC(XXVIII)/713

Printed by the
International Atomic Energy Agency
in Austria - July 1984



INTERNATIONAL ATOMIC ENERGY AGENCY

THE ANNUAL REPORT FOR 1983

CONTENTS

	<u>Paragraphs</u>	<u>Page</u>
INTRODUCTION	1 - 45	7
THE AGENCY'S ACTIVITIES		
Technical co-operation	46 - 68	15
Nuclear power	69 - 99	25
Nuclear fuel cycle	100 - 156	31
Nuclear safety	157 - 183	37
Food and agriculture	184 - 205	41
Life sciences	206 - 229	45
Physical sciences	230 - 262	48
The Laboratories	263 - 288	52
International Centre for Theoretical Physics	289 - 304	56
Safeguards	305 - 330	59
Information and technical services	331 - 349	88
ADMINISTRATION	350 - 373	91

LIST OF ABBREVIATIONS

Agency	International Atomic Energy Agency
AGRIS	Agricultural Information System
CEC	Commission of the European Communities
CERN	European Organization for Nuclear Research
CMEA	Council for Mutual Economic Assistance
EEC	European Economic Community
EURATOM	European Atomic Energy Community
FAO	Food and Agriculture Organization of the United Nations
GW(e)	Gigawatt (electrical)
HTR	High-temperature reactor
HWR	Heavy-water reactor
IAEA	International Atomic Energy Agency
ILO	International Labour Organisation
INTOR	International Tokamak Reactor
kCi	Kilocurie
LMFBR	Liquid-metal fast breeder reactor
LWR	Light-water reactor
MeV	Megaelectronvolt
MW(e)	Megawatt (electrical)
NDA	Non-destructive assay
NEA	Nuclear Energy Agency of OECD
NNW	Non-nuclear-weapon
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NW	Nuclear-weapon
OECD	Organisation for Economic Co-operation and Development
R&D	Research and Development
RCA	Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (INFCIRC/167)
SI units	Units belonging to the International Organization for Standardization's International System of Units
SQ	Significant quantity
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
UNIPED	International Union of Producers and Distributors of Electrical Energy
VIC	Vienna International Centre
WEC	World Energy Conference
WHO	World Health Organization

All sums of money are expressed in United States dollars

INTRODUCTION

Membership

1. Namibia, represented by the United Nations Council for Namibia, became a member of the Agency on 17 February 1983.
2. The Government of the People's Republic of China applied for membership of the Agency on 5 September 1983. Its application was unanimously approved by the General Conference, at its twenty-seventh regular session, on 11 October 1983 and China became a Member of the Agency on 1 January 1984. With China as Member, all States with significant nuclear programmes and activities are now Members of the Agency and participate in its work.

Nuclear power

3. The total installed nuclear power-generating capacity in the world reached 191 GW(e) by the end of 1983, with 25 new plants being connected to the grid during the year. Three of the new plants connected to the grid in 1983 were in developing countries; they had a total capacity of 1.4 GW(e). Nuclear power plants accounted for about 12% of the world's total electricity generation during 1983.
4. Construction work started on 23 new plants, with a total capacity of 17.5 GW(e), while contracts or firm plans for 12 plants, with a total capacity of 13 GW(e), were cancelled or indefinitely suspended. This was due mainly to the continued low growth in electricity demand and to increasing financing problems in several countries. Three of the new plants were in developing countries.
5. Work on several plants now under construction may be delayed or cancelled in the future, and it is now expected that the installed nuclear power-generating capacity worldwide in 1985 will be 255-275 GW(e). It is expected that nuclear plants will account for 15% of the world's electricity generation in 1985.
6. For the year 2000 a worldwide nuclear capacity of 485-725 GW(e) may now be expected, whereas 720-950 GW(e) were projected in 1982. The projected share of world electricity generation accounted for by nuclear plants in the year 2000 is 20%.
7. Nuclear power plant investment costs continued their general strong rise. As they constitute up to 80% of the total costs of nuclear-generated electricity, concern about nuclear power now relates more to the technical and economic performance of nuclear power plants. Accordingly, in addition to the standardization of licensing procedures and the reduction of construction times, nuclear power plant reliability is being emphasized as a key question from the point of view of ensuring the long-term competitiveness of nuclear power.
8. The renewed interest in small and medium power reactors, for both electricity and heat generation, may lead to new markets, not only in developing but also in industrialized countries, if the economic competitiveness of such reactors can be established.

9. There was a continued slowing-down of programmes for the development of advanced reactor systems in several countries, especially the United States. However, 1983 was also marked by a trend towards increasing international co-operation - for example, in the development of LMFBRs in Western Europe.

Nuclear safety

10. Efforts to strengthen nuclear safety throughout the world were furthered by a variety of activities. An Agency operational safety review team, the first of its kind, visited the Republic of Korea to review the status of a nuclear power plant and assess its ability to continue operating safely. Six further safety guides were published under the Nuclear Safety Standards (NUSS) programme for the development of internationally agreed codes and guides for nuclear power plants. Preparations continued for the establishment of an Agency incident reporting system which will receive and compile information on incidents of safety significance at nuclear power plants. The second annual Nuclear Safety Review, covering the highlights of 1982 and summarizing the Agency's programme, was presented to the Board of Governors in June.

11. Work continued on implementing the Basic Safety Standards for Radiation Protection, with the publication of several new documents on specialized subjects and with preparations for a comprehensive training programme intended to provide a basic level of understanding of the Agency's radiation protection policies. Assistance in emergency planning and preparedness for radiological emergencies was provided to several Member States, and plans were made for a document relating to intervention levels[1] in the event of nuclear accidents, particularly those with transboundary implications. An extensive revision of the Agency's Regulations for the Safe Transport of Radioactive Materials, designed - inter alia - to make them consistent with the Basic Safety Standards, is in its final stages.

Nuclear fuel cycle

12. The Agency continued work, in co-operation with NEA, on the assessment of uranium resources, on uranium exploration techniques and on uranium extraction. The latest NEA/IAEA report on "Uranium - Resources, Production and Demand" (the Red Book) was prepared for publication in early 1984.[2]

Spent fuel management

13. As only a small fraction of the world's spent power reactor fuel has been reprocessed, emphasis was placed on the technical aspects of spent fuel management. The Agency published a guidebook on spent fuel storage.

Waste management

14. The International Conference on Radioactive Waste Management, organized by the Agency in co-operation with the United States Department of Energy and held in Seattle, United States of America, in May, attracted wide interest. There were 528 participants from 29 Member States and eight international organizations. The Conference offered the possibility of both a broad review and a close scrutiny of the technological, environmental, regulatory, legal,

[1] Intervention levels are numerical values of projected radiological doses that relate to the initiation of protective measures.

[2] The report was published in February 1984.

economic and policy aspects of the subject. In general, the Conference confirmed that nuclear power can be developed and widely used without creating an unmanageable waste problem and there was a consensus that no technological breakthroughs are required for the safe management of radioactive waste.

International plutonium storage

15. In February the Director General submitted to the Board of Governors the report he had received in October 1982 from the Expert Group on International Plutonium Storage. The Board took the report under consideration and scheduled a discussion of it for a subsequent meeting.

Committee on Assurances of Supply

16. The Committee on Assurances of Supply (CAS) held its seventh to tenth sessions in January, April, September and December 1983 respectively.

17. It continued its consideration of principles of international co-operation in the field of nuclear energy in accordance with the mandate of the Committee on Assurances of Supply and narrowed down further the areas where the views of Member States diverge. During 1983 it also considered the question of mechanisms for revising international nuclear co-operation agreements and formulated a number of conclusions for examination by the Board of Governors.

18. It concluded its consideration of emergency and back-up mechanisms by making recommendations to the Board for the establishment within the Agency of a system which would:

- receive, register and keep records on supplies made available for a back-up mechanism and register and keep records on the conditions for making available and drawing on such supplies,
- provide Member States, upon request and to the extent possible, with such information and services as are needed for the implementation of the mechanism, and
- serve, upon request, as an intermediary between a State requesting relief from the mechanism and back-up suppliers.

Technical co-operation and the application of nuclear techniques

19. The size of the technical co-operation programme (expressed in current US dollars) doubled between 1980 and 1983. The Technical Assistance and Co-operation Fund, which is the largest source of funding for the Agency's technical co-operation activities, grew during this period from \$10.6 million to \$19.2 million. Three quarters of the 1983 programme resources were earmarked for the transfer of nuclear techniques in such fields as agriculture, medicine and industry. The remaining 25% was allotted for nuclear safety (with particular emphasis on radiation protection) and nuclear power development (which, in many cases, involves uranium prospecting and mining).

20. The composition of the resources available for 1983 was as follows: Technical Assistance and Co-operation Fund (\$19.2 million), extrabudgetary financial resources (\$9.4 million), assistance in kind (\$2.2 million) and UNDP resources (\$3.7 million). Total 1983 resources amounted to \$34.5 million.

21. During 1983, expenditures totalling \$26.6 million were incurred in implementing the technical co-operation programme; this represents an increase

in delivery of 16% over 1982. In addition, \$16.7 million were obligated for payment in 1984. The total expenditure and obligation figure, \$44 million, reflects the implementation of technical assistance programmes in 1983.

22. The expert component showed continued growth, the number of assignments increasing from 658 in 1982 to 849 in 1983. Once again a large number of expert assignments, about 30% of the total, were carried out by Agency staff members.

23. During the year, 1348 scientists and technicians received training - primarily in nuclear engineering and nuclear safety (34%), agriculture (19%), medicine (11%) and industrial applications of isotopes and radiation techniques (10%). Thirty-five training courses were attended by 779 participants from developing countries.

24. Significant progress was made on two major special programme projects:

(a) Implementation of a Mediterranean fruit fly eradication project in Egypt (Misr-Med) got under way. Training of the personnel who will operate an industrial plant for the mass-rearing of sterile flies and carry out release and other operations is being provided mainly by Mexico, at no cost to the project, under a TCDC (technical co-operation among developing countries) agreement. An initial cost-benefit analysis indicates that the project, once fully operational, should yield a net benefit to Egypt of some \$50 million annually;

(b) The number of countries participating in a project designed to strengthen the capability for non-destructive testing (NDT) in Latin American industries almost doubled, reaching 13 by the end of the year; this project is being carried out by the Agency together with the United Nations Financing System for Science and Technology for Development (UNFSSTD) and UNIDO. Training courses and workshops were held at the national and the regional level with the aim of increasing the skills of NDT workers and promoting greater uniformity in NDT certification standards.

25. The agreement of 1980 establishing the Asian Regional Co-operative Project on Food Irradiation within the framework of RCA[3] was extended for a period of one year with effect from 28 August 1983. By the end of 1983, the agreement as extended was in force for the Agency and the following Member States: India, Indonesia, Japan, the Republic of Korea, Malaysia, Pakistan, the Philippines, Sri Lanka, Thailand and Viet Nam. The sixth session of the RCA Working Group was held at Kalpakkam, India, in March, when the progress of current projects was reviewed and the establishment of new projects considered.

[3] Reproduced in document INFCIRC/285.

26. Activities being carried out under RCA expanded to comprise 14 projects, including four new projects on medical and biological applications of nuclear techniques and a new project on basic science using research reactors; financial contributions were made by Australia, India and Japan. The largest project, relating to industrial applications of isotopes and radiation technology, is being financed by Australia, Japan, UNDP and the Agency; in 1983, \$2.5 million were available for this programme, a large fraction contribute by participation Member States and local industries. The following RCA programmes were active in 1983:

Funds obligated in 1983

RCA programme	Source of funds			Total
	Regular Budget	Extra-budgetary	UNDP	
Animal production	13 500	-	-	13 500
Food preservation	-	46 613 ^{a/}	-	46 613
Plant breeding				
- grain legumes	30 904	-	-	30 904
- rice	38 432	-	-	38 432
Impact of mineral substances on man and the environment	5 000	-	-	5 000
Maintenance of medical instrumentation	43 000	-	-	43 000
Isotope hydrology	-	45 677 ^{b/}	-	45 677
Improvement of cancer therapy	51 100	-	-	51 100
Nuclear techniques for tropical parasitic diseases	11 000	-	-	11 000
Development of Tc-99 ^m generator systems	9 000	-	-	9 000
Industrial applications of isotopes and radiation technology	-	67 032 ^{a/}	884 855	951 887
Total	201 936	159 322	884 855	1 246 113

^{a/} Met from cash contributions made by the Government of Japan.

^{b/} Met from cash contributions made by the Government of Australia.

27. During the twenty-seventh session of the General Conference, a meeting of Latin American representatives was convened to discuss the possibility of concluding for Latin America an agreement on the lines of RCA. Following the meeting, arrangements were made with five Latin American Member States (Bolivia, Colombia, Ecuador, Peru and Venezuela) to initiate a programme aimed at accelerating the transfer of nuclear science and technology.

28. A technical co-operation policy review initiated by the Board in 1982 was concluded during 1983; the review concentrated on the introduction of improved procedures for programming, project planning and evaluation. It is expected that implementation of the recommendations resulting from that review will enhance the quality of the Agency's technical co-operation programmes and increase the responsiveness of the Agency to the needs of its developing Member States.

29. A Technical Co-operation Evaluation Unit was established within the Department of Technical Co-operation and began operation in June.

30. At regular intervals the Agency has, since 1963, comprehensively reviewed the state of the art of the applications of isotope and nuclear techniques in water resources exploration, evaluation, exploitation and conservation. The sixth International Symposium on Isotope Hydrology, organized by the Agency in co-operation with UNESCO, took place in September.

International Laboratory of Marine Radioactivity

31. In April the Agency took formal possession of temporary additional office and laboratory space provided by the Government of the Principality of Monaco.

International Centre for Theoretical Physics

32. On 22 April members of the Board of Governors visited the Centre in order to see at first hand its work in helping to stimulate research and training, particularly in the developing countries, on advanced topics in the physical and mathematical sciences.

Safeguards

33. In 1983, as in previous years, the Secretariat, in carrying out the safeguards obligations 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 for

[4] In the case of voluntary-offer agreements with nuclear-weapon (NW) States nuclear material to which safeguards were applied was not withdrawn from safeguards except in conformity with these agreements.

[5] In these two cases, relating to two nuclear power plants, additional technical safeguards measures were put into effect during the first half of 1983. The measures taken enabled the Agency thereafter to perform effective verification. Full use of the agreed additional equipment at these installations will further improve confidence in safeguards.

any other military purpose, or for the manufacture of any other nuclear explosive device, or for purposes unknown[4]. With the exception of two cases where the Agency was unable to draw conclusions for part of the year[5], it is considered reasonable to conclude that nuclear material under Agency safeguards in 1983 remained in peaceful nuclear activities or was otherwise adequately accounted for.

34. Negotiations started in May between the Agency and the Soviet Union on a voluntary offer to place some of the Soviet Union's peaceful nuclear installations under Agency safeguards.

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

35. The Preparatory Committee of the United Nations Conference for the Promotion of International Co-operation in the Peaceful Uses of Nuclear Energy held its fourth meeting in March/April 1983. The United Nations General Assembly, at its thirty-eighth session, decided that the Conference would be held in 1986 and that the Preparatory Committee would hold its fifth session in Vienna in June 1984. The Agency continued to assist in the preparations for the Conference and provided several working papers to the Secretary-General of the Conference.

Third Review Conference of the parties to the Treaty on the Non-Proliferation of Nuclear Weapons

36. The United Nations General Assembly, at its thirty-eighth session, noted that preparations had started for a Third Review Conference, to be held in 1985, of the parties to the Treaty on the Non-Proliferation of Nuclear Weapons and requested the Secretary-General to render the necessary assistance and to provide such services, including summary records, as might be required.

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

37. Several matters of interest to the Agency were discussed at the thirty-eighth session of the General Assembly. In the debate that followed the presentation of the Agency's Annual Report for 1982, delegates commented on the Agency's safeguards system, its responsibilities for technical assistance and its work in nuclear safety, and generally expressed their support for the Agency's activities. In its resolution on the report, the General Assembly expressed its satisfaction at the prospect of the membership of the People's Republic of China in the Agency and referred to the importance of the Agency's work in nuclear safety and to several resolutions that were adopted at the General Conference. It urged all States to co-operate in carrying out the work of the Agency and to implement strictly its Statute and affirmed its confidence in the role of the Agency in the application of nuclear energy for peaceful purposes.

38. A number of resolutions dealing with arms control and disarmament were adopted by the General Assembly.

39. The General Assembly adopted resolutions directed towards the establishment of nuclear-weapon-free zones in the Middle East and South Asia. Also, it recalled that a study should be undertaken to review and supplement the comprehensive study of nuclear-weapon-free zones to which the Agency is - by invitation - contributing.

40. The General Assembly expressed its deep appreciation for the study by the Group of Experts on the Consequences of the Israeli Armed Attack against the Iraqi Nuclear Installations.

41. In a resolution on Israeli nuclear armament the General Assembly requested the Security Council to ensure that its resolution 487 of 1981 is implemented and that Israel places its nuclear facilities under Agency safeguards. Also, it requested the Agency to suspend any scientific co-operation with Israel which could contribute to Israel's nuclear capabilities.

42. In resolutions on South Africa the General Assembly again requested the Agency to refrain from extending to South Africa any facilities which may assist it in its nuclear plans and, in particular, to exclude South Africa from all its technical working groups. It also repeated its demand that South Africa submit all its nuclear installations and facilities to inspection by the Agency.

43. In October 1983, the Agency's General Conference adopted two resolutions relating to matters dealt with in the General Assembly resolutions referred to in paragraphs 41 and 42 above - resolution GC(XXVII)/RES/409, entitled "Consequences of the Israeli military attack on the Iraqi nuclear research reactor and the standing threat to repeat this attack for: (a) the development of nuclear energy for peaceful purposes, and (b) the role and activities of the International Atomic Energy Agency", and resolution GC(XXVII)/RES/408, entitled "South Africa's nuclear capabilities".

Finance and personnel

44. The Regular Budget total for 1983 was \$91 561 000, of which \$81 036 000 was to be financed from contributions made by Member States on the basis of the 1983 scale of assessment, \$3 490 000 from income from work for others and \$7 035 000 from other miscellaneous income.

45. At the end of 1983, the Secretariat had 1756 staff members - 619 in the Professional and higher categories, 1002 in the General Service category and 135 in the Maintenance and Operatives Service category.

THE AGENCY'S ACTIVITIES

TECHNICAL CO-OPERATION

Resources and their utilization

46. The day-to-day administrative and technical management of technical co-operation activities is financed from the Agency's Regular Budget, while field programmes are supported through voluntary contributions and in-kind donations. The resources made available for field programmes are as follows (by category and in order of importance): the Technical Assistance and Co-operation Fund, extrabudgetary funds, UNDP funds and assistance in kind. Figure 1 shows the amounts available for the financing of technical co-operation activities by resource category.

47. The resources made available for technical co-operation reached a record level in 1983 - \$34.5 million, compared with \$27.5 million in 1982. The increase from 1982 to 1983 was 25%, compared with an increase of 12.4% from 1981 to 1982.

48. The total value of the technical assistance provided in 1983 was \$26.6 million, which is 15.7% higher than in 1982.

FIGURE 1

RESOURCES AVAILABLE FOR
AGENCY TECHNICAL CO-OPERATION PROGRAMMES: 1974 - 1983

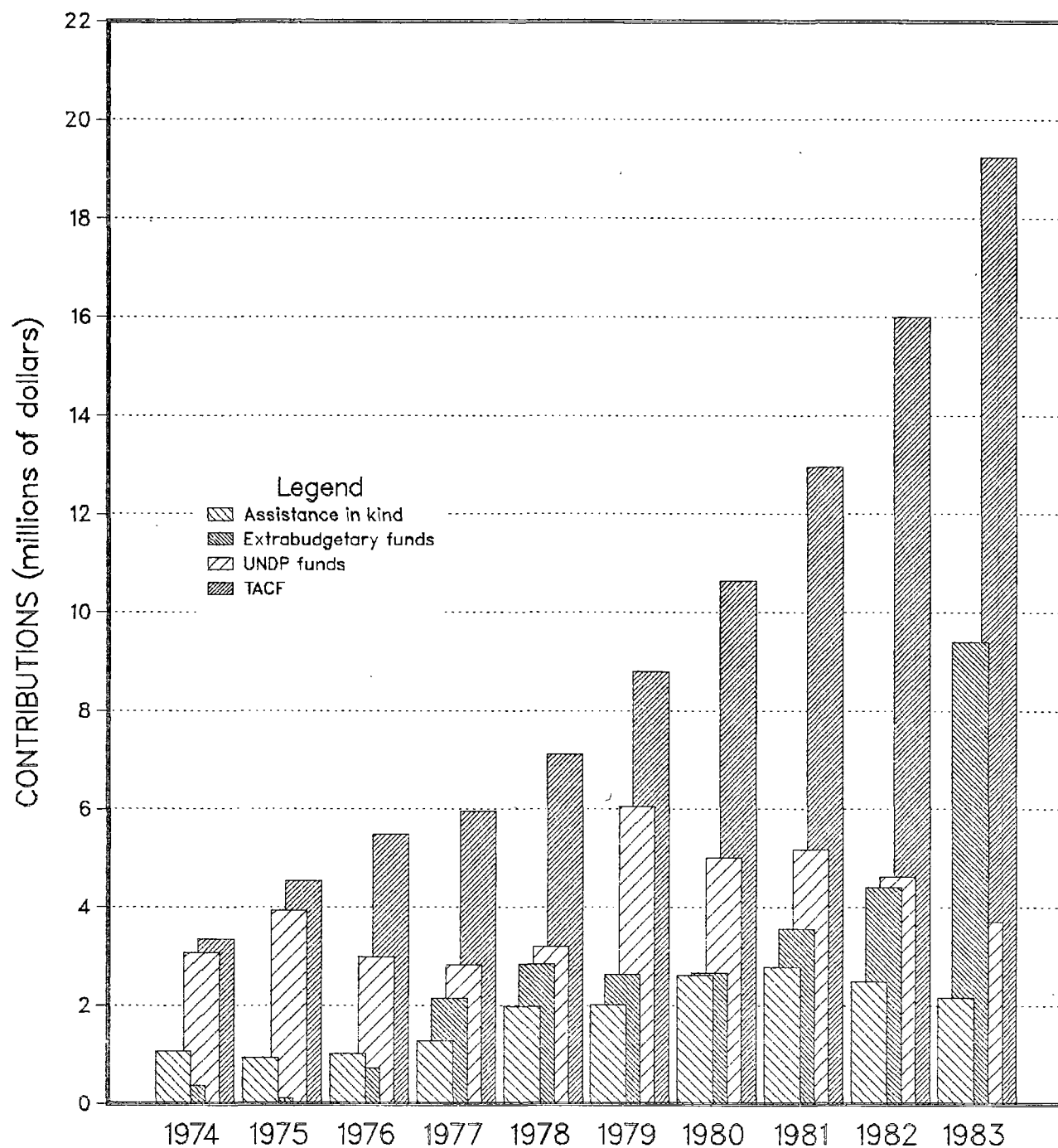
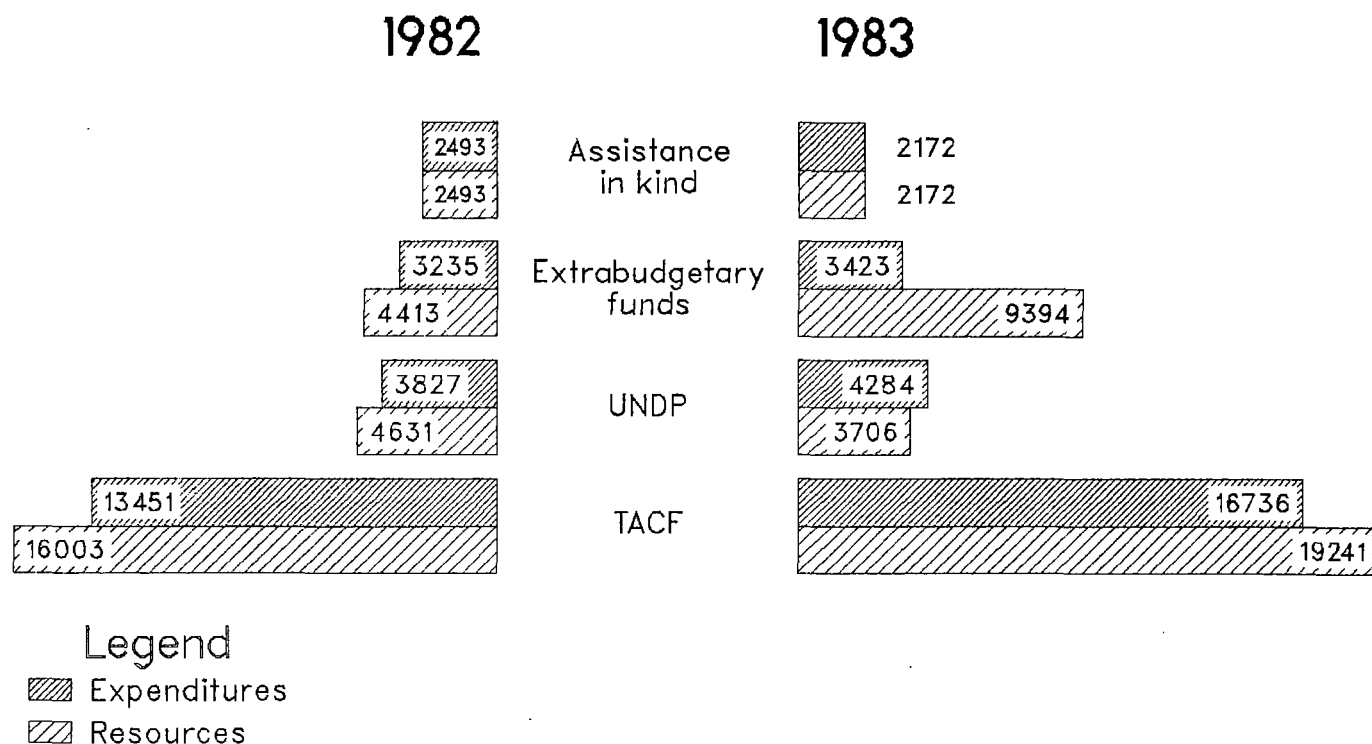


FIGURE 2

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



1. Technical Assistance and Co-operation Fund (TACF)

49(i) Resources: These consist of voluntary contributions of Member States towards the annual target and miscellaneous income (interest earnings and payments of assessed programme costs by recipient countries). Income to the TACF rose by 20.2%, from \$16 003 000 in 1982 to \$19 241 060 in 1983. By 31 December 1983, pledges amounting to 92.1% of the 1983 target had been made, but about half of the Agency's Member States had either made no pledge or pledged below their calculated rates.

49(ii) Expenditures: At \$16 736 100, the volume of assistance provided from the TACF was 24.4% higher than in 1982 (\$13 450 800). Whereas expenditures from the TACF represented 58.5% of the assistance provided in 1982, they accounted for 62.9% in 1983; this was due to (i) growth of the Fund, (ii) a continuing decline in assistance provided in kind, and (iii) a lack of improvement in the UNDP funding situation. Commitments for assistance still to be delivered at the end of the year (for example, equipment on order) were 3.5% higher in 1983 than in 1982 (\$11 488 000 against \$11 099 000).

2. Extrabudgetary funds

50(i) Resources: Funds in this resource category totalled \$9 394 000, representing a 113% increase over the 1982 amount. The major donors were Italy (55.4%), the United States of America (19.6%) and the Federal Republic of Germany (9.5%). The above total includes "funds in trust" received from developing countries to finance assistance for themselves; it does not include funds made available by Australia and Japan for RCA projects or contributions totalling \$2.9 million received in 1983 in support of projects scheduled for implementation in 1984.

50(ii) Expenditures: Assistance to a value of \$3 422 600 was provided from extrabudgetary funds in 1983 - an increase of 5.8% over the 1982 figure (\$3 235 300). There were two reasons for this modest increase: (i) contributions for footnote a/ projects[6] were received late in the year; and (ii) the medfly eradication project in Egypt did not become operational until the third quarter of 1983. Work started on 71% of the footnote a/ projects approved as part of the 1983 programme. About 50% of extrabudgetary funds went for expert services and equipment, 40% for Special Programme projects and the balance for fellowships and training courses.

3. Assistance in kind

51(i) Resources: The volume of resources provided under this heading dropped to \$2 172 500 in 1983 from \$2 493 000 in 1982. The major donors were the United States of America (\$753 100), the Federal Republic of Germany (\$193 600) and Australia (\$287 700). Developing countries also provided sizeable in-kind inputs. During 1983, in-kind resources were used in implementing three footnote a/ projects.

51(ii) Expenditures: At the beginning of the Agency's technical co-operation activities (1958), almost all in-kind assistance was in the form of fellowship training. In 1983, fellowships (with an estimated value of \$2 172 500) accounted for 70% of in-kind assistance; the corresponding share for 1982 was 84.7%. The next largest share, 11%, was that of equipment (0.8% in 1982). The balance, 19%, consisted of expert services (10.4%) and training courses (8.6%).

4. UNDP

52(i) Resources: UNDP's share of the total resources at the Agency's disposal continued to decline: from 24% in 1980 to 16.8% in 1982 and 10.8% in 1983. Resources for 1983 amounted to \$3.7 million, against \$4.6 million for 1982. Because of UNDP's financial situation, programming is still limited to 55%

52(ii) Expenditures: UNDP and the Agency use the term "expenditure" differently. The UNDP definition covers cash disbursements and unliquidated obligations; in the Agency only cash disbursements are covered. Owing to unliquidated obligations of \$3.1 million at the end of 1982, actual UNDP

[6] 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.

of individual country planning figures. It is expected that UNDP's share of total Agency resources will decline even further in 1984, as the Agency exercises no control over the distribution of UNDP resources. Twenty-nine UNDP-assisted projects were under implementation in 1983 (30 in 1982). Four projects were completed during the year and three new ones approved.

expenditures totalled \$4 284 200 in 1983, 12% above the 1982 amount of \$3 826 600. Expenditures were made in respect of projects in 24 countries (22 in 1982), the RCA project on industrial applications of isotopes and radiation technology and an interregional project implemented by the International Centre for Theoretical Physics.

Distribution of the assistance provided

53. Assistance provided by the Agency, whether in kind or through cash disbursements, is classified in several ways. In Figure 3, for example it is classified by field of activity and the major components (experts, equipment and fellowships). The average shares represented by experts, equipment and fellowships (including scientific visits, study tours, training courses and workshops) over the past ten years were 26.8%, 45.7% and 27.5% respectively. With regard to the fields of activity in which Agency assistance was provided, agriculture and nuclear engineering and technology ranked most prominently, accounting for 35% of the assistance provided in 1983. They were followed by (i) isotope and radiation applications in industry and hydrology, (ii) nuclear safety and (iii) physics, which together account for 37% of the assistance provided in 1983.

54. The funds, goods and services placed at the Agency's disposal are also classified by recipient country and source. In Figure 4, the technical assistance provided in 1983 is broken down by field of activity and geographic region ("interregional" indicates activities organized for recipients from more than one region). The needs and interests of countries vary somewhat from region to region, reflecting to some extent the level of advancement of groups of countries in applying nuclear technology; in 1983, agricultural applications ranked highest in Africa and Latin America, whereas in Asia and the Pacific and in Europe the emphasis was on more technology-oriented activities.

55. The distribution, by region and resource category of the technical assistance provided by the Agency in 1983 is shown in Figure 5. Asia and the Pacific ranked first in all resource categories except for "extrabudgetary funds".

General observations

56. The number of countries that provided extrabudgetary funds in support of footnote a/ projects dropped from ten in 1982 to five in 1983. In spite of that, the volume of funds made available for this purpose (\$3.4 million) was 20% higher than in 1982. Although a sizable portion of the extrabudgetary contributions was received very late in the year, it was still possible to make 71% of the footnote a/ projects approved as part of the 1983 Regular Programme operational.

57. Expenditures on equipment represented 55.4% of the total assistance delivered in 1983. However, the statistics on equipment delivery have traditionally included amounts expended for subcontracted services and miscellaneous items; such amounts were significant in 1983 (approximately \$1.4 million). Without subcontract and miscellaneous expenditures, equipment's share in total delivery would amount to 49.5%. Even so, this was the largest component of the programme delivered in 1983.

58. Expert services amounted for 23.2% of the total assistance delivered in 1983, 1020 man-months being provided (in 1982, the figure was 693 man-months). Despite this increase, 1437 man-months had still to be delivered at the end of 1983; the figures at the end of 1982 was 1197 man-months by the Board in 1983, to improve the provision of expert services.

59. Fellowships accounted for 21.4% of the total assistance delivered in 1983. The amount of training provided for 1336 scientists and technicians (4025 man-months) was 12% higher than in 1982. The main areas of study were nuclear engineering and nuclear safety.

60. The involvement of "technical-substantive" Departments of the Agency (especially the Department of Research and Isotopes and the Department of Nuclear Energy and Nuclear Safety) in technical co-operation activities continued to increase in 1983. Ninety-two technical officers provided support to 646 on-going projects (no including projects financed by UNDP). During the year, technical staff carried out 333 technical co-operation assignments (1982: 293 assignments), serving as lecturers in 124 cases and as project experts in 209 cases. Missions by Agency staff accounted for 30% of all expert assignments undertaken during the year. Roughly 7% of the staff resources of technical Divisions were made available for such assignments. In addition, technical officers processed 725 fellowship applications and appraised more than 300 project requests received from Member States in connection with the 1984 technical co-operation programme.

61. The Board concluded its first review of technical co-operation policies in June 1983. Five specific measures were approved in respect of technical co-operation programming, project planning and evaluation.

62. Although multi-year programming was encouraged, it was decided that at least 50% of the operational Regular Programme for each year should consist of new activities.

63. Under project planning, the Board stressed the need for the Secretariat to assist less experienced Member States in assessing priorities and formulating project requests; an allocation of \$90 000 for pre-project assistance was included in the 1984 annual programme. Also, specific fields were identified for which standardized or package projects will be developed. Greater integration of training with assistance provided in the form of projects was emphasized in the review. The intensification of intercountry assistance was recommended, and the Secretariat took steps to increase such assistance in the 1984 programme. The amounts programmed for intercountry assistance are twice as high in 1984 as in 1983.

64. In the review, the introduction of "dynamic programming", aimed at maintaining realistic project planning throughout the implementation process, was also recommended. From 1984 onwards, resources will be adjusted to needs on a continuing basis through the mechanism of rephasing. Funds released from rephasing will be used to finance additional activities in on-going projects and to meet the expected needs of projects approved by the Board but not yet operational.

65. In an effort to help keep Agency development assistance responsive to Member States' needs, it was decided that informal seminars on technical co-operation issues and formal policy reviews should be held periodically.

66. The Technical Co-operation Evaluation Unit started operation in June 1983. It has developed a simple and cost-effective methodology involving (i) the systematic use of information on project implementation and results achieved, (ii) the conduct of desk evaluation reviews, and (iii) intensive field evaluations. An Evaluation Procedures Manual outlining the methodology to be followed was distributed to Member States in 1983. To familiarize staff and government officials with the Agency's evaluation approach, a workshop was designed and training materials were prepared. Work began on 59 desk evaluation reviews in the fields of nuclear medicine, dosimetry, nuclear techniques in agriculture, radiation protection, nuclear engineering and technology, and nuclear physics and chemistry. The evaluation of all Agency-supported training courses held in the period 1977-83 also got under way. Plans have been made for six to ten field evaluations in 1984.

67. Progress was made in 1983 in incorporating UNDP project information into the computerized monitoring system. In addition, considerable time and effort were expended on improving the system's main outputs - namely, the reports used by all Agency staff involved in the implementation of technical co-operation activities. "Exception reports" (reports providing information on developments different from those normally expected) were added to the list of status reports being produced and, following the introduction of more meaningful criteria for determining implementation rates, implementation reports were designed and periodic report production started. A number of smaller system enhancements improved financial controls over the use of approved and available resources and further simplified procedures for entering and reviewing data via computer terminals.

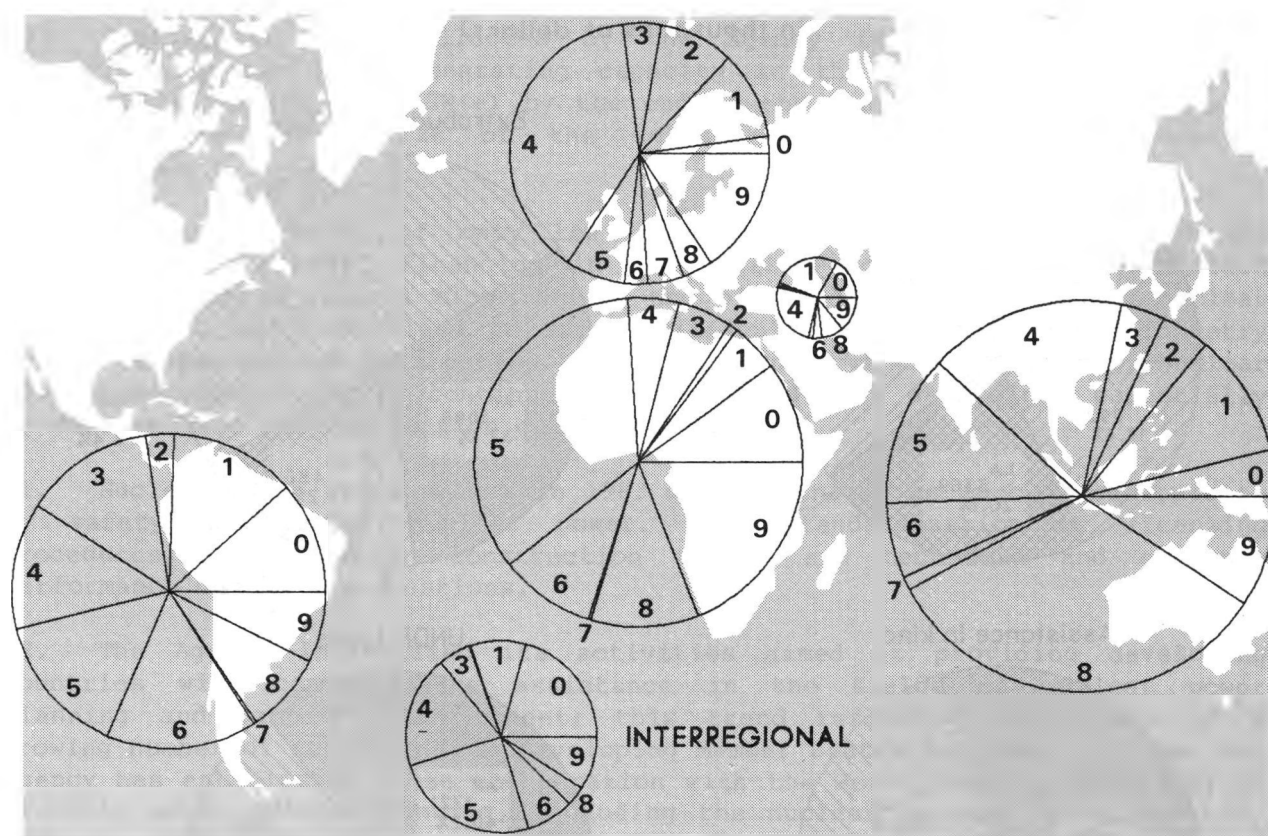
68. The Joint Inspection Unit (JIU) decided to include an inspection of the Agency's development aid activities in its work programme for 1983-84. A desk review, based on materials in the Agency's files, was completed in 1983 and field visits to a number of developing countries in Asia, Africa, Latin America and Europe got under way before the end of the year. It is expected that the JIU report will become available in 1984.

FIGURE 3
UTILIZATION OF RESOURCES: 1982 and 1983
(in thousands of dollars)

Field of activity	Year	Experts	Equipment	Fellowships	Share of total programme		
		\$	\$	\$	\$	%	
General atomic energy development	1982	746.9	1 610.6	258.2	2 615.7	11.4	
	1983	642.9	1 123.9	383.9	2 150.7	8.1	
Nuclear physics	1982	444.7	1 831.1	540.3	2 816.1	12.2	
	1983	381.4	1 878.0	346.2	2 605.6	9.8	
Nuclear chemistry	1982	83.9	774.3	342.0	1 200.2	5.2	
	1983	84.7	608.2	218.8	911.7	3.4	
Prospecting, mining and processing of nuclear materials	1982	1 094.8	1 192.0	270.5	2 557.3	11.1	
	1983	580.7	857.0	238.4	1 676.0	6.3	
Nuclear engineering and technology	1982	520.1	1 501.2	989.7	3 011.0	13.1	
	1983	763.0	2 470.3	1 143.9	4 377.3	16.5	
Application of isotopes and radiation in	Agriculture	1982	1 331.3	1 689.2	1 252.1	4 272.6	18.6
		1983	1 609.5	2 159.9	1 213.0	4 982.4	18.7
	Medicine	1982	325.7	952.5	928.8	2 207.0	9.6
		1983	412.6	1 016.6	821.6	2 250.8	8.5
	Biology	1982	27.2	105.3	153.6	286.1	1.2
		1983	20.0	111.1	171.4	302.5	1.1
	Industry and Hydrology	1982	457.7	1 003.8	263.2	1 724.7	7.5
		1983	893.3	2 824.6	435.8	4 153.7	15.6
Safety in nuclear energy	1982	624.2	850.3	840.5	2 315.0	10.1	
	1983	775.5	1 696.7	732.5	3 204.7	12.0	
Total assistance	1982	5 656.5	11 510.3	5 838.9	23 005.7	100.0	
	1983	6 163.6	14 746.3	5 705.5	26 615.4	100.0	

FIGURE 4

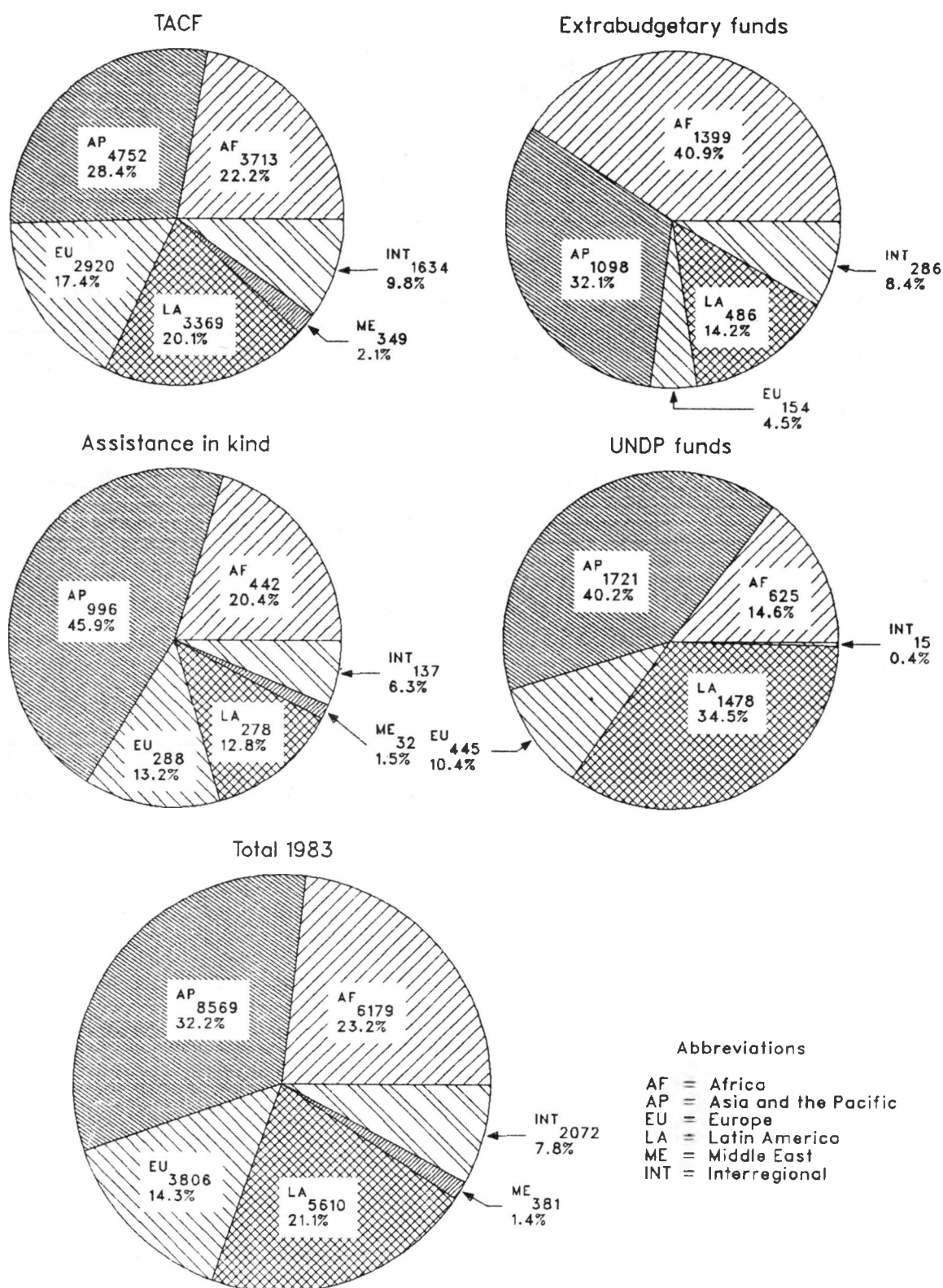
DISTRIBUTION OF TECHNICAL CO-OPERATION INPUTS BY FIELD AND REGION: 1983

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	619.0	328.0	80.3	626.6	64.6	432.2	2 150.7
1 - Nuclear physics	300.8	882.0	421.6	707.3	102.8	191.1	2 605.6
2 - Nuclear chemistry	54.9	340.9	347.5	159.0	3.6	5.8	911.7
3 - Prospecting, mining and processing of nuclear materials	328.0	316.5	186.3	726.4	3.5	115.3	1 676.0
4 - Nuclear engineering and technology	314.2	1 395.3	1 467.1	708.6	97.5	394.6	4 377.3
Application of isotopes and radiation in							
5 - Agriculture	2 132.0	1 069.5	282.7	977.1	7.7	513.4	4 982.4
6 - Medicine	580.9	533.3	109.2	848.1	14.3	165.0	2 250.8
7 - Biology	19.0	100.4	167.7	15.4	-	-	302.5
8 - Industry and Hydrology	650.6	2 809.5	143.6	446.5	33.9	69.6	4 153.7
9 - Safety in nuclear energy	1 180.0	792.2	599.6	395.1	53.2	184.6	3 204.7
Total	6 179.4	8 567.6	3 805.6	5 610.1	381.1	2 071.6	26 615.4

FIGURE 5

DISTRIBUTION OF TECHNICAL CO-OPERATION EXPENDITURES
BY SOURCE AND REGION: 1983
(in thousands of dollars)



NUCLEAR POWER

General

69. Statistical data collected by the Agency indicate that the total installed nuclear power-generating capacity in the world increased by 10% during 1983, reaching 191 GW(e) by the end of the year. Nuclear power plants accounted for around 12% of the world's total electricity generation during 1983.

70. The continuation of only low growth in electricity demand and the increasing problems of financing in most market-economy countries remained factors causing a general slow-down in the placing of orders for new nuclear power plants, which may lead to severe difficulties for the nuclear industry in the second half of this decade. In most planned-economy countries, nuclear power-generating capacity continued to grow at a rate determined essentially by construction and fabrication capabilities.

71. Nuclear power developments in 1983 were dominated as much by economic as by safety aspects of nuclear power. The standardization of licensing procedures, reduction in construction times, and technical and economic performance became key questions.

72. The Agency intensified its activities aimed at providing developing countries with comprehensive assistance in the fields of nuclear power planning and manpower development; this trend reflected the nature of a growing number of requests from developing Member States and the fact that the Agency has established close co-operation with the World Bank in the field of electric power system planning, including the nuclear option. Despite this, however, there were few signs in 1983 of additional developing countries making progress towards the start of nuclear power programmes.

73. There was renewed interest in small and medium power reactors, not only in developing countries but also in some industrialized countries.

74. The status of nuclear power programmes at the end of 1983 is summarized in Table 1, which shows 24 Agency Member States with 313 nuclear power plants in operation. Of the 21 GW(e) of new capacity connected to the grids in 1983 worldwide, 6.5% - 1.4 GW(e) - was in developing countries.

Table 1

Nuclear power reactors in operation
and under construction
at the end of 1983

Country ^{a/}	In operation		Under construction		Electricity supplied by nuclear power reactors in 1983	
	Number of units	Total MW(e)	Number of units	Total MW(e)	TW ^h (e)	% Share of total
Argentina	2	935	1	692	3.4	8.8
Belgium	6	3 473	2	2 012	22.8	45.7
Brazil	1	626	1	1 245	0.2	0.1
Bulgaria	4	1 632	2	1 906	12.3	32.3
Canada	15	8 303	8	5 925	46.3	12.9
China			1	300		
Cuba			1	408		
Czechoslovakia	2	762	9	4 354	5.7	8.0
Finland	4	2 206			16.7	41.5
France	36	26 903	25	29 200	136.9	48.3
German Democratic Republic	5	1 694			(11)*/	(12)*/
Germany, Federal Republic of	16	11 110	11	11 908	62.4	17.8
Hungary	1	408	3	1 224	2.3	10.0
India	5	1 030	5	1 100	2.9	(2.2)*/
Italy	3	1 232	3	1 999	5.6	3.2
Japan	28	19 023	10	10 022	106.5	(20)*/
Korea, Republic of	3	1 789	6	5 474	9.0	18.4
Mexico			2	1 308		
Netherlands	2	501			3.4	5.9
Pakistan	1	125			0.2	1.0
Philippines			1	621		
Poland			2	880		
Romania			2	1 320		
South Africa			2	1 842		
Spain	6	3 760	9	8 369	10.2	9.1
Sweden	10	7 355	2	2 100	39.1	36.9
Switzerland	4	1 940	1	942	14.8	29.3
Union of Soviet Socialist Republics	43	20 671	41	38 001	(113)*/	(8)*/
United Kingdom	35	8 304	7	4 252	43.9	17.0
United States of America	80	63 315	50	55 738	292.0	12.7
Yugoslavia	1	632			3.72	(6)*/
World total ^{b/}	313	187 729	207	193 142	(1 000)**/	(12)**/

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/ In Taiwan, China, there were four units with a total capacity of 3110 MW(e) in operation and two units with a total capacity of 1814 MW(e) under construction.

*/ Estimated - no data provided by Member State.

**/ Based on preliminary data for total production in 1983.

Nuclear power planning

75. Activities aimed at helping developing Member States to assess the appropriate role of nuclear power within their national energy plans continued; they included (a) the adaptation of assessment methodologies available in industrialized countries for use in developing countries, (b) energy and nuclear power planning missions, and (c) training courses on electricity system and nuclear power planning:

(a) Assessment methodologies

The Agency continued its co-operation with industrialized Member States in the use of methodologies for forecasting electricity demand in developing countries as a basis for determining the role of nuclear power;

(b) Planning missions

A World Bank/Agency advisory team visited Turkey in February and an Agency advisory team visited Jordan in September, the latter team's visit being a follow-up to a World Bank/Agency mission to Jordan in October 1982.

(c) Training courses

The sixth interregional training course on "Energy Planning in Developing Countries with Special Attention to Nuclear Energy" was held in Ljubljana, Yugoslavia; it included visits to facilities in Yugoslavia and the Federal Republic of Germany. A revised version of the training manual for this course was prepared for publication in 1984.

The fifth interregional training course on "Electric System Expansion Planning" was held at Argonne National Laboratory, United States of America; it included visits to nuclear, coal-fired and oil-fired power plants and to a load-dispatching centre. The draft of a guidebook on expansion planning for electrical generating systems was used during this course and, on the basis of the experience gained in using it, subsequently revised and completed for publication in 1984.

76. Planning for a co-ordinated research programme on the implications of nuclear power for the overall economic development of developing countries continued, and in November a group of consultants defined a number of research projects for initiation in 1984.

77. A simplified set of computer models was developed in the light of the results of the study by the International Institute for Applied Systems Analysis entitled "Energy in a Finite World" and implemented on a test basis through a contract with the Institute for Energy of the Technical University of Vienna. This work was subsequently reviewed by a group of experts from various United Nations agencies and other international organizations.

78. The booklet entitled "Energy, Electricity and Nuclear Power Estimates for the Period up to 2000" (Reference Data Series No. 1) was updated, in September, using data from the Energy and Economic Data Bank and results from Agency and other international projections of energy demand.

Economics of nuclear power

79. A report on the investment costs of nuclear power plants in comparison with fossil-fired power plants was completed for publication in 1984. In June a group of consultants discussed various aspects of revising the Agency's Guidebook on the Economic Evaluation of Bids for Nuclear Power Plants.

Power reactors of proven types

(a) Support to nuclear power programme development

80. As part of the Agency's efforts to ensure a systematic approach to preparing and strengthening the infrastructures needed for nuclear power programmes in developing Member States, a further guidebook in the series on this subject was published - its title is "Interaction of Grid Characteristics with Design and Performance of Nuclear Power Plants". Manuscripts for guidebooks entitled "Qualification and Training of Nuclear Power Plant Operations Personnel" and "Nuclear Power Plant Control and Instrumentation" were completed for publication in 1984, and manuscripts for guidebooks entitled "Bid Specifications for Nuclear Power Plants" and "Nuclear Power Plant Project Management" neared completion.

81. Work on a guidebook entitled "Nuclear Engineering Education" continued, with the collection of information on nuclear engineering curricula and continuing engineering education in Member States.

82. A mission visited Peru to advise on a nuclear power pre-feasibility study being carried out by the Peruvian authorities and another one visited Nigeria to advise on energy programme planning and manpower requirements for nuclear power.

83. A course on nuclear power planning and feasibility studies was held in France and one on project management methods and tools was held in the United States. By the end of 1983, more than 1400 trainees from 59 developing countries had participated in Agency nuclear power training courses since the inception of the programme, in 1975.

84. Three UNDP projects concerned with nuclear manpower development were supported. The number of projects in this subject area within the Agency's regular technical co-operation programme increased to 32 in 1983.

(b) Small and medium power reactors

85. Proposals for a major study on small and medium power reactors (SMPRs) to be launched in 1984 were reviewed by a technical committee against the background of new, more mature designs for SMPRs which could be introduced in both developing and industrialized countries.

(c) Technology of nuclear power plants of proven types

86. The Power Reactor Information System (PRIS), began to be used for data generation at the request of utilities and other bodies in Member States; some of the data so generated indicate that in several Member States - for example, the Federal Republic of Germany and Japan - there has been a considerable increase in the availability of nuclear power plants since 1979. With the help of PRIS the Agency's two annual reports on power reactor operating experience ("Operating Experience with Nuclear Power Reactors in Member States" and "Performance Analysis Report") are now produced almost entirely from the computer[7].

[7] The annual listing "Power Reactors in the World" (Reference Data Series No. 2) is now also produced directly from PRIS.

87. Work started on developing - with the assistance of UNIPED, WEC and CEC - a new questionnaire for the collection of operating experience information. It is intended that the questionnaire should be used by all organizations, thus streamlining data collection and minimizing the burden on plant operators.

88. A symposium on the reliability of reactor pressure components brought out how the considerable progress which has been achieved in materials technology, fabrication processes and non-destructive examination techniques has led to greater component reliability, with a consequent impact also on safety.

89. The International Working Group (IWG) on Nuclear Power Plant Control and Instrumentation and the IWG on Reliability of Reactor Pressure Components organized four specialists' meetings - on plant simulator utilization, on assistance to operators under normal and abnormal operating conditions, on the formation of cracks due to stress corrosion and on flaw detection and sizing.

90. A co-ordinated research programme on the irradiation embrittlement of advanced pressure vessel steels showed clearly the progress made in several countries in producing steels with increased radiation resistance.

91. Two manuals for users of the safety guides on quality assurance produced under the Nuclear Safety Standards (NUSS) programme were completed and the first draft of a manual on the training, qualification and certification of quality assurance personnel was prepared. The completeness, adequacy and consistency of Agency quality assurance documents were reviewed by groups of users, who made recommendations concerning their revision and the preparation of additional documents. An international training course on quality assurance was held at Saclay, France, and a national training course was held in Seoul, Republic of Korea. Seminars on quality assurance were held in Brazil and Egypt.

92. A technical committee meeting on nuclear heat applications held in Poland showed that there is considerable interest in low-temperature heat applications, although the difficulty of achieving economic competitiveness with fossil-fired heat sources was pointed out by participants from several Member States.

Advanced nuclear power reactor technology

93. The IWG on Fast Reactors reviewed current trends of national LMFBR development programmes; the slowing-down of these programmes in several countries was noted, but the conviction that fast breeder reactors offer a necessary option for the future was emphasized. This conviction was reflected in the fact that during 1983 six West European countries (Belgium, France, the Federal Republic of Germany, Italy, the Netherlands and the United Kingdom) took steps to establish closer co-operation in the field of LMFBR development.

94. The IWG on Fast Reactors organized specialists' meetings on absorber materials and control rods for LMFBRs, the properties of LMFBR structural materials, and LMFBR steam generator integrity and reliability - three topics closely related to the safe and reliable operation of fast reactors.

95. Work continued on compiling the parameters of LMFBRs in operation, under construction or planned in Member States participating in the activities of the IWG on Fast Reactors. The first draft of a technical report on the status of LMFBRs worldwide was prepared and reviewed. A co-ordinated research programme on the detection of boiling sodium coolant in LMFBR cores was initiated.

96. A specialists' meeting on fuel development and spent fuel management for gas-cooled reactors was held, and preparations were completed for the publication of a report on the status of and prospects for gas-cooled reactors.

97. Recent developments and current and future programmes relating to high-temperature process heat were reviewed by the technical committee on nuclear heat applications mentioned in paragraph 70 above, particular emphasis being placed on the production of clean-burning chemical fuels from coal and on the co-generation of electricity and process steam.

98. An advisory group considered plans for a co-ordinated research programme to assess the potential contribution of advanced reactors to energy supplies in Member States. The programme is based on country or regional case studies of the technical and economic potential of advanced systems under development in several Member States and the measures necessary in order to ensure that advanced reactors are a medium-term option as an independent energy source. The programme covers not only LMFBRs and HTRs, but also advanced LWRs and HWRs.

99. The first four computer software packages produced under a co-ordinated research programme on in-core fuel management were made available through a co-operative arrangement with the NEA Data Bank. During 1983, 29 packages were provided in response to requests from 20 Member States.

General

100. In 1983, the most important event organized by the Agency in the nuclear fuel cycle area was the International Conference on Radioactive Waste Management in Seattle, United States of America, organized in co-operation with the United States Department of Energy.

101. Major cut-backs in exploration and development of uranium occurred in many countries, although a few projects relating to low-cost deposits continued, especially in Australia and Canada. It is currently estimated that requirements for uranium will nearly double over the next ten years.

102. The Agency continued to co-operate with NEA, mainly through the working groups on uranium resources, on uranium exploration techniques and uranium extraction. The latest NEA/IAEA report on "Uranium - Resources, Production and Demand" ("Red Book") was prepared for publication at the beginning of 1984.

103. In the area of fuel performance and technology, emphasis continued to be placed on water reactor fuel reliability and safety and on fuel utilization.

104. In recognition of the fact that only a small fraction of the world's spent power reactor fuel has been reprocessed so far and growing importance is being attached to the technical aspects of spent fuel management, a guidebook on spent fuel storage was prepared for publication.

105. A Nuclear Fuel Cycle Information System for compiling and providing information on the status of nuclear fuel cycle facilities throughout the world was established.

106. In the waste management area, at the request of the Swedish Government a panel of experts was convened to evaluate a Swedish report (KBS-3) on the final storage of spent fuel; the results of the evaluation have been transmitted to the Government.

Nuclear materials and fuel cycle technology

Uranium resources and production

107. There was a reported decrease in uranium production in WOCA[8] countries from 44 000 tonnes in 1981 to some 38 000 tonnes in 1983, although both the contract and spot market prices of uranium increased. Contracts prices in the United States rose to \$70/kg and \$95/kg for imported and domestic uranium respectively and the spot market price of uranium rose from about \$44/kg in September 1982 to \$60/kg in the autumn of 1983.

108. It is estimated that uranium demand will increase from 32 000 tonnes in 1983 to 53 000 tonnes in 1990 and 60 000 tonnes in 1995; given the long lead times for uranium mining projects, uranium exploration will need to pick up if a demand of this order is to be met.

[8] "World Outside the Centrally planned economies Area".

109. The Joint NEA/IAEA Working Group on Uranium Resources revised "Uranium - Resources, Production and Demand", which contains, in addition to officially reported current information on uranium resources and production, an updated estimate of world speculative resources. In support of efforts to make the report more complete and to achieve more uniform reporting, work was done on preparing two manuals - one on estimating production capabilities and one on estimating ore reserves.

110. The Working Group on Uranium Geology continued its work on the preparation of comprehensive reports concerning the geological aspects of six major types of uranium deposit; two of the reports had been essentially completed by the end of 1983. In addition, a report on certain aspects of uranium deposits in sandstone was published.

111. A report on correlations between the uranium geology of South America and that of Africa reached the final stage of preparation.

112. The NEA/IAEA Working Group on R&D in Uranium Exploration Techniques, which was reorganized in 1982 into five project-groups, reviewed R&D activities and planned the work to be done under the projects; in addition, meetings were held by four of the groups. Work started on preparing publications on the construction of calibration facilities, the calibration of gamma-ray measuring equipment and biogeochemical exploration for uranium.

113. Information on world speculative uranium resources was incorporated into the International Uranium Geology Information System (INTURGEO).

114. On the basis of work done by the NEA/IAEA Working Group on Uranium Extraction, early in 1983 NEA and the Agency published a report entitled "Uranium Extraction Technology" which provides a broad outline of current practice at uranium ore processing plants in major producing countries and reviews recent technological developments in this field.

115. A technical committee met to consider advances in uranium ore processing and the recovery of uranium from non-conventional resources; the topics covered included in situ and heap leaching, improvements in conventional acid and alkaline uranium ore processing, and the recovery of uranium from wet-process phosphoric acid, from coal ash and from natural waters. The subject of uranium recovery from seawater was discussed at a specialists' meeting organized by the Agency jointly with the Atomic Energy Society of Japan.

116. During 1983 assistance was provided in connection with uranium projects in over 30 countries. Six missions were carried out and two interregional training courses (one on uranium ore processing and one on uranium exploration) were conducted.

Fuel performance and technology

117. The activities in this area focused on water reactor fuel and were carried out under the guidance of the IWG on Water Reactor Fuel Performance and Technology.

118. Specialists' meetings were held on "Water Reactor Fuel Safety and Fission Product Release in Off-Normal and Accident Conditions", "Effect of Water Chemistry on Fuel Cladding Behaviour in Power Reactors", and "Pellet-Cladding Interaction in Water Reactor Fuel".

119. The proceedings of specialists' meetings on "Water Reactor Fuel Element Performance Computer Modelling" and "Power Ramping and Power Cycling Behaviour of Water Reactor Fuel" and of the fifth meeting of the IWG on Water Reactor Fuel Performance and Technology were issued.

120. A seminar on heavy water reactor fuel technology was held in Argentina.

121. Under a co-ordinated research programme on computer modelling of the behaviour of water reactor fuels, a report on existing models was prepared and the problem of fission product release calculations was examined.

122. The second stage of a co-ordinated research programme on fuel element cladding interactions with water coolant in power reactors was initiated; it deals with analytical techniques for monitoring water chemistry in power reactors.

123. With the help of consultants, detailed plans were prepared for a co-ordinated research programme on the examination and documentation methodology for water reactor fuel; 15 Member States concluded a preliminary agreement of participation in this programme.

124. A status report on nuclear fuel cycle facilities was completed and, on the basis of the data in it, a "Nuclear Fuel Cycle Information System" (NFCIS) established; NFCIS contains data on milling and ore processing facilities, refining and conversion facilities, enrichment facilities, fuel fabrication facilities, away-from-reactor spent fuel storage facilities and reprocessing facilities.

125. In the area of fuels for advanced reactors, a report on the utilization of particle fuels in different reactor concepts was published and preparations started for holding in 1984 a specialists' meeting on advanced fuels.

126. Assistance was provided to the Department of Technical Co-operation in connection with projects on reactor materials and fuel production in Brazil, Egypt, Indonesia, Romania and Yugoslavia.

Spent fuel management

127. The Agency's activities in this area continued to focus on technical aspects of the management of spent fuel from various types of reactor. Information on short-, medium- and long-term storage options and on transport, reprocessing and recycling technologies continued to be collected and evaluated.

128. Work on a guidebook on spent fuel storage - the first Agency publication on this subject - was completed and it will be published in 1984.

129. Plans for future activities under a co-ordinated research programme on the behaviour of spent fuel assemblies during extended storage were formulated at a research co-ordination meeting in October; they include the preparation of a glossary of terms relating to the dry and wet storage of spent fuel and a survey of experience with dry and wet storage.

130. A seminar on technical and environmental aspects of spent fuel management was held in Madrid in September 1983; as a result of the discussions at this seminar, the plans for future Agency activities in this field were modified. Preparations began for holding an advisory group meeting in 1984 on spent fuel management.

131. Future Agency activities relating to the back-end of the nuclear fuel cycle were discussed at a consultants' meeting in the light of recent developments in this area. The preliminary draft of a reference book concerning the back-end of the nuclear fuel cycle was prepared.

Waste management

132. The International Conference on Radioactive Waste Management held in May 1983 in Seattle, United States of America, was the first Agency conference to cover the entire spectrum of radioactive waste management, including technological, environmental, regulatory, institutional, legal, economic, social and policy issues.

133. With the increasing role of nuclear power in the energy strategies of many countries, waste management problems have come to the fore. In view of the developments which have taken place in the waste management field in recent years, such a comprehensive international review was very timely.

134. The Conference programme covered the following major topics:

- (1) Waste management policy and implementation;
- (2) Handling, treatment and conditioning of wastes;
- (3) Storage and underground disposal;
- (4) Environmental and safety assessment;
- (5) Releases into the environment.

135. In addition to presentations describing experience already gained in the waste management field, a panel of representatives of related international organizations and selected Agency Member States discussed prospects for future international co-operation.

136. In general, the Conference confirmed that nuclear power can be harnessed for the benefit of mankind without creating an unmanageable waste disposal problem and there was a consensus that no technological breakthroughs are required for the safe management of radioactive waste.

137. The worldwide interest in radioactive waste management was demonstrated by the fact that 528 participants from 29 Member States and eight international organizations attended the Conference, at which 149 papers were presented.

138. A panel of experts evaluated a Swedish report (KBS-3) entitled "Final Storage of Spent Nuclear Fuel" and describing a system for the final disposal - after conditioning - of spent fuel in crystalline rock, with emphasis on the long-term safety aspects.

139. The Agency conducted a waste management training course designed particularly to meet the needs of developing countries.

140. The Agency/WHO booklet "Nuclear Power, the Environment and Man", published in English in 1982, was translated into French, Russian and Spanish in response to several requests from Member States. A further annual edition of "Waste Management Research Abstracts" (the 14th, containing 408 abstracts from 27 Member States) was issued.

Handling and treatment of radioactive wastes

141. The cleaning of off-gases from nuclear facilities, waste management at nuclear power plants, and the treatment and conditioning of radioactive wastes were the main subjects considered at two technical committee meetings and two research co-ordination meetings.

142. In recognition of the growing interest in the decontamination and decommissioning of nuclear facilities, the Agency convened a technical committee on decontamination technology. The committee's meeting, which was attended by specialists from 14 Member States and two international organizations, covered the "state of the art" and areas for future development; suggestions were made for future Agency activities in this field.

143. Among the material on waste management questions issued during 1983 were: Characteristics of Radioactive Waste Forms Conditioned for Storage and Disposal - Guidance for the Development of Waste Acceptance Criteria (IAEA-TECDOC 295); Management of Waste from Nuclear Power Plants (seminar proceedings); Conditioning of Waste for Storage and Disposal (symposium proceedings); Testing and Operation of Off-Gas Cleaning Systems at Nuclear Facilities (seminar proceedings); Handling and Storage of Conditioned High-level Wastes (Technical Reports Series No. 229); and Decommissioning of Nuclear Facilities (Technical Reports Series No. 230).

144. The draft of a code of practice on the management of radioactive waste from nuclear power plants was distributed to Member States for comment.

145. Two co-ordinated research programmes were initiated - one on the retention of iodine and other airborne radionuclides during abnormal and accident conditions, and the other on the decommissioning and decontamination of nuclear facilities.

146. Three co-ordinated research programmes - on the evaluation of solidified high-level waste forms, the treatment of spent ion exchange resins and the testing of particulate filters - were completed.

Underground disposal of radioactive wastes

147. Three technical committee meetings and one advisory group meeting were held on regulatory, safety, technological and other aspects of underground disposal.

148. Among the material on underground disposal published in 1983 were: "Concepts and examples of safety analysis for radioactive waste repositories in continental geological formations" (Safety Series No. 58), "Disposal of low- and intermediate-level solid radioactive wastes in rock cavities - a guidebook" (Safety Series No. 59) and "Criteria for underground disposal of solid radioactive wastes (Safety Series No. 60).

149. Work continued on reports covering the following areas: rock cavities for shallow-ground disposal (repository site investigation, design, construction, operation, shutdown and surveillance); safety analysis methodologies and waste acceptance criteria relating to shallow-ground disposal in rock cavities; heat and near-field effects of high-level radioactive wastes in deep geological formations; and guidelines for evaluating the performance of deep geological formations used as repositories.

150. Preparatory work was done on a report containing guidance for the management of radioactive waste produced by isotope users in medicine and industry; it is expected that this report will be useful to many developing countries.

151. An advisory group met to revise the code of practice and guide to the code for the management of wastes from the mining and milling of uranium and thorium ores (Safety Series No. 44); the need for a revision arises from the technological and regulatory developments which have taken place since 1976, when this Safety Series document was issued.

152. Further planning was done with a view to preparing international guidelines and technical criteria for the underground disposal of high-level radioactive wastes.

Environmental aspects of nuclear energy

153. A seminar on the environmental transfer to man of radionuclides released from nuclear installations, co-sponsored by CEC, was held in Brussels, Belgium, in October.

154. Among the material relating to environmental aspects of nuclear energy which was published in 1983 were "Control of radioactive waste disposal into the marine environment" (Safety Series No. 61), a bibliography of information and data for a review of the scientific and technical considerations related to the dumping of radioactive wastes at sea and reports on: an oceanographic model for the dispersion of wastes disposed of in the deep sea, environmental assessment methodologies for sea dumping, de minimis concepts in radioactive waste disposal, and the regional and global environmental behaviour of radionuclides.

155. Considerable groundwork for a revision of the Agency's definition of waste unsuitable for dumping at sea was carried out, and a report on the oceanographic and radiological basis of the definition was prepared in order to facilitate the process of revision.

156. Two co-ordinated research programmes are in progress: one on the role of sediments in the transport and accumulation of radioactive pollutants in rivers and estuaries, and one on the environmental migration of radium and other contaminants present in solid and liquid wastes from the mining and milling of uranium.

NUCLEAR SAFETY

General

157. In 1983 the Agency continued its efforts directed at the enhancement of nuclear safety, through direct assistance to Member States, advisory missions, training programmes and in other ways.

158. In the field of radiological safety work on implementing the Basic Safety Standards for Radiation Protection (Safety Series No. 9) continued, with documents on subjects such as occupational radiological safety, radiation protection of the public and the environment, radiation safety during transport, emergency planning and preparedness for radiological emergencies, and handling of exposed individuals.

159. The Nuclear Safety Standards (NUSS) programme for developing codes and guides for nuclear power plants neared completion, with the publication of six further safety guides bringing the total number of NUSS documents published to 47 guides and five codes of practice.

160. As part of a new activity aimed at increasing the safety of operating nuclear installations, an operational safety review team was sent to the Republic of Korea to assess the safety of a power plant; this activity is to be expanded, and teams are being sent to several other Member States in 1984.

161. Final preparations were made for initiating the Agency's incident reporting system, in which member countries of CMEA and NEA and also developing countries will participate; the system will collect information about incidents occurring at nuclear power plants throughout the world. In accordance with Member States' recommendations, the Agency will follow a policy of close co-operation with NEA to ensure that the system is compatible with the incident reporting system already operated by NEA and to avoid duplication of effort.

162. With the increased interest in problems of evaluating the risks involved in using nuclear power, the Agency continued to assist Member States in the use of probabilistic risk analysis techniques. Two programmes of co-ordinated research have been initiated in this area.

163. The second annual Nuclear Safety Review was presented to the Board in June. It covered highlights of the year 1982, described events in the area of operational safety experience and discussed current safety issues. Also, it summarized the activities of other international organizations and the main elements of the Agency's nuclear safety programme.

Radiological safety

164. Questions regarding the control of release of radioactive materials giving rise to radiation exposures beyond the frontiers of the country of origin were studied. An advisory group was convened, with the co-operation of WHO, to consider what principles and methodology could be used by Member States in controlling the trans-frontier component of exposures and to recommend a minimum value to be assigned to the unit collective dose for that component.

165. As part of its efforts connected with implementing the Basic Safety Standards for Radiation Protection, the Agency prepared to embark on a

comprehensive training programme intended to provide a basic level of understanding of its radiation protection policy; already a long-term interregional course is being conducted by Argentina under Agency sponsorship.

166. A revised Code of Practice on Radiation Protection in the Mining and Milling of Radiation Ores, jointly prepared by ILO, WHO and the Agency, was published; also, the three organizations co-sponsored a seminar, in Gabon, for African developing countries on radiation protection in the exploration, mining and milling of radioactive ores. The radiological and safety aspects of fusion were the subject of another seminar, and the proceedings of a workshop on fusion safety were published.

167. In the area of emergency planning and preparedness for radiological emergencies, activities designed to assist Member States in developing and improving their programmes continued to expand. An interregional training course which includes, for the first time, instruction in the use of computers in accident assessment was developed. Missions to assess emergency planning arrangements visited three countries, and a report was prepared on a full-scale emergency exercise carried out in Yugoslavia. Guidelines for mutual emergency assistance arrangements were prepared for issuance in 1984. Work started on a document concerning intervention levels in the event of nuclear accidents, particularly those with trans-boundary implications.

168. In the area of radiation safety during transport, the Agency continued to play a necessary international role. An extensive revision of the Agency's Regulation for the Safety Transport of Radioactive Materials (Safety Series No. 6) is underway, with a view to the publication of a revised version in 1984; for them to be consistent with the Basic Safety Standards, it will be necessary to apply further measures for controlling the exposure of transport workers and the public during package transport and storage. A seminar on the transport of radioactive materials by post provided a valuable forum both for informing postal authorities about the safety aspects of shipping such materials and for determining the problems associated with transport by post; the results of the seminar will be reflected in the revised version of the Regulations.

169. The Agency embarked on the establishment of guidelines for handling over-exposed individuals. The use of biological and biochemical indicators in biological dosimetry received new emphasis, a co-ordinated research programme on the use of chromosomal aberration analysis as a complement to physical dosimetry being supervised by the Division of Nuclear Safety in co-operation with the Division of Life Sciences. A realistic "chest phantom" - a device used in calibrating equipment for measuring plutonium deposition in the lungs - was developed under another co-ordinated research programme; such phantoms are to be made available to Member States.

170. A total of 62 technical co-operation projects concerning radiation protection were handled and 39 missions visited developing Member States. Fellowships in the field of radiation protection were arranged for 32 persons from developing countries.

Physical protection of nuclear facilities and materials

171. The fifth international training course on the physical protection of nuclear facilities and materials, held in the United States in September, was attended by 26 participants from 18 Member States.

Radiation protection service

172. Radiation protection services were provided for the Agency's laboratories, for safeguards inspectors, for technical co-operation experts, and for trainees from Member States.

173. The services of the Agency's personnel monitoring system were made available to a number of Member States where Agency-assisted activities are being carried out and where personnel monitoring services are not yet available locally; about 150 dosimeters worn by local staff in Ethiopia, Mali, Nigeria, Senegal and Sierra Leone were evaluated.

174. Missions visited Ethiopia, Kenya and Sudan to advise on the establishment of national radiation protection services. The provision of quality assurance services for personnel monitoring systems in developing countries was initiated. Some 19 man-months of training in radiation protection were given to fellows from the Democratic People's Republic of Korea, Malaysia, Nigeria and Pakistan.

Safety of nuclear installations

175. The Agency's first operational safety review team (OSART) was sent at the request of the Republic of Korea to review the status of a nuclear power plant in that country and to assess its ability to continue operating safely. An OSART consists typically of two or three staff members aided by five or six consultants, and it is made available to the regulatory authority of a Member State. It carries out an on-site review lasting about three weeks and covering such subjects as managerial aspects, training programmes, operating procedures, technical support, maintenance, radiation protection, plant chemistry and emergency preparedness. The findings are submitted to the Member State in a confidential report, which may be made public later if that State so agrees.

176. Six further safety guides were published under the NUSS programme, bringing the total number of NUSS documents published to 47 guides and five codes of practice. The series of guides on governmental organization and quality assurance are now complete; the series on siting, design and operation will take a few more years to finish.

177. As emphasis in the NUSS programme shifted to implementation, a meeting was held for the users of NUSS documents, the aim being to provide feedback to the Agency on problems encountered in adapting the codes and guides to the needs of Member States. A meeting was held specifically for users of the documents on quality assurance, and plans were made for similar meetings dealing with the other four NUSS series. Several interregional and national training courses and seminars were held in order to continue familiarizing Member States with the NUSS codes and guides and to provide guidance on nuclear power plant operation.

178. Safety missions visited three Member States to advise on the siting of power plants and other Member States to provide advice on research reactors.

179. Work continued on the development of the Agency's incident reporting system, which will receive and compile information on incidents of safety significance at nuclear power plants; it is hoped that the Agency reports containing this information will help plant operators and designers and regulatory bodies to prevent - or mitigate the consequences of - similar incidents. Guidelines for the establishment of national and international

incident reporting systems were prepared. Several meetings brought together specialists from various Member States to discuss lessons learned from incidents in their countries. Details of the Agency's system were presented at an Agency-organized symposium on operating safety and at other meetings.

180. As part of the Agency's efforts to encourage information exchange and co-operation in reactor safety research, a meeting was held on hydrogen behaviour and control and related containment loading aspects and another was held on modelling aspects of and experiments relating to small-break loss-of-coolant accidents. A trial project relating to the establishment of a worldwide index of safety research activities was undertaken by the Agency in co-operation with NEA and CEC.

Risk assessment

181. Assistance in using probabilistic risk analysis techniques was provided through a training course and follow-up training for fellows from several Member States. A computer code designed to enable Member States to use the techniques of "fault tree" and "event tree" analysis became operational on the Agency's computer.

182. Two co-ordinated research programmes were initiated, one dealing with the development of risk criteria for the nuclear fuel cycle and the other with the cost-effectiveness of risk reduction in different energy systems. Approximately 15 Member States are participating in each programme.

183. The results of surveys of public attitudes towards energy were published in three reports. A computer code and a methodology for analysing data on public attitudes were developed.

General

184. In 1983, increasing emphasis was placed on biotechnology applications of nuclear and associated methods. They included the biological control of insect pests, the study of nitrogen fixation by legumes, the use of radiation in connection with tissue culture techniques for crop improvement, the use of immunoassay for assessing livestock reproduction and for the diagnosis of contagious diseases, studies of animal nutrition, the microbial degradation of biomass, and studies of pesticide formulations and their fate in the environment.

185. The Agency continued to assist and advise Member States with regard to the commercial application of food irradiation. Support was given to about 140 technical co-operation projects in 46 developing Member States. Some 350 agricultural laboratories and institutes took part in 27 co-ordinated research programmes. In addition, six training courses and study tours were held and programming missions visited Bangladesh, Colombia, Indonesia, Madagascar, Peru and Venezuela.

Soil fertility, irrigation and crop production

186. The Agency co-ordinated four research programmes aimed at improving the ability of various plants in different cropping systems to make optimum use of the abundant supply of atmospheric nitrogen, and thereby eliminating or drastically reducing the need for expensive nitrogen fertilizer inputs; isotopic techniques are the only tools capable of directly assessing the amount of nitrogen contributed by the atmosphere, which one needs to know in order to determine the management practices under which maximum nitrogen fixation may be achieved. The pasture management programme supported by Italy, showed that the potential of legumes for fixing atmospheric nitrogen is higher when they are grown together with grasses than when they are grown alone. The fixation of atmospheric nitrogen by Azolla, when it is used as a biofertilizer, has been shown to be as efficient as urea in supplying the nitrogen needed for rice cultivation. Participants in the co-ordinated research programme on nitrogen fixation in grain legumes obtained results which confirmed the existence of a large genetic variability in nitrogen fixation by existing grain legume varieties. A consultants' meeting was accordingly held on mutation breeding for improved nitrogen fixation in grain legumes and recommendations were made for a co-ordinated research programme. An interregional training course on the use of isotopes and radiation in soil-plant studies was held at the Seibersdorf Laboratory.

Plant breeding and genetics

187. Work in the field of mutation plant breeding and genetics continued under six co-ordinated research programmes - on grain legumes, cereals, oil seed crops and other major crops - aimed at improving yields through the induction and selection of mutants and their direct and/or indirect use in breeding new varieties. New mutant varieties were released in a number of countries; more than 500 mutant varieties of major food crops have now been released. Scientists involved in the programmes on legumes and oil seed crops met at Maracaibo, Venezuela, and those involved in the programme on semi-dwarf rice mutants met at Los Baños, Philippines, to report on results and discuss future research plans.

188. Two new co-ordinated research programmes were initiated - one on the improvement of root and tuber crops and similar vegetatively propagated crops in tropical countries; and the other on the improvement of oil seed and industrial crops with the help of induced mutations. Twelve research contracts and two research agreements were awarded to institutes in seven Member States. A co-ordinated research programme was started with the primary aim of providing better cultivars, thus increasing the agricultural production of food through improvements in mutation induction and selection achieved using in vitro culture techniques. Research agreements have been awarded to institutes in 11 Member States.

189. At the Seibersdorf Laboratory facilities were established for developing in vitro culture techniques for use in mutation breeding.

190. Two FAO/IAEA interregional training courses were conducted - one at the Seibersdorf Laboratory on the induction and use of mutations in plant breeding; the other in Sofia, Bulgaria, on mutation breeding with special attention to cross-pollinating plant species. The latter course was followed by a study tour to the Ukrainian and Byelorussian Soviet Socialist Republics. These courses were attended by more than 39 scientists from developing Member States.

Animal production and health

191. Co-ordinated research programmes continued on the nutrient value and use of low-quality roughages and agro-industrial by-products as potential feedstuffs for ruminant animals, on the productivity of domestic buffalo in Asia (carried out within the framework of RCA), on the control of parasitic diseases, on the reproductive efficiency of large ruminants, on the optimization of grazing animal productivity in the Mediterranean and North African regions, and on the productivity of sheep and goats in Africa and the Middle East.

192. An FAO/IAEA interregional training course on the use of nuclear techniques in animal parasitology was held in Kenya and a manual on the application of radioimmunoassay techniques in animal reproduction was published.

Insect control

193. The eradication phase of the BICOT project[9] began. Experimental releases of sterile flies in four riverine forest patches have shown conclusively that the sterile-insect technique can be effective against Glossina palpalis. Considerable improvements have been effected in mass-rearing the target species using both animal hosts and reconstituted freeze-dried blood fed through a silicone membrane. Financial support continued to be provided by Belgium, the Federal Republic of Germany, Italy, Sweden and the United Kingdom.

194. The "MISR-MED" project - a four-year project, jointly sponsored by the Agency and the Government of Egypt, to eradicate the Mediterranean fruit fly (medfly) from the Nile Valley - became operational. A site was selected for the project headquarters, an ecological study was carried out, and a survey was made of crop losses caused by the medfly. A scheme for training

[9] IAEA/Government of Nigeria Project on the Biological Control of Tsetse Flies by the Sterile-Insect Technique, the aim of which is to eradicate the tsetse-fly from a 1500 km² area in Nigeria.

Egyptian entomologists and technical personnel was initiated. Much of this training will take place in Mexico. Austria and Italy are supporting the project with extra-budgetary contributions.

195. A medfly eradication project began in Peru with the objective of eradicating the pest from two large and three small isolated fruit-growing valleys in the south of the country. Initial activities included the start of fly rearing and preliminary surveys to determine fly incidence and distribution in the valleys. Italy is providing financial support for this project.

196. Research continued at the Seibersdorf Laboratory on tsetse-fly rearing methods (including artificial diets for mass rearing) and on genetic sexing for the separation of female from male medflies at the egg or early larval stage. Construction work started on a pilot facility in which procedures, diets and the rearing system to be used in Egypt for the "MISR-MED" project will be developed.

197. An advisory group reviewed the FAO/IAEA tsetse-fly programme. Current work on tsetse and medfly genetic sexing was reviewed and guidelines prepared for future work at two research co-ordination meetings.

Agrochemicals

198. Co-ordinated, isotope-aided research programmes continued on pesticide residues in meat, milk and stored products and on bound pesticide residues in plants, soils and food. Bound residues cannot be extracted from a substrate, but it was concluded at a research co-ordination meeting that the use of isotopically labelled pesticides provided an excellent technique for understanding the nature of irreversible binding.

199. Twenty-four students attended an FAO/IAEA regional training course in Thailand on the application of nuclear techniques in pesticide research, and a laboratory training manual was published on this topic.

200. Controlled-release pesticide formulations were prepared at the Seibersdorf Laboratory and at the co-operating laboratory of the Gesellschaft für Strahlen- und Umweltforschung GmbH in Neuherberg, Federal Republic of Germany. Under the programme in question, which is supported by the Government of the Federal Republic of Germany, nuclear techniques are used in the design of new pesticide formulations or evaluation in developing countries.

201. Work started at the Seibersdorf Laboratory on identifying microorganisms present in African termites which are capable of degrading lignin and on improving the technology of lignin degradation through the selection of mutant organisms. Also at the Seibersdorf Laboratory, methods were developed for analysing trypanocidal drugs used in treating cattle infected with trypanosomiasis, and preparations were made for a project involving the use of isotopically labelled trypanocides for pharmacokinetic studies in cattle in Kenya. The activities in both these areas are being supported by the Italian Government.

Food preservation

202. In February, representatives of 19 Members States and of WHO, FAO and the Agency discussed the possible continuation of international co-operation in the field of food irradiation and adopted a declaration containing the modalities for the establishment of an "International Consultative Group on Food Irradiation".

203. A group of experts visited Bangladesh, Indonesia, the Philippines and Thailand in order to evaluate the RCA Project on Food Irradiation and the potential in the countries participating in the Project for commercializing specific food irradiation applications. The group concluded that in most of the participating countries food irradiation has reached the stage of practical use; however transfer of the technology to the food industry would much depend on continued financial support from the sponsors of the Project.

204. The International Facility for Food Irradiation Technology (IFFIT) at Wageningen, the Netherlands, organized a training course for Spanish-speaking scientists from Latin American countries in Lima, Peru; it was attended by 21 scientists from ten countries. The last week of the course coincided with an FAO/IAEA Seminar on Food Irradiation for Latin American Countries, in which 78 scientists from 11 Member States participated.

205. Two research co-ordination meetings were held (in Manila, Philippines, and in Honolulu, Hawaii) on the pre-commercial-scale radiation treatment of food and the insect disinfestation of food and agricultural products by irradiation treatment. The meetings were attended by 22 scientists from 16 Member States.

General

206. Assistance continued to be rendered to Member States - and especially the developing countries among them - with the application of nuclear techniques in medicine, biology and health-related environmental research. Also, the Agency - often in co-operation with WHO and other international organizations - continued to promote greater reliability and accuracy in radiation dosimetry for medical and industrial purposes, with emphasis on the needs of developing Member States.

Medical applications

207. Efforts to upgrade the preventive and corrective maintenance of nuclear instruments in developing countries continued, through two co-ordinated research programmes (one in Asia and one in Latin America), an interregional technical co-operation programme (in 28 countries) and the provision of training. Emphasis was placed on local initiatives in maintenance management and technician training and on regional co-operation in the training of electronics engineers in microprocessor techniques. Progress was reviewed at two research co-ordination meetings.

208. In the field of radioimmunoassay and related techniques, particular emphasis was placed on quality control and training. A co-ordinated research programme on quality control of the assay of thyroid-related hormones was initiated, with emphasis on the national management of quality control schemes. Work on upgrading quality control through the introduction and improvement of data processing continued under another co-ordinated research programme. In collaboration with WHO, textual and audiovisual training aids were prepared for training courses conducted at the local level. Support continued for additional research contracts and for technical co-operation projects in about 25 Member States.

209. The use of in vivo nuclear medicine procedures was supported in about 25 countries through technical co-operation projects and research contracts. A document on quality control procedures for nuclear medicine instruments was finalized, and workshops on the use of these procedures were organized in five countries. An interregional training course and study tour for participants from 18 countries was organized in the Soviet Union.

210. Support continued for the use of nuclear-based techniques in studying the concentrations of essential and toxic trace elements in biomedical samples, including support through four co-ordinated research programmes (with 23 participants in 19 countries); one of these programmes is concerned with the use of nuclear-based analytical techniques in occupational health studies; another one, started in 1983, is concerned with nutritional trace element deficiencies which are known to affect hundreds of millions of people, mostly in developing countries.

Dosimetry

211. In 1983 Venezuela nominated a dosimetry laboratory for membership in the IAEA/WHO network of Secondary Standard Dosimetry Laboratories (SSDLs), raising the number of SSDLs in the network to 46. About ten other developing Member States approached the network secretariat for information and assistance related to the setting up of SSDLs. The SSDL network, which is

recognized by other relevant international organizations, fulfils a major function in the world's radiological measurement system.

212. A training seminar on calibration procedures at SSDLs held at the Agency's Dosimetry Laboratory and the dosimetry laboratory of the Austrian Research Centre "Oesterreichisches Forschungszentrum Seibersdorf", was attended by 40 participants, mostly from developing countries; the lectures were complemented by experimental sessions organized by Agency staff and staff of the Austrian Research Centre.

213. Support continued for technical co-operation projects in 24 Member States and for an interregional technical co-operation project. Agency staff and outside experts recruited by the Agency assisted in dosimetry and SSDL projects in Afghanistan, Bangladesh, Bolivia, Burma, Colombia, the Democratic People's Republic of Korea, Ecuador, Egypt, Indonesia, the Republic of Korea, Malaysia, Mongolia, Pakistan, Peru, the Philippines, Portugal, Singapore, Sri Lanka, Thailand, Turkey, Uruguay and Venezuela.

214. In SSDL Circular Letter No. 21, the SSDL network secretariat recommended the use of two specific radiation quantities for calibration work at SSDLs in order to standardize calibration procedures and to minimize confusion caused by the transition to SI units.

215. An advisory group meeting on the future of the dose intercomparison service for radiation therapy recommended that this service be extended and that the intercomparisons among SSDLs be continued; an automated thermoluminescent read-out instrument was acquired in order to make possible the extension of the service.

216. Preparatory work for the initiation of an international dose assurance service for radiation processing facilities in Member States continued, and the co-ordinated research programme on high-dose standardization and intercomparison for industrial radiation processing was completed. The alanine/ESR (electron spin resonance) system was selected as a reference dosimeter for the dose assurance service.

217. A pilot dose assurance exercise involving 15 gamma-irradiation plants was carried out with the objective of identifying organizational problems in the operation of a dose assurance service and investigating selected dosimetry systems under practical conditions.

218. A co-ordinated research programme was started on high-dose electron inter-comparisons.

Radiation biology

219. An IAEA/WHO technical co-operation project on the use of brachy-therapy in treating cancer of the cervix started in Egypt and a first training/demonstration course was attended by 33 participants.

220. Co-ordinated research programmes continued on using high-LET (linear energy transfer) radiation in cancer therapy and on improving cancer therapy through the combined use of conventional radiation and chemical or physical means. A first research co-ordination meeting was held under the latter programme to review data relating to Asian and Pacific countries.

221. The Agency's activities in the radiation sterilization of medical supplies in Asia and the Far East were extended to include tissue graft

sterilization practices and tissue banking in support of reconstructive surgery. In co-operation with WHO, the Agency convened an advisory group meeting in India to review current practices in the region and the relevant nuclear techniques developed in the region and elsewhere.

222. An international symposium on the biological effects of low-level radiation with special regard to stochastic and non-stochastic effects was held in Italy, with 225 participants from 28 countries and eight international organizations.

223. A co-ordinated research programme on comparative biological hazards from low-level radiation and major chemical pollutants, which ended with a research co-ordination meeting in India, assisted the development of radiation genetics and toxicology methodologies for the qualitative and quantitative estimation of the potential health hazards from environmental pollutants, including those released from energy sources. These methodologies will be useful to Member States in their environmental health monitoring programmes.

224. A research co-ordination meeting in Greece concluded a co-ordinated research programme on radiation-induced chromosomal aberrations for genetic risk evaluation in man. This programme has helped to elucidate the characteristics of the dose-response curve at very low dose levels of both low-LET and higher-LET radiation; the data obtained for the low dose levels which may be encountered in accidental exposures of radiation workers will facilitate risk estimation in national and international radiation protection programmes.

225. Support continued for studies aimed at developing nuclear techniques for dealing with parasitic infections. The results of a co-ordinated research programme on nuclear techniques for the detection of parasitic antigens in host body fluids were reviewed at a research co-ordination meeting, and a programme on the same subject was initiated under the RCA project.

226. Programmes on the monitoring of malaria vectors and on the use of antigens produced by radiation-attenuated larval schistosomes in developing a vaccine against schistosomiasis were also initiated.

227. A training course on nuclear techniques for dealing with parasitic infections, organized by the Agency in collaboration with the United States Department of Energy, was attended by 30 clinicians and biomedical researchers from developing Member States.

Health-related environmental research

228. The use of nuclear analytical techniques in assessing the impact of mineral substances (particularly heavy metals) on human health and environmental quality continued to receive support under two co-ordinated research programmes (with 25 participants in 22 countries). The results of these programmes were reviewed at research co-ordination meetings in Malaysia and the Netherlands. Preparations were made for a co-ordinated research programme on the monitoring of compliance with national and international regulations regarding maximum permissible concentrations of toxic elements in human foodstuffs.

229. Results obtained during the first two years of a co-ordinated research programme on improving the methodology for epidemiological studies of health impacts from low-level ionizing radiation were evaluated at a first research co-ordination meeting, in Yugoslavia; the results are important for developing a generally acceptable methodology for a typical follow-up system for radiation workers..

PHYSICAL SCIENCES

General

230. The Agency's activities in the field of physical sciences are designed to help Member States in using nuclear methods to solve problems in the physical sciences and in industry, and thereby to strengthen research and development in many areas.

231. During 1983, support was provided for more than 200 technical assistance projects in more than 60 developing Member States and for three regional projects - in Asia and the Pacific, in Latin America and in Africa. More than a hundred laboratories and other institutes took part in 19 co-ordinated research programmes.

Physics

Physics-related activities in developing countries

232. National programmes in nuclear physics were evaluated at meetings of an advisory group which formulated guidelines for the introduction of nuclear physics education and research in developing countries and made recommendations to the Agency on ways of supporting their introduction. A group of consultants made recommendations on the use of solid-state nuclear track detectors in developing countries.

233. Work started on the preparation of laboratory manuals to be used in Agency-organized nuclear instrumentation training courses and in nuclear electronics training at universities in developing countries.

234. Technical supervision continued of projects concerned with applications of nuclear techniques, nuclear physics training and nuclear instrumentation.

Research reactor support programme

235. Final drafts were prepared of three documents designed to supplement a guidebook, published in 1980, on the technical aspects of converting research reactor cores so that they are able to use low-enriched uranium (LEU). These drafts deal with the safety and licensing aspects of core conversion, the conversion of heavy-water-moderated research reactor cores, and the instrumentation and pre-operational procedures related to core conversion to LEU.

236. Work started on preparing a document on the use of research reactors for basic research in developing countries, and a regional seminar was held in Malaysia on the effective utilization and management of research reactors.

237. Other activities included:

- (a) A consultants' meeting on the production of radioisotopes in TRIGA reactors;
- (b) A consultants' meeting on the development of small computer software for research reactor operation and use; and
- (c) A four-week training course on research reactor utilization.

Fusion

238. The report on "Phase Two A, Part I" of the INTOR Workshop was published.
239. The Agency's activities aimed at facilitating research co-ordination and information exchange between Member States reflected a shift in emphasis from basic science to technological, engineering and safety studies.
240. The problems facing developing countries in their plasma physics and fusion work were addressed at several informal meetings, and assistance was provided in a number of cases.

Industrial applications and chemistry

241. Under a UNDP-supported large-scale industrial demonstration programme on the use of nuclear techniques in various industries, which is being conducted within the framework of RCA, construction of a 300-kCi cobalt-60 irradiation facility and the commissioning of an associated rubber vulcanization plant were completed in September.
242. An advisory group on industrial radiation processing met to review obstacles to the wider use of this technology and recommended priorities for international action to overcome these obstacles.
243. Work aimed at predicting the lifetime of organic materials in nuclear reactor environments continued.
244. The latest results obtained under a co-ordinated research programme on the immobilization of bioactive materials by means of radiation techniques were analysed and new strategies discussed at a research co-ordination meeting.
245. Training-demonstration courses were conducted, within the framework of RCA, on the use of nuclear techniques in steel-making, paper-making, rubber vulcanization and the sterilization of medical products. A training course was held for non-destructive testing (NDT) engineers and the outline of a regional NDT certification scheme was prepared.
246. The use of nuclear analytical methods in exploring for mineral resources continued to be promoted through training seminars and support for research.
247. The use of nuclear techniques for improving industrial safety and environmental pollution control was reviewed.
248. Co-ordinated research programmes on the development of new technology for technetium-99m production and on the development of new, more specific radiopharmaceuticals began to yield promising results.
249. A report was prepared on developments in radiochemical separation techniques designed to make analytical methods more sensitive, more versatile (useful for a wider range of matrices), simpler to use and/or cheaper.
250. Co-ordination of the compilation of thermodynamic data for actinide elements and their compounds continued, with the completion of manuscripts for four further volumes in the series and the holding of a consultants' meeting.
251. In co-operation with CEC's Central Bureau for Nuclear Measurements the Agency initiated a comprehensive inquiry into the need for and availability of

nuclear reference materials in Member States, the aim being to encourage the production and certification of nuclear reference materials not currently available and to make them readily available to users in Member States.

Isotope hydrology

252. During 1983 the Agency supported 24 technical co-operation projects in over 20 countries; seven projects were completed in the course of the year. These projects involved the execution of and the provision of guidance on isotope-aided studies aimed at solving hydrological problems associated with the development of water resources, including the problem of sedimentation and sediment transport. Also, assistance was provided to various Member States in establishing and/or upgrading facilities for environmental isotope analyses.

253. Through 18 research contracts the Agency continued to promote the development of new methodologies and the improvement of existing ones.

254. An RCA isotope hydrology and sedimentology project funded by Australia continued, and preparations were made for a similar project in Latin America, to be funded by the Federal Republic of Germany and covering ten countries in the region.

255. A symposium on isotope hydrology in water resources development was attended by 197 participants from 55 countries; 78 papers were presented.

256. An advisory group evaluated the results of an intercomparison of various reference standards being used for isotopic measurements of water and assessed the need for additional stable isotope reference samples. A group of consultants carried out a thorough review of the programme for the global-scale collection of data on isotopes in precipitation, the aim of which is to provide basic data for the application of environmental isotopes in hydrology.

257. An interregional training course on environmental isotopes in hydrology covered both techniques for isotopic analyses of water and methodologies for interpreting environmental isotope data; the course was attended by participants from 25 countries.

Nuclear data

258. The Agency continued to provide nuclear and atomic data services to Member States and to co-ordinate a worldwide network of data centres; in 1983 the Agency received approximately 700 requests for data and associated information from more than 60 Member States. Also, the Agency continued to publish CINDA (Computer Index of Neutron Data) and the quarterly Bulletin on Atomic and Molecular Data for Fusion.

259. As part of the continuing effort to keep abreast of the nuclear data requirements of nuclear science and technology, the Agency convened expert groups to assess the status of data relating to basic nuclear properties of reactor materials, of uranium-235 and californium-252 fission data, and of the neutron cross-sections of structural materials used in nuclear reactors. Also, experts met to identify nuclear data requirements associated with the use of nuclear techniques in geological exploration.

260. Research co-ordination meetings were held within the framework of co-ordinated research programmes on the decay properties of heavy radioisotopes, atomic data for fusion plasma diagnostics, and the measurement and analysis of 14-MeV neutron cross-sections.

261. The Agency organized an interregional training course and study tour, in the Soviet Union, on neutron physics and nuclear data measurements with accelerators and research reactors; 20 scientists from developing countries participated. It continued to provide equipment, fellowships and experts and to award research contracts for an interregional project on nuclear data techniques and instrumentation.

262. The International Nuclear Data Committee, which advises the Agency in the field of nuclear data, met in Rio de Janeiro, Brazil, and reviewed the Agency's nuclear data programme, particularly with regard to the needs of developing Member States. Reference data compiled under the auspices of the Committee were published as a technical report entitled "Nuclear Data Standards for Nuclear Measurements".

THE LABORATORIES

Seibersdorf Laboratory

General

263. The Seibersdorf Laboratory continued to provide support for the Agency's research contract programme, for technical co-operation projects and for safeguards by - inter alia - performing analyses, developing instruments and techniques, and providing analytical quality control services. Scientists and technicians from Member States attended training courses at the Laboratory or held elsewhere with the assistance of Laboratory staff; also, training was provided at the Laboratory for individual fellows.

264. The following description of the activities of the Seibersdorf Laboratory is divided into sections corresponding to the Agency programmes which the Laboratory supports.

I. Food and agriculture

265. Studies were carried out on the use of fertilizers in mixed cropping systems and orchards. The availability of nutrients from natural sources - for example, rock phosphates, guano and Azolla - was investigated in greenhouse and field experiments using isotope techniques; symbiotic nitrogen fixation by grain and forage legumes was also investigated. Ongoing co-ordinated research programmes were supported by analytical assays of 15 000 samples for nitrogen-15 content.

266. Studies of mutation breeding for the improvement of seed proteins in wheat and studies aimed at improving the recovery of mutations after the mutagen treatment of seeds were initiated. The transfer of single traits into a recipient cultivar was achieved by fertilization with irradiated pollen. The adaptation of a laboratory for in vitro mutagenesis was completed. About 400 seed radiation treatments were carried out as a service to institutes in Member States.

267. A new controlled-release formulation of endosulfan (an insecticide used in cotton fields and against tsetse flies) was developed. With this formulation the active ingredient remains intact for one month instead of one week, so that a smaller quantity of the insecticide and a lower application frequency suffice, and there is accordingly a reduction in costs and environment contamination. Projects on agrochemicals and agricultural residues were initiated: one is on biomass degradation with the aid of micro-organisms (the products being fuel or feedstock chemicals), and the other is on the fate of trypanocide drugs in cattle, the aim being to obtain precise data that will lead to greater efficacy and safety in the use of such drugs.

268. More efficient and effective methods for rearing tsetse flies were developed for use in the BICOT project in Nigeria (see paragraph 193 above). An artificial diet for rearing tsetse flies was formulated and found to perform well in tests. Work began on developing genetic techniques for ensuring that in Mediterranean fruit fly rearing only male flies are produced. A pilot facility for developing mass-rearing procedures for fruit flies was constructed.

II. Life sciences

269. Work in the environment and nutrition field focused on applications of nuclear analytical techniques in studies of trace elements. An Agency/WHO research programme on 24 minor and trace elements in human milk specimens from six Member States was completed. This programme has shown that formula products used in many countries for feeding babies differ significantly from human milk in their contents of several nutritionally important trace elements.

270. Further work on quality control required the preparation of a mixed human diet reference material for use in a co-ordinated research programme on human dietary intakes of nutritionally important trace elements. Better data were obtained on certain trace elements in two reference materials (milk powder and animal muscle). A directory of internationally available reference materials for trace element studies was prepared.

271. Training was given in various aspects of trace element analysis and gamma-ray spectrometry.

272. The Agency's Secondary Standard Dosimetry Laboratory (SSDL) continued its postal dose calibration service for hospitals which engage in radiotherapy and organized a dosimetry intercomparison for the laboratories belonging to the SSDL network. Three staff members from SSDLs in developing countries received a total of 10 man-months of training at the Agency's SSDL, which also co-operated with the Austrian SSDL in providing laboratory training during a seminar on calibration procedures for SSDLs.

III. Physical sciences

273. Eighteen international intercomparisons of radionuclide, stable nuclide and trace element analyses were completed. Laboratories in about 30 Member States took part in one or more of these intercomparisons.

274. Nine analytical quality control reference materials were added to the list of such materials available from the Agency; five became sold out and were deleted from the list. The Laboratory supplied 673 aliquots of such materials to 362 institutes in Member States.

275. Co-operation started with the World Meteorological Organization on analysing air dust and precipitation samples collected at the stations belonging to the latter's Background Air Pollution Monitoring Network. Some support for this work was obtained from UNEP.

276. Some 600 water samples were analysed for tritium, 150 for radiocarbon and 1800 for deuterium and oxygen-18. A training course on the use of isotopes in hydrology was held.

277. A simple and cheap modular gamma-ray spectrometer was designed and constructed; it is in kit form for assembly at the place of use.

IV. Safeguards

278. During the first 11 months of 1983 the Safeguards Analytical Laboratory (SAL) analysed 720 samples of uranium, 183 samples containing plutonium or mixtures of uranium and plutonium, and 143 samples of spent fuel solutions. In addition, 78 samples were analysed in the course of quality control and field test projects.

279. Laboratories providing back-up facilities when SAL is overloaded ("network" laboratories) reported the analysis of 11 samples of plutonium and 77 samples of spent fuel solutions.

280. A contract was concluded with the Austrian Research Centre (Oesterreichisches Forschungszentrum Seibersdorf) for an extension of SAL's premises; construction work began in September.

International Laboratory of Marine Radioactivity

General

281. With the additional Laboratory space made available by the Monegasque authorities, the Laboratory strengthened its programme of training in environmental measurements on marine pollutants. The Laboratory continued to support national institutions in environmental monitoring and in research on radioactive and non-radioactive pollutants through its intercalibration activities and by developing new methods. In investigations of the fate of radionuclides released into the marine environment, emphasis was placed on evaluating the radiological impacts of radioactive wastes after deep-sea disposal. The participation of the Laboratory in action plans in a number of regions continued, with financial contributions from UNEP.

Details of the Laboratory's activities

282. Additional, temporary premises (about 350 m²) provided by the Monegasque authorities in order to relieve the shortage of space at the Oceanographic Museum were inaugurated in April, and non-nuclear activities of the Laboratory were transferred to them. With the additional space it became possible for the Laboratory to increase the number of trainees accepted. More than ten trainees, mostly from developing countries, were accepted during 1983 for training in the measurement of radioactive and non-radioactive marine pollutants and in the carrying out of radiotracer experiments.

283. The Laboratory continued to organize intercalibrations of measurements of radionuclides in marine samples and to develop methodologies for low-level measurements in support of national and international environmental monitoring and research programmes. With financial support from UNEP, these activities were extended to include non-nuclear pollutants such as heavy metals and chlorinated and petroleum hydrocarbons.

284. In order to evaluate the impact of radionuclides released into the marine environment, the Laboratory concentrated on:

- (a) The physical, chemical and biological mechanisms of the transport of long-lived transuranics and other long-lived radionuclides in the oceanic water column;
- (b) The uptake, distribution and loss of long-lived transuranics and other long-lived radionuclides in marine biota; and
- (c) The development of scientific models applicable to biogeochemical processes governing the fate of radionuclides released in various sectors of the marine environment.

285. Particular attention was paid to problems connected with the disposal of radioactive wastes into deep-sea environments, with investigations of:

- (a) The adsorption-desorption of long-lived transuranics and other long-lived radionuclides in deep-sea sediments;
- (b) The transfer of long-lived radionuclides from sediments to marine organisms; and
- (c) Radiological models of human exposure to radioactivity from the deep-sea disposal of radioactive wastes.

286. In collaboration with 13 national institutions in 11 Member States, the Laboratory continued to co-ordinate a research programme on the behaviour of long-lived radionuclides associated with the deep-sea disposal of radioactive wastes. Also, the Laboratory participated in a co-ordinated research programme on radioactive materials in the Baltic Sea.

287. In support of UNEP's Regional Marine Pollution Monitoring and Research Programmes, the Laboratory provided scientific and technical expertise for the Mediterranean Action Plan, the Kuwait Action Plan and action plans for West and Central Africa.

288. Laboratory staff took part in more than 30 scientific and technical meetings organized by international organizations and in technical co-operation missions to Algeria, Bahrain, Oman and the United Arab Emirates.

General

289. The main fields of research and training-for-research at the International Centre for Theoretical Physics in 1983 were:

- (a) Physics and energy (plasma physics, non-conventional energy, nuclear physics);
- (b) Fundamental physics (elementary particles and fundamental theory);
- (c) Physics of the living state (medical physics, applications of physics in medicine and biology);
- (d) Physics and technology (condensed-matter physics, atomic molecular and laser physics, physics of communications);
- (e) Mathematics (applicable mathematics); and
- (f) Physics of the environment and of natural resources (soil physics, geophysics).

Physics and energy

290. A spring college on radiation in plasmas attended by 183 scientists (85 of them from developing countries) was followed by a conference and workshop on non-conventional energy sources, which brought together 168 scientists (115 of them from developing countries). The conference dealt with the general state of the art and with specific research projects; the workshop was devoted to a review of recent progress in the main branches of non-conventional energy development and to applications of non-conventional energy in both developing and industrialized countries.

291. A workshop/symposium on perspectives in nuclear physics at intermediate energies was organized by the Centre in collaboration with the Italian National Institute for Nuclear Physics (INFN); it was attended by over 95 scientists, 21 from developing countries.

Fundamental physics

292. One hundred and eighty-seven researchers, 101 from developing countries, took part in the work of the research group in elementary particles and fundamental theory. While at the Centre they also attended an additional topical conference and a colloquium on group theoretical methods in physics. The colloquium, which was attended by an additional 154 scientists, 63 from developing countries, was organized with the help of the International School for Advanced Scientific Studies (SISSA), Trieste, and INFN.

293. A workshop on particle physics gave the Centre's associates and affiliates an opportunity to interact with the research group in elementary particles and fundamental theory and with well-known leaders in this field. Recent developments were described and individual research reviewed in informal seminar sessions. Ninety-two scientists participated in the workshop, 54 from developing countries.

Physics of the living state

294. A workshop in medical physics was held with the aim of providing a basic, conceptual understanding and practical working experience to scientists wishing to collaborate in health programmes or to establish research activities in the field of medical physics; approximately 55 scientists participated, with 33 from developing countries. The workshop was followed by a second international conference on applications of physics in medicine and biology; 259 scientists took part, 67 from developing countries.

Physics and technology

295. Sixty-six scientists (43 from developing countries) participated in research projects of the condensed-matter physics research group. The annual workshop in condensed-matter physics was attended by 243 scientists, of whom 162 were from developing countries.

296. A winter college on lasers and atomic and molecular physics was attended by 126 scientists, of whom 85 were from developing countries.

297. The Centre held - for the first time - a workshop/college on the physics of communications, the aim being to develop the fundamental mathematical and physical basis of modern communications systems, with particular emphasis on the significant advances made during the past two decades in connection with space research; 62 scientists took part, 51 of them from developing countries.

Mathematics

298. A college on the technology of microprocessors and their applications in physics, organized by the Centre in collaboration with CERN, was attended by 134 researchers, 98 of whom were from developing countries. A summer school on dynamical systems was attended by 211 scientists, 138 of them from developing countries.

Physics of the environment and of natural resources

299. The Centre and the United Nations Financing System for Science and Technology in Development co-sponsored a regional training workshop on monsoon rainfall prediction, held in Bangladesh. A college on soil physics, co-sponsored by the Italian Dipartimento per la Cooperazione allo Sviluppo, attracted 79 scientists, 58 of them from developing countries. A workshop on the analysis of seismicity was attended by 60 scientists, 36 of them from developing countries.

Other activities

300. Under the "Physics and Development" programme, which began in 1982 with the aim of increasing the awareness of scientists of the role of physics in social and economic development, lectures were given by invited speakers and by a number of the scientists already present at the Centre for the activities described above.

301. Once again, many scientists availed themselves of the Centre's facilities in order to carry out independent research in fields for which no activity was scheduled last year or in periods when no activities relating to their particular fields were taking place; the number of such independent researchers in 1983 was 136, 96 of them from developing nations.

302. In 1983, the Centre welcomed altogether some 2200 scientists, for a total of 1800 man-months; nearly 1200 of these scientists were from developing countries, and they accounted for 77.2% of the total man-months. For the first time scientists from Angola, Fiji and the Democratic People's Republic of Korea visited the Centre.

303. The Centre provided financial and organizational support for numerous regional activities organized in response to the needs of scientists in developing countries. Also, the Centre hosted an international conference on calcium-binding proteins and a congress on clusters and groups of galaxies organized by the University of Trieste.

304. Close collaboration continued with SISSA and the University of Trieste's Institute of Physics.

Safeguards statement for 1983

305. In 1983, as in previous years, the Secretariat, in carrying out the safeguards obligations 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 for any other military purpose, or for the manufacture of any other nuclear explosive device, or for purposes unknown[10]. With the exception of two cases where the Agency was unable to draw conclusions for part of the year[11], it is considered reasonable to conclude that nuclear material under Agency safeguards in 1983 remained in peaceful nuclear activities or was otherwise adequately accounted for. This statement should be seen in the light of the following observations:

- (a) Extensive safeguard activities in 1983 resulted in almost 1840 (1700 in 1982) inspections carried out at about 520 (500) nuclear installations in 50 (46) non-nuclear-weapon States and 3 (three) nuclear-weapon States. In 26% (23%) of inspections nuclear material was verified by non-destructive assay (NDA). More than 230 (190) automatic photo and television surveillance systems operated in the field, and 6600 (6000) seals applied to nuclear material were detached and subsequently verified at Headquarters. More than 1150 (870) plutonium and uranium samples were analysed, with about 2980 (1870) analytical results being reported. Accounting and other safeguards data comprising 800 000 (655 000) 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 420 (406), mostly minor, discrepancies or anomalies were found. All cases but one were satisfactorily explained upon subsequent appraisal or investigation; one case is still being investigated;
- (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 funds, manpower and equipment available to the Agency, and on the co-operation of the State and of the facility operators in it;

[10] In the case of voluntary-offer agreements with nuclear-weapon (NW) States nuclear material to which safeguards were applied was not withdrawn from safeguards except in conformity with these agreements.

[11] In these two cases, relating to two nuclear power plants, additional technical safeguards measures were put into effect during the first half of 1983. The measures taken enabled the Agency thereafter to perform effective verification. Full use of the agreed additional equipment at these installations will further improve confidence in safeguards.

- (d) The findings of the Safeguards Implementation Report (SIR) refer for each facility to the latest available State report, Agency inspection, analysis etc. relating to that facility.

Safeguards coverage

306. By the end of 1983, a total of 159 safeguards agreements were in force with 92 States (90 in 1982).

307. During 1983, safeguards agreements concluded pursuant to NPT with the Ivory Coast and Papua New Guinea entered into force, bringing the total number of non-nuclear-weapon States with agreements in force pursuant to NPT and/or the Tlatelolco Treaty to 77.

308. Of the 118 non-nuclear-weapon States party to NPT, 41 have not yet complied with their obligations under Article III.4 of the Treaty regarding the conclusion of the relevant safeguards agreement with the Agency[12]. With the exception of Viet Nam, with which a safeguards agreement pursuant to NPT is under negotiation, none of these States has, as far as the Agency is aware, significant nuclear activities.

309. During 1983, safeguards were actually applied in 39 non-nuclear-weapon States under agreements concluded pursuant to NPT or to NPT and the Tlatelolco Treaty and in one non-nuclear-weapon State pursuant to the Tlatelolco Treaty. In addition, safeguards were applied in three nuclear-weapon States pursuant either to voluntary-offer agreements or to safeguards transfer agreements.

310. Forty safeguards agreements based on INFCIRC/66/Rev.2 were in force with the following ten non-nuclear-weapon States not party to either NPT or the Tlatelolco Treaty: Argentina, Brazil, Chile, Cuba, the Democratic People's Republic of Korea, India, Israel, Pakistan, South Africa and Spain. Safeguards were actually applied pursuant to these agreements in nine of the ten States and also in Viet Nam (see para. 308 above).[13]

311. In six of these States, as in nuclear-weapon States, unsafeguarded facilities of significance for safeguards were known to be in operation or under construction.[14]

312. At the end of 1983, there were 455 facilities under safeguards or containing safeguarded material in non-nuclear-weapon States. In addition, there were 425 locations outside facilities containing small amounts of safeguarded material and one non-nuclear installation. Also, there were nine facilities in nuclear-weapon States where safeguards were being applied (pursuant either to safeguards transfer agreements or to voluntary-offer agreements).

[12] A safeguards agreement pursuant to NPT with Nauru entered into force on 13 April 1984.

[13] The Agency also applies safeguards to nuclear facilities in Taiwan, China.

[14] In one of the six States, Agency safeguards cover all nuclear facilities except a fuel fabrication facility which is under construction. It is expected that, when operational, this facility will handle only safeguarded nuclear material and therefore be covered by Agency safeguards.

313. In 1983, the nuclear material under Agency safeguards, excluding that covered by the voluntary-offer agreements with nuclear-weapon States, amounted to 6.8 t (6 t in 1982) of separated plutonium, 11 t (10 t) of high-enriched uranium (HEU), 92.9 t (83 t) of plutonium contained in irradiated fuel, 18 590 t (16 782 t) of low-enriched uranium (LEU) and 28 000 t (25 000 t) of source material. Non-nuclear material under Agency safeguards included 1307 t of heavy water.

Major activities during 1983

Safeguards implementation

314. Progress was achieved in several areas thanks to an increase in available manpower, improvements in implementation, the use of more sophisticated instruments, better co-ordination in the field and at Headquarters, and better co-operation between States and the Agency. As a result, further to the achievements noted above in para. 305(a) and (b),

- inspection effort (including the application and evaluation of nuclear material accountancy and the application of containment/surveillance (C/S) measures), the number of measurements and the scope of data processing increased considerably,
- the number of major facilities at which inspection goals were fully attained in 1983 for the whole facility increased by about 9% compared with 1982,
- the number of inspections where NDA measurements were performed was more than 20% higher in 1983 than in 1982,
- simultaneous physical inventory verification was performed in one State, covering all major facilities involved in the natural uranium fuel cycle in that State.

Safeguards information treatment

315. A high level of timeliness, quality and user-orientation was maintained in the Agency's treatment of State reports, inspection data and management data. Computerized data processing was routinely used for inspection planning and for inspection reporting, as well as for safeguards evaluation purposes.

316. By the end of 1983, the IAEA Safeguards Information System (ISIS) data base contained approximately 2 900 000 records, compared with about two million at the end of 1982. During the year:

- Software and quality control procedures for the computerized inspection report (CIR) sub-system were developed, tested and used with reports relating to item facilities; preparatory work was done on extending this sub-system to cover reports relating to bulk-handling facilities (BHF's);
- The use of ISIS was further decentralized through the assignment of responsibility for inspection data entry and inspection report checking and production to the Divisions of Operations, under conditions of strict data security;

- In one of the Divisions of Operations, a pilot project was initiated involving the use of two PC-350 microcomputers (one in the field and one at Headquarters), the aim being to increase the quality, quantity and reliability of information exchanged between field locations and Headquarters. Transmissions of telex-type messages from computer to computer were achieved using a commercial teleprocessing network. Work also started on the use of similar technology in linking Headquarters with another field location;
- Advisory services were provided to several countries in the process of computerizing their reporting procedures;
- The Agency continued to seek the full implementation of recommendations made by a group of consultants from Member States concerning reporting procedures, the intention being to provide for greater efficiency and effectiveness in the processing of data on nuclear material in international transit;
- An internal review started of the experience gained with ISIS during its first three years of operation, the aim being to establish short-term and long-term plans for the further development of ISIS;
- A workshop seminar on safeguards data processing was attended by participants from 20 countries and one regional organization.

Safeguards development and technical support

317. During 1983 there was a further increase in the field use of new safeguards equipment and a commensurate increase in the programme for procurement, documentation, maintenance, repair and distribution. Routine services included the provision and verification of seals, photo processing, the analysis of gamma spectrometric data, and arrangements for shipping and for the destructive analysis of inspection samples.

- The first five Surveillance Television and Recording (STAR) systems were installed in November and December, following an extensive assessment of their reliability.
- A computerized system for safeguards equipment inventory control was introduced and initial steps taken for extending the system so as to provide for maintenance management.

318. An instrument performance monitoring and control programme was implemented, the aim being to achieve better performance of instruments under normal field conditions.

319. Field tests of a number of instrument systems developed under Member States' programmes in support of Agency safeguards were conducted:

- a portable analysis unit for plutonium isotopic measurements,
- equipment (ION-1) for the simultaneous measurement of gamma radiation and neutrons from irradiated fuel assemblies,

- special detector heads for high-level neutron coincidence counters (HLNCCs) for carrying out measurements of plutonium in specific chemical and physical forms,
- a calorimeter for the assay of plutonium in bulk form (to be used in the calibration of HLNCCs),
- tracer techniques for calibrating the volumes of accountability tanks, and
- modified Cherenkov glow monitoring devices capable of operating with ambient lighting.

Four bundle counters were installed in two on-load refuelled reactors and put into use.

320. The following instruments and techniques were tested and evaluated at Headquarters:

- two commercially available battery-powered multichannel analyser units controlled by built-in microprocessors,
- reliable film surveillance cameras with increased film capacity, extended light range, and date-time annotation, and
- an improved transportable closed-circuit television system.

321. In the designing of specific safeguards approaches:

- special attention was paid to developing and improving safeguards approaches for sensitive facilities such as reprocessing plants, HEU and MOX fuel fabrication plants and ultracentrifuge uranium enrichment plants. Progress was made in studying the use of advanced safeguards methods such as near-real-time material accountancy at reprocessing plants. Following the recommendation resulting from the Hexapartite Safeguards Project, preparatory work was done on including the "limited-frequency unannounced-access" concept in the safeguards approach for specific enrichment plants,
- the development of safeguards approaches for heavy-water production plants continued.

322. Guidelines for designing nuclear facilities in such a way as to make the application of safeguards easier were developed for four types of nuclear facilities; work on recommendations for other facility types continued.

Safeguards evaluation

323. In the area of data evaluation:

- services were provided to the Divisions of Operations, particularly in connection with the analysis of samples at the Safeguards Analytical Laboratory (SAL) and through the network of analytical laboratories, with inspection data from fuel fabrication plants and reprocessing plants, with the calibration of accountability tanks, and with the preparation and characterization of NDA reference materials,
- work was completed on two manuals, for internal use, describing computer procedures for the evaluation of inspection data from fuel fabrication plants and reprocessing plants,
- data evaluation services were provided to the Division of Development and Technical Support in connection with the testing and calibration of NDA equipment, with the automatic transfer of data from instruments to computers in the field and at Headquarters, with the testing of isotope correlation methods for the verification of reprocessing plant inputs, and with the co-ordination of several Member States' support activities relating to data evaluation methods, and
- evaluation procedures and criteria were reviewed and further developed with regard to inspection goal attainment, sampling plans, inspection reports and inspection statements.

324. Further improvements were made in the review and evaluation of inspection reports and of inspection statements to States pursuant to safeguards agreements based on INFCIRC/153 (Corrected) and on INFCIRC/66/Rev.2.

- 1315 inspection reports and 1402 inspection statements were reviewed using computer-assisted review procedures.
- Quality assurance activities relating to inspection report data on seals and surveillance were extended so as to cover a larger number of inspections.
- Detailed procedures for the internal review of safeguards implementation were worked out and applied in specific cases.

In addition, an algorithm was developed to perform evaluations for the Safeguards Implementation Report (SIR) using computerized inspection report data relating to item facilities.

Support by outside expert groups

325. A number of advisory group and similar meetings took place in 1983.

- The Standing Advisory Group on Safeguards Implementation (SAGSI) held two series of meetings.

- An advisory group considered questions relating to the non-destructive determination of the isotopic contents of plutonium samples.
- An advisory group considered aspects of designing nuclear facilities in such a way as to facilitate the implementation of Agency safeguards.
- An advisory group considered questions connected with evaluating the quality of safeguards analytical measurements.
- Consultant groups considered (1) detailed recommendations for States' systems of accounting for and control of nuclear material (SSACs) at the facility level; (2) safeguards effectiveness assessment methodologies; and (3) closed-circuit television equipment for surveillance purposes.

Co-operation between States and the Agency

326. Continuing co-operation between States and the Agency is exemplified by the following:

- A training course on SSACs was attended by participants from 13 countries;
- Substantial contributions to the safeguards development programme were made by national programmes in support of Agency safeguards. Australia, Belgium, Canada, France, the Federal Republic of Germany, Japan, the Soviet Union, the United Kingdom, the United States of America and the European Community provided support in the framework of formalized support programmes, while other Member States contributed through arrangements such as research and development agreements, contracts and test programmes. A first "support programme co-ordinators' meeting" was held with a view to achieving better co-ordination;
- Committees and other regular forms of contact, including working arrangements with facility operators, continued to make a significant contribution to the solution of problems relating to safeguards implementation.

The Agency's resources

Manpower

327. In 1983 there was an increase of 4.5% in the available inspector (including inspection assistant) man-years; this resulted in an increase of 1.9% in the available man-years of designated inspectors (and inspection assistants) for carrying out inspections at facilities. A total of 6727 man-days of inspection at facilities was produced, representing an increase of 6.7% compared to 1982.

328. Training for new inspectors included two inspection exercises at facilities in Member States. In addition, advanced courses in NDA, inspection procedures and computer data base utilization were provided at Headquarters and in four Member States. One refresher course for experienced inspectors was held, but more emphasis on refresher courses is needed, particularly in the fields of NDA measurements and computer-assisted inspection reporting. The trainee programme for junior professionals began, the first phase being an introductory course at Headquarters.

329. The final stage in the reorganization of the Department of Safeguards was completed, with the establishment of a third Division of Operations and two supporting Divisions.

Equipment

330. The budgetary resources for equipment increased by 150% (from \$1.6 million in 1982 to \$4 million in 1983). This permitted the acquisition of advanced safeguards devices, including HLNCCs with special detector heads, advanced high-resolution gamma spectrometer multichannel analyser systems and advanced closed-circuit television surveillance systems. These devices will be subjected to thorough field testing and evaluation programmes in preparation for their routine use. The benefits resulting from their acquisition, mainly increased safeguards effectiveness, will therefore become apparent only in a few years' time.

Table 2

States having significant nuclear activities
(at the end of the year indicated)

	Number of States		
	1981	1982	1983
NNW States with safeguards applied under NPT and/or Tlatelolco agreements	36	39	40
NNW States with safeguards applied under INFCIRC/66/Rev.2 agreements ^{a/}	12	11	11
Sub-total (NNW States in which safeguards measures were implemented)	48	50	51
NNW States without safeguards agreement in force	1	0	0
Total number of NNW States with significant nuclear activities	49	50	51
NW States party to NPT	3	3	3
Other NW States	2	2	2
Total number of States with significant nuclear activities	54	55	56

^{a/} Some States with INFCIRC/66/Rev.2 agreements which have not yet been suspended, although NPT and/or Tlatelolco agreements have entered into force, are listed as falling under NPT and/or Tlatelolco agreements only.

Table 3

Approximate quantities of material subject to Agency safeguards
except that covered by voluntary-offer agreements with NW States
at the end of 1983

Type of material	Quantity of material (t)		Quantity in SQ
	in NNW States	in NW States ^{a/}	
<u>Nuclear material</u>			
Plutonium ^{b/} contained in irradiated fuel	85.8	7.1	11 600
Separated plutonium	5.3	1.5	850
HEU (equal to or greater than 20% uranium-235)	11.0	0	260
LEU (less than 20% uranium-235)	17 600	990	5 820
Source material ^{c/} (natural or depleted uranium and thorium)	28 000	0	2 270
<u>Total significant quantity</u>			20 800
<u>Non-nuclear material^{d/}</u>			
Heavy water	1 307	0	- ^{e/}

^{a/} Material in facilities in NW States subject to safeguards under safeguards transfer agreements.

^{b/} The quantity includes an estimated 39.7 t (4970 SQ) of plutonium in irradiated fuel, which is not reported to the Agency under the reporting procedures agreed to (the non-reported plutonium is contained in irradiated fuel assemblies to which item accountancy and C/S measures are applied).

^{c/} This table does not include material within the terms of sub-paragraphs 34(a) and (b) of INFCIRC/153 (Corrected) - in essence, yellow cake.

^{d/} Non-nuclear material subject to Agency safeguards under INFCIRC/66/Rev.2-type agreements.

^{e/} "Quantity in SQ" does not apply to non-nuclear material.

Table 4

Installations in NNW States under safeguards or containing
safeguarded material at the end of 1983

Installation category	Number of installations		
	INFCIRC/153 ^{a/}	INFCIRC/66/Rev.2	Total ^{b/}
A. Power reactors	121	26	147 (143)
B. Research reactors and critical assemblies	151	26	177 (177)
C. Conversion plants	5	2	7 (6)
D. Fuel fabrication plants	32	8	40 (39)
E. Reprocessing plants	4	2	6 (6)
F. Enrichment plants	4	0	4 (4)
G. Separate storage facilities	26	2	28 (23)
H. Other facilities	45	1	46 (42)
I. Other locations	398	27	425 (404)
J. Non-nuclear installations	0	1	1 (0)
Totals	786	95	881 (844)

^{a/} Covering safeguards agreements pursuant to NPT and/or Tlatelolco Treaty.

^{b/} Numbers for 1982 are indicated in parentheses for comparison.

Table 5

Situation on 31 December 1983 with respect to the conclusion of safeguards agreements between the Agency and non-nuclear-weapon 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	27 September 1979	In force: 11 June 1982	301
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	24 October 1979		
Central African Republic	25 October 1970		
Chad	10 March 1971		
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 ^{e/}	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	26 February 1981	In force: 30 June 1982	302
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/}	22 September 1970	In force: 1 February 1982	299
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, Islamic Republic of	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	In force: 8 September 1983	309
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
Nauru ^{d/}	7 June 1982		
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		
Papua New Guinea	25 Jan 1982	In force: 13 October 1983	312
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
Solomon Islands	17 June 1981		
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/}			

(1)	(2)	(3)	(4)
Tunisia	26 February 1970		
Turkey	17 April 1980	In force: 1 September 1981	295
Tuvalu	19 January 1979		
Uganda	20 October 1982		
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/}	26 September 1975	In force: 11 March 1982	300
Viet Nam	14 June 1982		
Yemen Arab Republic ^{c/}			
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 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. The Table does not contain information relating to the participation of Taiwan, China in NPT.

b/ The relevant safeguards agreement refers to 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 agreement with Nauru entered into force on 13 April 1984.

Table 6

Agreements providing for safeguards, other than those
in connection with NPT,
approved by the Board as of 31 December 1983

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) <u>Project Agreements</u>			
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, Islamic Republic of ^{b/}	UTRR Reactor	10 May 1967	97
Jamaica ^{b/}	Fuel for research reactor	Approved by Board, Oct. 1983 ^{c/}	
Japan ^{b/}	JRR-3	24 March 1959	3
Malaysia ^{b/} /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
Morocco ^{b/}	Fuel for research reactor	2 December 1983	313
Pakistan	PRR Reactor	5 March 1962	34
	Booster rods for KANUPP	17 June 1968	116
Peru ^{b/}	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
	Experimental fuel elements	1 July 1983	307
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 ^{b/}	RV-1 Reactor	7 November 1975	238
Viet Nam ^{d/}	Fuel for research reactor	1 July 1983	308
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) <u>Unilateral submissions</u>			
Argentina	Atucha Power Reactor Facility	3 October 1972	168
	Nuclear material	23 October 1973	202
	Embalse Power Reactor Facility	6 December 1974	224
	Equipment and nuclear material	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
	Nuclear material	8 July 1982	303
Chile	Nuclear material	31 December 1974	256
	Nuclear material	22 September 1982	304
Cuba	Nuclear research reactor and fuel therefor	25 September 1980	298
	Nuclear power plant and nuclear material	5 May 1980	281
	Zero-power nuclear reactor and fuel therefor	7 October 1983	311
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

Party(ies) ^{a/}	Subject	Entry into force	INFCIRC
<u>(c) Tlatelolco Treaty</u>			
Colombia	All nuclear material	22 December 1982	306
Mexico ^{e/}	All nuclear material, equipment and facilities	6 September 1968	118
Panama ^{f/}	All nuclear material		
<u>(d) Agreements concluded with nuclear-weapon States on the basis of voluntary offers</u>			
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 of America	Nuclear material in facilities designated by the Agency	9 December 1980	288
<u>(e) Other agreements</u>			
Argentina/United States of America		25 July 1969	130
Australia ^{e/} /United States of America		26 September 1966	91
Austria ^{e/} /United States of America		24 January 1970	152
Brazil/Germany, Federal Republic of ^{e/}		26 February 1976	237
Brazil/United States of America		31 October 1968	110
Colombia/United States of America		9 December 1970	144
India/Canada ^{e/}		30 September 1971	211
India/United States of America		27 January 1971	154
Iran, Islamic Republic of ^{e/} /United States of America		20 August 1969	127
Israel/United States of America		4 April 1975	249
Japan ^{e/} /Canada ^{e/}		20 June 1966	85
Japan ^{e/} /France		22 September 1972	171
Japan/United States of America		10 July 1968	119
Japan ^{e/} /United Kingdom		15 October 1968	125
Korea, Republic of/United States of America		5 January 1968	111
Korea, Republic of ^{e/} /France		22 September 1975	233
Pakistan/Canada		17 October 1969	135
Pakistan/France		18 March 1976	239
Philippines ^{e/} /United States of America		19 July 1968	120
Portugal ^{e/} /United States of America ^{g/}		19 July 1969	131
South Africa/United States of America		26 July 1967	98
South Africa/France		5 January 1977	244
Spain/Germany, Federal Republic of ^{e/}		29 September 1982	305
Spain/United States of America		9 December 1966	92
Spain/Canada ^{e/}		10 February 1977	247
Sweden ^{e/} /United States of America		1 March 1972	165
Switzerland ^{e/} /United States of America ^{g/}		28 February 1972	161
Turkey/United States of America		5 June 1969	123
Venezuela ^{e/} /United States of America ^{g/}		27 March 1968	122

(f) The Agency also applies safeguards under two agreements (INFCIRC/133 and INFCIRC/158) to the nuclear facilities in Taiwan, China. Pursuant to the decision adopted by the Board of Governors on 9 December 1971 that the Government of the People's Republic of China is the only government which has the right to represent China in the Agency, the relations between the Agency and the authorities in Taiwan are non-governmental. The agreements are implemented by the Agency on that basis.

^{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/} Agency safeguards are being applied to the items required to be safeguarded under this (these) project agreement(s) pursuant to an agreement in connection with NPT covering the State indicated.

^{c/} Entered into force on 25 January 1984.

^{d/} The requirement for the application of safeguards under this agreement is satisfied by the application of safeguards pursuant to the agreement of 12 June 1981 (INFCIRC/293).

^{e/} 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.

^{f/} Entered into force on 23 March 1984.

^{g/} Application of Agency safeguards under this agreement has been suspended in the United States of America in order to comply with a provision of INFCIRC/288.

Table 7

Facilities under Agency safeguards or containing safeguarded
material on 31 December 1983

A. Power reactors

State ^{a/}	Abbreviated name of installation	Location	Subsidiary arrangements in force
Argentina	Atucha NPS Embalse PR	Lima Embalse	x -b/
Austria	Tullnerfeld	Zwentendorf	x
Belgium	BR3-CEN DOEL-1 DOEL-2 DOEL-3 DOEL-4 SEMO-1 SEMO-2	Mol Doel Doel Doel Doel Tihange Tihange	x x x -b/ -b/ x -b/
Brazil	Angra-1	Angra dos Reis	x
Bulgaria	Kozloduy-I, Unit 1 Kozloduy-I, Unit 2 Kozloduy-II, Unit 1 Kozloduy-II, Unit 2	Kozloduy Kozloduy Kozloduy Kozloduy	x x -b/ -b/
Canada	Bruce A, Unit 1 Bruce A, Unit 2 Bruce A, Unit 3 Bruce A, Unit 4 Bruce B, Unit 2 Douglas Point Gentilly-1 Gentilly-2 NPD G.S. Pickering-1 Pickering-2 Pickering-3 Pickering-4 Pickering-5 Pickering-6 Point Lepreau G.S.	Tiverton Tiverton Tiverton Tiverton Tiverton Tiverton Gentilly Gentilly Rolphoton Pickering Pickering Pickering Pickering Pickering Pickering Point Lepreau	x x x x -b/ x x -b/ x x x x x x x -b/
Czechoslovakia	A1 EDU-1, Unit 1 V-1, Unit 1 V-1, Unit 2 V-2, Unit 1	Bohunice Dukovany Bohunice Bohunice Bohunice	x -b/ x x x
Finland	Loviisa-1 Loviisa-2 TVO-1 TVO-2	Loviisa Loviisa Olkiluoto Olkiluoto	x x x x

State ^{a/}	Abbreviated name of installation	Location	Subsidiary arrangements in force
German Democratic Republic	Bruno Leuschner-I, Unit 1	Greifswald	x
	Bruno Leuschner-I, Unit 2	Greifswald	x
	Bruno Leuschner-II, Unit 1	Greifswald	x
	Bruno Leuschner-II, Unit 2	Greifswald	x
	Rheinsberg PWR	Rheinsberg	x
Germany, Federal Republic of	AVR	Jülich	-b/
	GFK-MZFR	Eggenstein-Leopoldshafen	x
	GKN	Neckarwestheim	x
	KKB	Brunsbüttel	x
	KKG	Grafenrheinfeld	-b/
	KKI	Ohu	x
	KKK	Geesthacht-Krümmel	-b/
	KKS	Stade	x
	KKP-1	Philippsburg	x
	KKU	Stadland	x
	KNK	Eggenstein-Leopoldshafen	x
	KRB	Gundremmingen	x
	KRB II, Block B	Gundremmingen	-b/
	KWL	Lingen	x
	KWW	Würgassen	x
	KWO	Obrigheim	x
	RWE-BIBLIS-A	Biblis	x
	RWE-BIBLIS-B	Biblis	x
	Thorium Hochtemperatur Reactor	Hamm	-b/
	VAK-KAHL	Karlstein-Grosswelzheim	x
Hungary	PAKS-I, Unit 1	Paks	x
India	RAPS Unit 1	Rajasthan	x
	RAPS Unit 2	Rajasthan	x
	TAPS Unit 1	Tarapur	x
	TAPS Unit 2	Tarapur	x
Italy	ENEL	Borgo-Sabatino	x
	ENEL	San Venditto	x
	ENEL	Caorso	x
	FERMI	Trino-Vercellese	x
Japan	Fugen	Tsuruga-Fukui	x
	Fukushima Dai-Ichi-1	Okuma-Fukushima	x
	Fukushima Dai-Ichi-2	Okuma-Fukushima	x
	Fukushima Dai-Ichi-3	Okuma-Fukushima	x
	Fukushima Dai-Ichi-4	Okuma-Fukushima	x
	Fukushima Dai-Ichi-5	Okuma-Fukushima	x
	Fukushima Dai-Ichi-6	Okuma-Fukushima	x
	Fukushima Dai-Ni-1	Naraha-Fukushima	x
	Fukushima Dai-Ni-2	Naraha-Fukushima	-b/
	Genkai-1	Kyushu	x
	Genkai-2	Kyushu	x
	Hamaoka-1	Hamaoka-cho	x
	Hamaoka-2	Hamaoka-cho	x
	Ikata-1	Nishiuwa-gun	x
	Ikata-2	Nishiuwa-gun	x
	JPDR	Tokai-Mura	x

State ^{a/}	Abbreviated name of installation	Location	Subsidiary arrangements in force
Japan (cont'd)	Mihama-1	Mihama-Fukui	x
	Mihama-2	Mihama-Fukui	x
	Mihama-3	Mihama-Fukui	x
	N.S. Mutsu	Minato-Machi Mutsu	x
	Ohi-1	Ohi-cho, Fukai-ken	x
	Ohi-2	Ohi-cho, Fukai-ken	x
	Onugawa-1	Tsukahama	-b/
	Sendai-1	Sendai	-b/
	Shimane	Kashima-cho	x
	Takahama-1	Takahama	x
	Takahama-2	Takahama	x
	Takahama-3	Takahama	-b/
	Tokai-1	Tokai-Mura	x
	Tokai-2	Tokai-Mura	x
	Tsuruga	Tsuruga	x
Korea, Republic of	Kori-1	Pusan	x
	Kori-2	Pusan	x
	Wolsung-1	Ulsan	x
Mexico	Laguna Verde 1	Alto Lucero	-b/
	Laguna Verde 2	Alto Lucero	-b/
Netherlands	GKN	Dodewaard	x
	PZEM	Borssele	x
Pakistan	KANUPP	Karachi	x
South Africa	Koeberg-1	Cape Town	x
	Koeberg-2	Cape Town	x
Spain	Almaraz-1	Almaraz	x
	Almaraz-2	Almaraz	x
	Asco-1	Asco	x
	Asco-2	Asco	x
	Cofrentes	Cofrentes	x
	José Cabrera	Almonazid de Zorita	x
	Lemoniz-1	Lemoniz	x
	Lemoniz-2	Lemoniz	x
	Santa María de Garona	Santa Maria de Garona	x
	Vandellos	Vandellos	-b/
Sweden	Barsebäck I	Malmö	-b/
	Barsebäck II	Malmö	-b/
	Forsmark I	Uppsala	-b/
	Forsmark II	Uppsala	-b/
	Oskarshamn I	Oskarshamn	x
	Oskarshamn II	Oskarshamn	x
	Ringhals I	Göteborg	x
	Ringhals II	Göteborg	x
	Ringhals III	Göteborg	-b/
	Ringhals IV	Göteborg	-b/
Switzerland	KKB-I	Beznau	x
	KKB-II	Beznau	x
	KKG	Gösgen-Däniken	x
	KKL	Leibstadt	-b/
	KKM	Mühleberg	x
United States	Arkansas II	Pope County	-b/
	San Onofre, Unit 2	San Diego County	-b/
Yugoslavia	Krško	Krško	x

B. Research reactors and critical assemblies

State ^{a/}	Abbreviated name of installation	Location	Subsidiary arrangements in force
Argentina	RA-1	Constituyentes	x
	RA-2	Constituyentes	x
	RA-3	Ezeiza	x
	RA-4	Rosario	x
	RA-6	Bariloche	-b/
Australia	HIFAR	Lucas Heights	x
	MOATA	Lucas Heights	x
	CF	Lucas Heights	x
Austria	ASTRA	Seibersdorf	x
	SAR	Graz	x
	Triga II	Vienna	x
Belgium	BRL-CEN	Mol	x
	BR2-CEN	Mol	x
	BRO2	Mol	x
	CEN-Venus	Mol	x
	Thetis	Gent	x
Brazil	IEAR-1	São Paulo	x
	RIEN-1	Rio de Janeiro	x
	Triga-CDTN	Belo Horizonte	x
Bulgaria	IRT-2000	Sofia	x
Canada	McMaster	Hamilton	x
	NRX	Chalk River	x
	NRU	Chalk River	x
	PTR	Chalk River	x
	Slowpoke-AECL	Ottawa	x
	Slowpoke-Dalhousie Univ.	Halifax	-b/
	Slowpoke-Ecole Polytechnique	Montreal	x
	Slowpoke-Saskatchewan	Saskatoon	-b/
	Slowpoke-Toronto University	Toronto	x
	Slowpoke-Univ. of Alberta	Edmonton	-b/
	WR-1	Pinawa	x
	ZED-2	Chalk River	x
Chile	La Reina	Santiago	x
	Lo Aguirre	Santiago	x
Colombia	IAN-R1	Bogotá	x ^{c/}
Czechoslovakia	LR-O	Rez	x
	SR-OB	Vochov	x
	SR-OD	Vochov	x
	VVR-S	Rez	x
Democratic People's Republic of Korea	Critical assembly	Nyonphyon	x
	IRT-DPRK	Nyonphyon	x
Denmark	DR-1	Roskilde	x
	DR-3	Roskilde	x

State ^{a/}	Abbreviated name of installation	Location	Subsidiary arrangements in force
Egypt	Nuclear Research Centre	Inshas	x
Finland	Triga II	Otaniemi	x
German Democratic Republic	RAKE	Rosendorf	x
	RRR	Rosendorf	x
	Training Reactor AKR	Dresden	x
	Training research reactor	Zittau	x
	WWR-S M	Rosendorf	x
Germany, Federal Republic of	FMRB	Braunschweig	x
	FRF-2	Frankfurt	x
	FRM	Garching	x
	GFK-FR-2	Eggenstein-Leopoldshafen	x
	GFK-SNEAK	Eggenstein-Leopoldshafen	x
	GKSS-FRG1	Geesthacht	x
	GKSS-FRG2	Geesthacht	x
	KFA-FRJ1	Jülich	x
	KFA-FRJ2	Jülich	x
	KFA-NEA	Jülich	x
	KWU Hot Cell	Karlstein	x
	SUR 100	Garching	x
	SUR 100	Darmstadt	x
	SUR 100	Stuttgart	x
	SUR 100	Hamburg	x
	SUR 100	Kiel	x
	SUR 100	Ulm	x
	SUR 100	Eggenstein-Leopoldshafen	x
	SUR 100	Bremen	x
	SUR 100	Furtwangen	x
	SUR 100	Aachen	x
	SUR 100	Hannover	x
	Triga	Mainz	x
	Triga II	Heidelberg	x
	Triga	Hannover	x
	Triga	Neuherberg	x
	BER-2	Berlin (West)	x
	SUR 100	Berlin (West)	x
Greece	GRR-1	Attiki	-b/
Hungary	Training reactor	Budapest	x
	WWR-S M	Budapest	x
	ZR-4	Budapest	x
	ZR-6	Budapest	x
Indonesia	Gama	Yogyakarta	x
	PPTN	Bandung	x
Iran, Islamic Republic of	TSPRR	Teheran	x
Iraq	IRT-5000	Baghdad Tuwaitha	x
	Tamuz-2	Baghdad Tuwaitha	-b/

State ^{a/}	Abbreviated name of installation	Location	Subsidiary arrangements in force
Israel	IRR-1	Soreq	x
Italy	AGN-201	Palermo	x
	CESNEF-L54	Milan	x
	ESSOR	Ispra	x
	RANA	Santa Maria di Galeria	x
	RB-1	Montecuccolino	x
	RB-2	Montecuccolino	x
	RB-3	Montecuccolino	x
	RITMO	Santa Maria di Galeria	x
	RTS-1	San Piero a Grado	x
	TAPIRO	Santa Maria di Galeria	x
	Triga-RC1	Santa Maria di Galeria	x
	Triga-2	Pavia	x
Japan	DCA	Oarai-Machi	x
	FCA	Tokai-Mura	x
	HTR	Kawasaki-shi	x
	JMTR	Oarai-Machi	x
	JMTR-CA	Oarai-Machi	x
	JOYO	Oarai-Machi	x
	JRR-2	Tokai-Mura	x
	JRR-3	Tokai-Mura	x
	JRR-4	Tokai-Mura	x
	Kinki University R.R.	Kowake	x
	KUCA	Kumatori-cho	x
	KUCA	Kumatori-cho	x
	KUCA	Kumatori-cho	x
	KUR	Kumatori-cho	x
	Musashi College R.R.	Kawasaki	x
	NSRR	Tokai-Mura	x
	NAIG-CA	Kawasaki-ku	x
	Rikkyo University R.R.	Nagasaka	x
	SHE	Tokai-Mura	x
	TCA	Tokai-Mura	x
	TODAI	Tokai-Mura	x
	TTR	Kawasaki-shi	x
Korea, Republic of	Triga II	Seoul	x
	Triga III	Seoul	x
	Kyung-Hee Univ.	Seoul	x
Libyan Arab Jamahiriya	IRT-TAJURA	Tajura	x
Malaysia	Puspati	Bangi, Selangor	-b/
Mexico	Triga	Ocoyoacac	x
	SUR 100	Mexico City	x
Netherlands	BARN	Wageningen	x
	HOR	Delft	x
	HFR	Petten	x
	LFR	Petten	x

State ^{a/}	Abbreviated name of installation	Location	Subsidiary arrangements in force
Norway	HBWR-Halden	Halden	x
	JEEP-II	Kjeller	x
Pakistan	PARR	Rawalpindi	x
Peru	RP-O	Lima	x
Philippines	PRR-1	Diliman, Quezon City	x
Poland	Agata	Świerk	x
	Anna	Świerk	x
	Ewa	Świerk	x
	Maria	Świerk	x
	Maryla	Świerk	x
Portugal	RPI	Sacavem	x
Romania	RP-01	Margurele	x
	Triga II	Pitesti-Colibasi	x
	VVR-S	Margurele	x
South Africa	SAFARI-1	Pelindaba	x
Spain	ARBI	Bilbao	x
	ARGOS	Barcelona	x
	CORAL-1	Madrid	x
	JEN-1 and JEN-2	Madrid	x
Sweden	R2	Studsvik	x
	R2-O	Studsvik	x
	RO	Studsvik	x
Switzerland	AGN 201P	Geneva	x
	AGN 211P	Basel	x
	Crocus	Lausanne	x
	Proteus	Würenlingen	x
	Saphir	Würenlingen	x
Thailand	TRR-1	Bangkok	x
Turkey	TR-1	Istanbul	x
	ITU-TRR	Istanbul	x
Uruguay	Lockheed	Montevideo	x
Venezuela	RV-I	Altos de Pipe	-b/
Viet Nam	Da-Lat	Da Lat	-b/
Yugoslavia	RA	Vinča	x
	RB	Vinča	x
	Triga II	Ljubljana	x
Zaire	Triga-Zaire	Kinshasa	x

C. Conversion plants, including pilot plants with an annual throughput or inventory exceeding one effective kilogram

State ^{a/}	Abbreviated name of installation	Location	Subsidiary arrangements in force
Argentina	UO ₂ Conversion Plant	Cordoba	<u>-b/</u>
Canada	ENL	Port Hope	x
	ENL	Port Hope	x
Japan	Japan Nuclear Fuel Conversion Co. Ltd.	Tokai-Mura	x
	PNC Pilot Conversion Plant	Ningyo	<u>-b/</u>
	PCDF	Tokai-Mura	<u>-b/</u>

D. Fuel fabrication plants, including pilot plants with an annual throughput or inventory exceeding one effective kilogram

State ^{a/}	Abbreviated name of installation	Location	Subsidiary arrangements in force
Argentina	Atucha Fuel Fabrication Plant	Ezeiza	-b/
	Fuel Fabrication Plant (CANDU)	Ezeiza	-b/
	Pilot Fuel Fabrication Plant (HEU)	Constituyentes	x
Belgium	Belgonucléaire-BN-MOX	Dessel	x
	FBFC	Dessel	x
Brazil	Fuel Fabrication Plant Resende	Resende	-b/
Canada	OGE	Peterborough	x
	OGE	Toronto	x
	Combustion Engineering	Moncton	x
	CRNL Metallurgy	Chalk River	x
	CRNL Workshop	Chalk River	x
	CRNL Workshops	Chalk River	x
	ENL	Port Hope	x
	Noranda Metal	Montreal	x
	WCL	Varennes	x
Denmark	WCL	Port Hope	x
	Metallurgy	Roskilde	x
Germany, Federal Republic of	ALKEM	Wolfgang	-b/
	Exxon	Lingen	x
	NUKEM	Wolfgang	x
	RBU-1	Wolfgang	x
	RBU-2	Karlstein	x
India	NFC	Hyderabad	x
Iraq	ERLFF	Baghdad Tuwaitha	-b/
Italy	Comb. Nuc.	Policoro	x
	COREN	Saluggia	x
	Fabnuc	Bosco Marengo	x
	IFEC	Saluggia	x
Japan	JNF	Yokosuka	x
	MNF	Tokai-Mura	x
	NFI (Kumatori-1)	Kumatori, Osaka	x
	NFI (Kumatori-2)	Kumatori, Osaka	x
	NFI (Tokai) Fuel Fabrication	Tokai-Mura	x
	NFI (Takayama-R&D)	Takayama	x
	PPFF	Tokai-Mura	x
Korea, Republic of	Fuel Fabrication Pilot Plant	Daejeon	x
Spain	Planta Metall. Juan Vigon Res. C.	Madrid	x
Sweden	ASEA - ATOM	Västeras	x
United States	Combustion Engineering Fuel Fab. Plant	Windsor, Conn.	-b/

E. Chemical reprocessing plants including pilot plants with an annual throughput or inventory exceeding one effective kilogram

State ^{a/}	Abbreviated name of installation	Location	Subsidiary arrangements in force
Germany, Federal Republic of	WAK	Eggenstein-Leopoldshafen	x
India	PREFRE	Tarapur	x
Italy	EUREX	Saluggia	x
	ITREC-Trisaia	Rotondella	x
Japan	Tokai Reprocessing Plant	Tokai-Mura	x
Spain	Juan Vigon Research Centre	Madrid	x

F. Enrichment plants, including pilot plants with an annual throughput or inventory exceeding one effective kilogram

State ^{a/}	Abbreviated name of installation	Location	Subsidiary arrangements in force
Germany, Federal Republic of	Uranit*	Jülich	-b/
Japan	PNC Pilot Enrichment Plant	Ningyo	-b/
Netherlands	URENCO	Almelo	-b/
	Ultra-Centrifuge*	Almelo	-b/
United States	Portsmouth Gas Centrifuge Enrich. Pl.	Portsmouth	-b/

* Location associated with enrichment technology.

G. Separate storage facilities

State ^{a/}	Abbreviated name of installation	Location	Subsidiary arrangements in force
Argentina	Storage of 20% enriched uranium	Cac	-b/
Belgium	BN UF ₆ store Eurochemic	Dessel Mol	-b/ x
Canada	Bruce A Bruce B CRNL Pickering WNRE	Tiverton Tiverton Chalk River Pickering Pinawa	x -b/ x x x
Czechoslovakia	Al	Bohunice	x
Denmark	Risø Store	Roskilde	x
France	COGEMA Storage Pond COGEMA Pu and U Storage	La Hague La Hague	x x
Germany, Federal Republic of	Braunkohle Bundeslager Brennelementlager Exxon Nuclear UF ₆ Lager Lageranlage für abgereichertes Uran KFA Jülich RBU Lageranlage Transnuklear Transnuklear GmbH Urananlage	Wesseling Wolfgang Gorleben Lingen Kalkar Jülich Karlstein Landesbergen-Leese Wolfgang Birkenfeld	x -b/ -b/ -b/ -b/ -b/ -b/ -b/ -b/ -b/ x
Iraq	Separate storage facility	Baghdad Tuwaitha	-b/
Italy	AGIP Avogadro Ispra Central Storage	Bosco Marengo Saluggia Ispra	x -b/ x
Japan	KUFFS	Kyoto	-b/
Pakistan	Storage at Government depot	Karachi Malir	x
Portugal	Instalacao de Armazenagens	Sacavem	x
Switzerland	Diorit Storage	Würenlingen	x
United Kingdom	Sellafield Pu-storage Sellafield Storage Pond	Sellafield Sellafield	x x
United States	CP-5 Research Reactor facility	Argonne	x

H. Other facilities

State ^{a/}	Abbreviated name of installation	Location	Subsidiary arrangements in force
Australia	Research Laboratory	Lucas Heights	x
Belgium	BCMN	Geel	x
	BN	Mol	<u>-b/</u>
	CEN-Labo	Mol	x
	PULAB	Mol	x
Canada	CRNL Chemistry	Chalk River	x
	CRNL Fuel Engineering	Chalk River	x
	CRNL Health Science	Chalk River	x
	CRNL Physics	Chalk River	x
	CRNL Workshops	Chalk River	x
	WNRE	Pinawa	x
Czechoslovakia	Nuclear Fuel Inst. (UJB)	Zbraclau	x
	Research Laboratories	Rez	x
Denmark	Hotcell Plant	Roskilde	x
German Democratic Republic	Uran Technikum	Rosendorf	<u>-b/</u>
Germany, Federal Republic of	KFK-heisse Zellen	Eggenstein-Leopoldshafen	x
	KFK/IHCH	Eggenstein-Leopoldshafen	x
	KFK/IMF3	Eggenstein-Leopoldshafen	x
	KFA-Lab	Jülich	<u>-b/</u>
	KFA-heisse Zellen	Jülich	<u>-b/</u>
	Transuran	Eggenstein-Leopoldshafen	x
Hungary	Institute of Isotopes	Budapest	x
Italy	CNEN-LAB. TEC.	Santa Maria di Galeria	x
	CNEN-LAB.PU.	Santa Maria di Galeria	x
	Joint Research Centre	Ispra	<u>-b/</u>
Japan	JAERI-Oarai R&D	Oarai-Machi	x
	JAERI-Tokai R&D	Tokai-Mura	x
	MAPI Ohmiya	Ohmiya	x
	NERL, University of Tokyo	Tokai-Mura	x
	NFD	Oarai-Machi	x
	NFI Tokai II	Tokai-Mura	<u>-b/</u>
	NRF Neutron Radiation Facility	Sakura-Mura	x
	PNC Tokai R&D	Tokai-Mura	x
	PNC-Oarai R&D	Oarai-Machi	x
Korea, Republic of	PIEF	Daejeon	<u>-b/</u>
Netherlands	ECN+JRC	Petten	x
	Kema Lab.	Arnhem	x
	ZWO-Lab-Iso	Amsterdam	<u>-b/</u>
Norway	Research laboratories	Kjeller	x
Poland	Institute of Nuclear Research	Świerk	x
	Miscellaneous locations combined in one material balance area	Various	x
Romania	Demfuel	Pitesti-Colibasi	x

State ^{a/}	Abbreviated name of installation	Location	Subsidiary arrangements in force
Sweden	Central storage fresh fuel	Studsvik	x
	Central Hot Laboratory	Studsvik	x
Switzerland	Fed. Inst. of Reactor Research	Würenlingen	x

J. Non-Nuclear Installations

State ^{a/}	Abbreviated name of installation	Location	Subsidiary arrangements in force
Argentina	Heavy water plant	Arroyito	- <u>b/</u>

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/ Under negotiation.

c/ Concluded pursuant to the Colombia/United States of America/Agency safeguards agreement (INFCIRC/144).

Note: The Agency also was applying safeguards in Taiwan, China at six power reactors, six research reactors/critical assemblies, one uranium pilot conversion plant, two fuel fabrication plants and one research and development facility.

General

331. The information services provided by the Agency continued to expand in response to demand from Member States. The use of computer techniques made it possible to cope with the expansion and to improve the quality and efficiency of the services provided.

Scientific journals

332. Twelve regular issues of "Nuclear Fusion" were published, the articles and papers in them involving (as authors and/or referees) scientists from more than 100 laboratories in 28 Member States.

333. Within the framework of a "Fusion Vocabulary Control Project" which is being conducted at three levels (i) fusion thesaurus, (ii) subject classification covering the whole nuclear fusion field and (iii) index of scientists' fields of interest - and which entails computerization of many of the operations involved in producing "Nuclear Fusion", a draft version of the fusion thesaurus was produced, the electronic data processing needs of "Nuclear Fusion" were defined, a computer model was developed and an experiment for testing the concept was started.

334. Special Issue No. 9 of the "Atomic Energy Review" series entitled "Thermodynamics of nuclear elements and their components and alloys" was published; it deals with titanium and was the last of the series. In addition, a cumulative index listing and cross-referencing the 464 articles and reports which were published under the "Atomic Energy Review" symbol during the journal's lifetime (1963-83) was issued.

International Nuclear Information System (INIS)

335. INIS is operated by the Agency in collaboration with 72 Member States and 14 international organizations. Its purpose is to provide, using modern computer and micrographic techniques, a comprehensive nuclear information announcement and abstracting service. The collection of input and the dissemination of output are completely decentralized. In 1983, the input to the data base exceeded 92 000 documents, an increase of 20 000 documents over 1982. The size of the data base had risen to 807 000 records by the end of the year.

336. The fourth meeting of the Advisory Committee for INIS was held in Vienna in January and the annual consultative meeting of INIS liaison officers was held in Paris during May. Sixty persons from countries and international organizations participating in INIS attended a one-week INIS training seminar in November.

337. Major changes were introduced into the INIS subject category scheme and the terminology used for indexing alloys was overhauled.

338. Revisions of five volumes in the INIS Reference Series were issued: "Authority List for Corporate Entries and Report Number Prefixes", "Authority List for Journal Titles", "Subject Categories and Scope Descriptions", "Manual for On-Line Retrieval", and "INIS: Thesaurus". Four volumes of the "Multilingual Dictionary" were published, providing access to the indexing terminology of the Thesaurus in English, French, German and Russian. The "INIS Input Training Kit" was put on sale as a self-teaching tool for the staff of INIS input centres in Member States.

339. The INIS Clearinghouse distributed a record number (599 000) of microfiches, partly as a result of two orders for a complete backfile of fiches; the income from the Clearinghouse's operations was correspondingly high. New computer software was made available to the Clearinghouse to assist in managing the large inventory of microfiches and to keep track of shipments and billings.

340. Thirty Member States used the remote on-line access to the INIS and AGRIS data bases during 1983, the income from users being approximately equal to the marginal cost of providing this service. A special small file for training was made available to users at a reduced cost.

Table 8

INIS Statistics

	<u>1982</u>	<u>1983</u>
Number of records added to the data base	72 690	92 216
Number of microfiches distributed	406 000	599 000
Number of full microfiche subscriptions	33	37
Number of participating Member States	67	70
Number of participating international organizations	14	14
Direct access usage (connect hours)	1 650	1 747

Computer services

341. Overall computer usage at the Vienna International Centre increased by 28%, confirming projections made at the time the new computer was purchased.

342. An additional 30 word-processing stations were installed and more than 300 staff members were trained to use the equipment, two-thirds of them at an advanced level. The total number of staff members attending courses conducted by the Computer Section in 1983 exceeded 800.

343. A pilot project on the use of microcomputers was established, the aim being to provide information needed for formulating an Agency-wide policy on their use by mid-1984. Microcomputers were located in seven areas in order to determine their possible impact on various kinds of office work.

344. A major effort was invested in software development for the INIS and Power Reactor Information System (PRIS) data bases.

Library services

345. During 1983 the Library commenced a period of rationalization and consolidation following the physical reorganization in 1982. Some 3650 volumes were added to the book collection, with a number of generous donations from Member States through their Permanent Missions. The journal collection has stabilized at about 3430 current titles. The Library dealt with 8526 reference questions, and 13 115 books and 328 films were borrowed.

346. Considerable effort was expended on further development of the Library's computer systems. A detailed register of outstanding tasks was prepared, and these tasks are being undertaken as resources permit.

Publishing and printing services

347. In 1983, some 156 separate books or journal issues were published. The net income to the Agency from the sale of Agency publications (including INIS and CINDA publications and microfiches) was \$1.06 million, compared with \$1.12 million in 1982 and \$1.13 million in 1981.

348. The printing services continued to meet the documentation and publications needs of the Agency, the United Nations and UNIDO.

349. The output in terms of printed pages was 271 million, compared with 236 million in 1982 and 209 million in 1981. Approximately 50% of it was for organizations other than the Agency; the corresponding figures for 1981 and 1982 were 36% and 43% respectively. The income for services provided to other organizations was \$1.37 million, compared with \$1.19 million in 1982 and \$926 885 in 1981.

Legal Affairs

Advisory services

350. Advisory services were provided to the Government of Morocco in connection with legislation for radiation protection and for the control of nuclear installations.

351. Advice and assistance were provided to the Government of Tunisia in connection with the framing of radiation protection regulations.

Seminar on nuclear law

352. An interregional seminar on nuclear law and safety regulations was organized in Morocco in co-operation with the Ministry of Energy and Mines and the National Electricity Board of Morocco. The purpose of the seminar was to provide an overview of the major areas of nuclear regulation and to discuss both the elaboration and the implementation of legislation. More than 100 participants - from Algeria, Morocco and Tunisia - took part in the seminar. Lectures were presented by Agency staff members and by experts from France, Spain and NEA. The lectures and discussions covered nuclear safety, radiation and environmental protection, functions of a nuclear regulatory body, licensing requirements, site selection and environmental impact assessment, national systems of materials control, and nuclear third-party liability and insurance. Emphasis was placed on the regulatory steps required in the planning and implementation of a nuclear power programme.

Physical protection

353. By the end of 1983, 36 States and one regional organization had signed the Convention on the Physical Protection of Nuclear Material[15] and eight States had ratified it. The Convention requires 21 ratifications for its entry into force.

Fuel supply arrangements

354. In February the Agency and the Governments of the United States of America and Yugoslavia concluded an agreement for the transfer of approximately 20 200 grams of uranium of United States origin, enriched to

[15] Reproduced in document INFCIRC/274/Rev.1. There was one ratification in 1983.

less than 20%, for use in the operation of the TRIGA Mark II research reactor at the Jozef Stefan Institute in Ljubljana, Yugoslavia[16]. The material in question was donated in the form of fuel elements by the Federal Republic of Germany.

355. Agreements for the supply of enriched uranium by the Agency to the Governments of Romania and Viet Nam were concluded in July[17]. These were the first cases where enriched uranium was provided by the Government of the Union of Soviet Socialist Republics under the Agency's technical co-operation programme. Five kilograms of uranium dioxide powder containing 4.5 kilograms of 20%-enriched uranium were supplied to Romania for the fabrication of experimental fuel elements for use in irradiation tests in a TRIGA research reactor and in post-irradiation studies at the Institute of Nuclear Power Reactors, Pitesti. In the case of Viet Nam, 3.6 kilograms of 36%-enriched uranium were supplied for the operation of a TRIGA-type research reactor which was being reconstructed and upgraded at the Nuclear Research Institute, Da Lat.

356. In December an agreement was concluded between the Agency and the Governments of Morocco and the United States of America[18] concerning the transfer of about 12 896 grams of uranium enriched to less than 20% for use as fuel in a TRIGA Mark I research reactor which was to be installed at and operated by the National School for the Mineral Industry, Rabat, and used for training and research.

357. In October the Board of Governors approved an agreement between the Agency and the Governments of Canada, Jamaica and the United States of America for the transfer from Canada to Jamaica, through the Agency, of approximately 906 grams of 93%-enriched uranium of United States origin, contained in fuel elements, and of approximately one gram of the same material contained in metal foils. The materials were for the operation of a low-power critical-experiment reactor supplied by Canada to Jamaica. The reactor has been installed at the Centre for Nuclear Sciences of the University of the West Indies in Kingston, Jamaica, for training and research purposes.

Guidelines for emergency assistance arrangements

358. A group of experts met, in April, to consider terms and conditions which could be applied to emergency assistance and could -

- (a) serve as a model for the negotiation of bilateral or regional agreements, and
- (b) be readily agreed between a requesting State and an assisting party at the time of a nuclear emergency.

The group recommended a set of "Guidelines for Mutual Emergency Assistance Arrangements in Connection with a Nuclear Accident or Radiological Emergency", together with a technical annex which provides information on the nature and extent of the assistance which might be required.[19]

[16] The agreement was concluded in connection with the Fourth Supply Agreement of 1980, reproduced in document INFCIRC/32/Add.4, part I.

[17] Reproduced in documents INFCIRC/307 and INFCIRC/308 respectively.

[18] Reproduced in document INFCIRC/313.

[19] Reproduced in document INFCIRC/310.

Privileges and immunities

359. By the end of 1983, 54 Member States were parties to the Agreement on the Privileges and Immunities of the Agency.[20]

Financial resources

360. The Regular Budget total for 1983 was \$91 561 000, of which \$81 036 000 was to be financed from contributions made by Member States on the basis of the 1983 scale of assessment, \$3 490 000 from income from work for others and \$7 035 000 from other miscellaneous income.

361. The appropriation Sections were based on a rate of exchange of 16.60 Austrian schillings to the United States dollar. Throughout 1983, however, the mean United States operational rate of exchange was AS 17.67, resulting in a reduction of the estimated requirements by \$3 412 000.

362. The actual obligations in 1983 amounted to \$84 170 637, resulting in an unobligated balance of \$7 390 363, of which \$3 412 000 was due to currency exchange rate fluctuations. The total provisional budgetary surplus, including additional and special income and savings on the liquidation of prior years' obligations, amounted to \$8 964 070, compared with \$10 455 606 in 1982.

363. The target for voluntary contributions to the Technical Assistance and Co-operation Fund in 1983 was established at \$19 million. At the end of the year, \$17 615 572 had been pledged by Member States in support of the technical assistance programme. Actual obligations incurred during 1983 amounted to \$17 125 187.

364. A total of \$11 337 896 was received as special contributions from Member States during 1983. Of this amount, \$6 764 400 was for technical assistance projects, \$3 302 763 was in support of safeguards, \$578 333 was for projects in the field of food and agriculture, and \$346 000 was in support of RCA. The remaining \$346 400 was in support of various other projects implemented by the Agency.

General Services

365. Services were provided partly within the framework of VIC Common Services and partly for the Agency's Secretariat alone.

366. Communications services were improved and the management of records was adapted to the use of advanced techniques.

367. Procurements financed from the Agency's Regular Budget amounted to over \$9 million.

368. Assistance in finding housing was provided to nearly 3600 persons; 416 lease contracts were concluded - 376 for staff members of the international organizations based at the VIC and 40 for Mission members.

369. The Commissary served approximately 6000 households, total sales amounting to nearly AS 230 million.

[20] Reproduced in document INFCIRC/9/Rev.2.

Personnel

370. In 1983, 213 staff members left the Agency and 251 were appointed. Of the new staff members, 111 were in the Professional and higher categories.

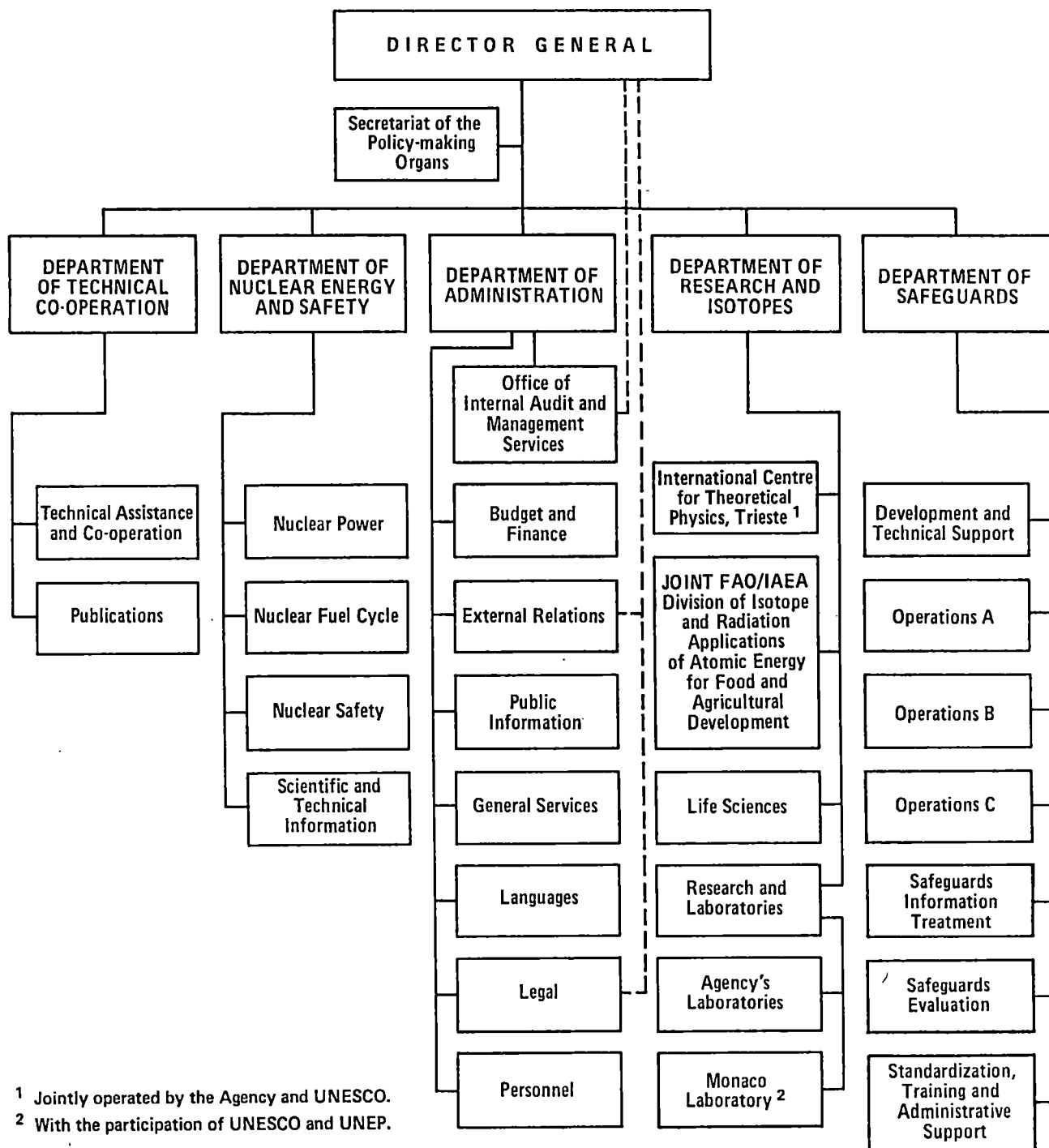
371. At the end of 1983, the Secretariat had 1756 staff members - 619 in the Professional and higher categories, 1002 in the General Service category and 135 in the Maintenance and Operatives Service category[21].

372. Among the staff in posts subject to geographical distribution, 74 nationalities were represented.

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

[21] These figures represent: filled manning-table posts (1402); staff charged to manning-table posts (107), to temporary assistance funds (95) and to consultancy funds (3); and staff serving on a reimbursement basis (135) and on secondment (14).

ORGANIZATIONAL CHART



¹ Jointly operated by the Agency and UNESCO.

² With the participation of UNESCO and UNEP.